

INDIANA

DEPARTMENT OF TRANSPORTATION

STANDARD SPECIFICATIONS

2022

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GOVERNOR

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DEPARTMENT OF TRANSPORTATION

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MEASUREMENTS

The first two paragraphs of 109.01, Measurement of Quantities reads as follows:

(a) General Requirements

All measurements of work completed under the contract will be according to the English System unless otherwise specified.

The standard measures shown in this publication are primarily in the English System of Units such as feet and inches, pounds, gallons, and acres. Any metric equivalents, shown in parentheses, are intended only for those contracts in which they are specified, or to maintain consistency with industry standards. No guarantee is provided, explicit or implicit, that the units are accurate conversions.

The following table and general notes are provided to assist you in becoming familiar with the metric system.

SI UNITS AND CONVERSION FACTORS

MEASUREMENT	ENGLISH UNIT	ENGLISH UNIT SYMBOL	MULTIPLIER FOR CONVERSION FROM ENGLISH UNIT TO SI UNIT (*)	SI UNIT	SI SYMBOL
Acceleration	foot per second squared	ft/sec ²	0.304 8 exactly	meter per second squared	m/s ²
	mile per hour squared	mi/h ²	1.060 93	kilometer per hour squared	km/h ²
Area	square inch	sq in	645.16 exactly	square millimeter	mm ²
	square foot	sq ft	0.092 9	square meter	m ²
	square yard	sq yd	0.836 1	square meter	m ²
	acre	ac	0.404 7	hectare	ha
	square mile	sq mi	2.59	square kilometer	km ²
Density	pound per cubic foot	lb/cu ft	16.018 46	kilogram per cubic meter	kg/cu m
Energy	foot-pound force	ft lbf	1.355 8	joule	J
	kilowatt hour	kW h	3 600 000. exactly	joule	J
Force/Weight (Gravity of Force)	pound force	lbf	4.448 2	newton	N
	kilopound force	kip	4.448 2	kilonewton	kN
	ton	t	8.896 4	kilonewton	kN
Length	inch	in.	25.4 exactly	millimeter	mm
	foot	ft	0.304 8 exactly	meter	m
	yard	yd	0.914 4 exactly	meter	m
	mile	mi	1.609 3	kilometer	km
Mass	ounce	oz	28.349 5	gram	g
	pound mass	lbm	0.453 6	kilogram	kg
	ton mass	t	0.907 2	megagram	Mg
Power	horsepower (550 ft·lbf/s)	hp	745.669 9	watt	W
Pressure/Stress	pound per square inch	lb/sq in	6.894 8	kilopascal	kPa
	pound per square foot	lb/sq ft	0.047 88	kilopascal	kPa
	kilopound per square inch	kip/sq in	6.894 8	megapascal	MPa
Speed/Velocity	foot per second	ft/s	0.304 8 exactly	meter per second	m/s
	mile per hour	mph	1.609 3	kilometer per hour	km/h

Temperature	degree Fahrenheit	°F	(°F -32)/1.8(**) exactly	degree Celsius	°C
Volume, Fluid	cubic inch	cu in	16.387 1	milliliter	mL
	fluid ounce	fl oz	29.573 4	milliliter	mL
	gallon	gal.	3.785 4	liter	L
	1000 gallons	kGAL.	3.785 4	kiloliter	kL
Volume, Solid	cubic inch	cu in	16.387.06 exactly	cubic millimeter	mm ³
	cubic foot	cu ft	0.028 32	cubic meter	m ³
	bushel	bu	0.035 24	cubic meter	m ³
	cubic yard	cu yd	0.764 6	cubic meter	m ³
	1000 feet board measure	MFBM	2.359 7	cubic meter	m ³

(*) Conversion from SI unit to English unit may be made by dividing the SI unit by the conversion factor shown in this column.

(**) This is a formula, and not a multiplier. The Fahrenheit temperature is substituted for °F in the formula to attain the Celsius temperature. Conversion from Celsius temperature to Fahrenheit temperature may be made by substituting the Celsius temperature for °C in the formula $(1.8 \times \text{°C}) + 32$. This is an exact conversion.

14.

Angles will continue to be measured in degrees, minutes, and seconds instead of radians.

GENERAL NOTES

1. The SI unit of millimeter shall be used to convert inches to millimeters.
2. The SI unit of Mass is the Kilogram (Kg) which shall be used for smaller masses expressed in pounds. The megagram (Mg) shall be used for larger masses expressed in tons.
3. All units peculiar to the various cgs systems (measurement systems constructed by using the centimeter, gram and second as base units) shall be avoided.
4. In commercial and everyday use, the term weight nearly always means mass; thus, when one speaks of a person's weight, the quantity referred to is mass. In Science and Technology, the term weight of a body has usually meant the force that, if applied to the body, would give it an acceleration equal to the local acceleration of free fall g (acceleration of gravity). When the term is used, it is important to know whether mass or force is intended and to use SI Units properly, by using Kilograms for Mass or Newtons for Force. The use of force of gravity (mass times acceleration of gravity) instead of weight with this meaning is recommended. Because of the dual use of the term weight as a quantity, this term shall be avoided in technical practice except under circumstances in which its meaning is completely clear.
5. The term load means either mass or force, depending on its use. A load that produces a vertically downward force because of the influence of gravity acting on a mass may be expressed in mass units. Any other load is expressed in force units.
6. A quantity stated as limits, such as "not more than" or "maximum", shall be handled so that the stated limit is not violated.
7. Conversion of quantities shall be handled with careful regard to the implied correspondence between the accuracy of the data and the given number of digits. In all conversions, the number of significant digits retained shall be such that accuracy is neither sacrificed nor exaggerated. For example, a length of 125 ft converts exactly to 38.1 m. If however, the 125 ft length has been obtained by rounding to the nearest 5 ft, the conversion shall be given as 38 m. The proper conversion procedure is to multiply a value by a conversion factor that is more accurate than is required, the result is then rounded to the appropriate number of significant digits.
8. For calculation of results, avoid rounding of intermediate quantities. For reporting results, the rule for addition and subtraction is that the answer shall contain no significant digits farther to the right than occur in the least precise number. The rule for multiplication and division is that the product or quotient shall contain no

more significant digits than are contained in the number with the fewest significant digits used in the multiplication.

9. When a figure is to be rounded to fewer digits than the total number available, the standard “5” up procedures shall be used as follows:
 - (a) When the first digit discarded is less than 5, the last digit retained shall not be changed. For example, 3.46325, if rounded to three digits, would be 3.463; if rounded to two digits, would be 3.46.
 - (b) When the first digit discarded is 5 or greater, the last digit retained shall be increased by one unit. For example, 8.37652, if rounded to three digits, would be 8.377; if rounded to two digits would be 8.38.
10. Refer to ASTM SI10 American National Standard for Use of the International System of Units (SI) for other conversion factors.
11. This specification book uses the word “shall” to describe the Contractor’s responsibilities. The word “will” is used to describe the Department’s responsibilities. The words “shall” and “will” are not required to be followed by the words “by the Contractor” or “by the Department” to retain these meanings.

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DIVISION 100 – GENERAL PROVISIONS

SECTION 101 – DEFINITIONS AND TERMS

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows.

101.01 Abbreviations

Wherever the following abbreviations are used in these specifications, the Proposal book, or on the plans, they are to be construed the same as the respective expressions represented.

	AAR	Association of American Railroads
	AASHTO	American Association of State Highway and Transportation Officials
	ACBF	air-cooled blast furnace slag
	ACI	American Concrete Institute
	AE	asphalt emulsion
	AIA	American Institute of Architects
	AMRL	AASHTO Materials Reference Laboratory
20	AMS	Aerospace Material Specifications
	ANSI	American National Standards Institute
	APS	accessible pedestrian signal
	ARA	American Railway Association
	AREA	American Railway Engineering Association
	ASCE	American Society of Civil Engineers
	ASLA	American Society of Landscape Architects
	ASNS	American Standards for Nursery Stock
	ASTM	American Society for Testing and Materials
	ATSSA	American Traffic Safety Services Association
30	AWPA	American Wood Protection Association
	AWS	American Welding Society
	AWWA	American Water Works Association
	BBR	bending beam rheometer
	BF	blast furnace slag
	BMP	best management practice
	CAPP	Certified Aggregate Producer Program
	CAPWAP	Case Pile Wave Analysis Program
	CCPR	Cold Central Plant Recycling
40	CCRL	Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology
	CESSWI	Certified Erosion Sediment and Stormwater Inspector
	CFR	Code of Federal Regulations
	CIR	Cold In-Place Recycling

	CISEC	Certified Inspector of Sediment and Erosion Control
	CPESC	Certified Professional in Erosion and Sediment Control
	CMA	cold mix asphalt
	CMD	concrete mix design
	COE	Corps of Engineers (US Army)
	CWI	Certified Welding Inspector
50	DBE	disadvantaged business enterprise
	DCP	Dynamic Cone Penetrometer
	DMF	design mix formula
	DSR	dynamic shear rheometer
	DTE	District Testing Engineer
	EPA	Environmental Protection Agency
	ESAL	equivalent single-axle loads
	FDR	Full Depth Reclamation
	FHWA	Federal Highway Administration, Department of Transportation
60	FSS	Federal Specifications and Standards, General Services Administration
	GBF	granulated blast furnace slag
	GGBFS	ground granulated blast furnace slag
	HDB	hydrostatic design basis
	HDPE	high density polyethylene
	HFRS	high float seal coat asphalt emulsion
	HMA	hot mix asphalt
	HRWR	high range water reducing
	HRWRR	high range water reducing and retarding
70	IAC	Indiana Administrative Code
	IC	Indiana Code
	IDEM	Indiana Department of Environmental Management
	IDNR	Indiana Department of Natural Resources
	IEEE	Institute of Electrical and Electronics Engineers
	IMSA	International Municipal Signal Association
	IOSHA	Indiana Occupational Safety and Health Administration
	INDOT	Indiana Department of Transportation
	ISO	International Organization for Standardization
	ITM	Indiana Test Method or Procedure
80	IVOSB	Indiana Veteran Owned Small Business
	JITT	Just-in-Time Training
	JMF	job mix formula
	JRCP	jointed reinforced concrete pavement
	LRFD	Load and Resistance Factor Design
	LWD	Light Weight Deflectometer
	MAF	mixture adjustment factor
	MC	medium curing asphalt
	MCA	medium curing asphalt with additive
	MSE	mechanically stabilized earth

90	MSG	maximum specific gravity
	MUTCD	Manual on Uniform Traffic Control Devices
	MWBE	Minority and Women's Business Enterprises
	NACE	National Association of Corrosion Engineers
	NCHRP	National Cooperative Highway Research Program
	NEMA	National Electrical Manufacturers Association
	NHS	National Highway System
	NIST	National Institute of Standards and Technology
	NOI	Notice of Intent
	NOS	Notice of Sufficiency
100	NOT	Notice of Termination
	NPDES	National Pollutant Discharge Elimination System
	NTPEP	National Transportation Product Evaluation Program
	OG	open graded
	OHWM	Ordinary High Water Mark
	OSHA	U.S. Occupational Safety and Health Administration
	PAV	pressurized aging vessel
	PCC	portland cement concrete
	PCCP	portland cement concrete pavement
	PDA	pile driving analysis
110	PG	performance grade asphalt
	POTW	Publicly Owned Treatment Works
	PVC	polyvinyl chloride
	QC	quality control
	QC/QA	quality control/quality assurance
	QCP	quality control plan
	QPL	qualified products list
	RAS	reclaimed asphalt shingles
	RAP	reclaimed asphalt pavement
	RBC	reclaimed base course
120	RCBA	reinforced concrete bridge approaches
	RCRA	Resource Conservation and Recovery Act
	RECP	rolled erosion control product
	RS	seal coat asphalt emulsion
	RTFO	rolling thin film oven
	SAE	Society of Automotive Engineers
	SC	slow curing asphalt
	SCA	slow curing asphalt with additive
	SDS	Safety Data Sheet
	SF	steel furnace slag
130	SHRP	Strategic Highway Research Program
	SMA	stone matrix asphalt
	SSD	saturated surface dry
	SSPC	the Society for Protective Coatings
	SWPPP	Stormwater Pollution Prevention Plan
	SWQCP	Stormwater Quality Control Plan

	SWQM	Stormwater Quality Manager
	TCLP	Toxicity Characteristic Leaching Procedure
	TSR	tensile strength ratio
	UA	utility asphalt
140	UL	Underwriter Laboratory
	UST	underground storage tank
	VFA	voids filled with asphalt
	VMA	voids in mineral aggregate
	VOC	volatile organic compounds
	WWR	welded wire reinforcement

101.02 Above Normal Inclement Weather Days

150 The specific yearly number of days over and above the normal inclement weather days shown below which work on the controlling operation is delayed by rain or other inclement weather. The above normal days include the days following a weather event on which the controlling operation is still delayed.

The following table shows the estimated number of normal inclement weather days, in each month, the Department considers when setting completion dates.

Month	ESTIMATED NUMBER OF DAYS	
	R, RS, and M Contracts	T and B Contracts
April	18	8
May	8	5
June	5	3
July	5	3
August	4	3
September	5	3
October	6	4
November	12	5

101.03 Blank

101.04 Bid Bond

160 The approved form of security furnished with a bid to guarantee that the bidder will enter into the contract if the bidder is awarded the contract.

101.05 Bidder

An individual, partnership, firm, corporation, or combination of same submitting a bid for the advertised work.

101.06 Bridge

170 A structure, including supports, erected over a depression or an obstruction such as water, highway, or a railway having a track or passageway for carrying traffic or other moving loads, and having a length measured along the center of the roadway of

more than 20 ft between undercopings of abutments or extreme ends of openings for multiple boxes.

(a) Length

The length of a bridge structure is the overall length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor, but in no case less than the total clear opening of the structure.

(b) Roadway Width

- 180 The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or, in the case of multiple height of curbs, between the bottoms of the lower risers.

101.07 Business Day

Monday through Friday except for holidays in accordance with 101.27.

101.08 Calendar Day

Every day shown on the calendar.

- 190 **101.09 Change Order**

A written order issued to the Contractor covering changes in the contract and establishing payment for the work affected by the changes.

101.10 Construction Limits

The line shown on the plans beyond which no work is intended to be performed and that which no disturbance of existing terrain will be allowed unless otherwise authorized by the Engineer.

101.11 Concrete Wastewater

- 200 Wastewater associated with liquid waste from concrete, grout, mortar, stucco, and other similar construction materials resulting from concrete washout, hydrodemolition, saw cutting, coring, or dewatering operations contaminated by concrete pours or similar activities.

101.12 Contract

The written agreement between the Department and the Contractor setting forth the obligations of the parties thereto including, but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

- 210 The contract may include, but is not limited to, the Proposal book, Schedule of Pay Items, contract form, bid bond, performance bond, specifications, special provisions, information to bidders, instructions to bidders, general and detailed plans, notice to proceed, and any change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

101.13

101.13 Contract Information Book

A document which includes a contract information sheet, an estimate of quantities, special provisions, and additional contract requirements. Such document
220 may include the plans.

101.14 Contract Item (Pay Item)

A specifically described unit of work for which a price is provided in the contract.

101.15 Contract Time

The number of work days or calendar days allowed for completion of the contract or phase of the contract, including authorized time extensions.

If a calendar date of contract completion or contract phase completion is shown
230 in the Proposal book in lieu of the number of work or calendar days, the contract shall be completed by that date.

101.16 Contractor

The individual, partnership, firm, corporation, or combination of same contracting with or desiring to contract with the Department for performance of prescribed work.

101.17 Culvert

A structure not classified as a bridge which provides an opening under the roadway.
240

101.18 Commissioner

The chief executive and chief administrative officer of the Department who is responsible for administering the Department.

101.19 Department

The Indiana Department of Transportation as constituted under the laws of Indiana for the administration of highway work.

101.20 Embankment Foundation

The existing materials upon which an embankment is to be constructed.
250

101.21 Engineer

The Chief Engineer of the Department acting directly or through the duly authorized representatives.

101.22 Equipment

All machinery and equipment together with the necessary supplies for upkeep and maintenance, and all tools and apparatus necessary for the proper construction and acceptable completion of the work.
260

101.23 Extra Work

An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract.

101.24 Failed Material

Material or a finished product determined not to be in accordance with applicable specifications or tolerances and that has been adjudicated by the Department's Failed Materials Committee or other Department representatives in accordance with 105.03.

270 **101.25 Force Account Work**

Extra work in the contract for which the Contractor and the Department cannot reach agreement on the unit price or lump sum price prior to performing the work. Settlement will be made upon receipt and approval of documents substantiating and truly representing the allowable costs incurred by the Contractor for performing such extra work.

101.26 Frequency Manual

280 A document issued by the Department which is titled Manual for Frequency of Sampling and Testing and Basis for Use of Materials. The number of samples and tests, the basis for approval, the basis for use, and similar requirements for furnished materials are specified in the document.

101.27 Holidays

Holidays are considered to be:

290 All Sundays
 New Year's Day
 Martin Luther King Day
 Lincoln's Birthday
 Washington's Birthday
 Good Friday
 Primary Election Day
 Memorial Day
 Independence Day
 Labor Day
 Columbus Day
 Election Day
 Veteran's Day
 Thanksgiving Day
 300 Friday after Thanksgiving Day
 Christmas Day

If a holiday listed above, except Sunday, falls on a Sunday, the following Monday shall be considered a holiday. If a holiday listed above falls on a Saturday, the preceding Friday shall be considered a holiday.

101.28 Invitation for Bids

The advertisement for proposals for all work or materials on which bids are required. Such advertisement will indicate with reasonable accuracy the quantity and

101.29

- 310 location of the work to be done or the character and quantity of the material to be furnished, and the time and place of the opening of proposals.

101.29 Itemized Proposal

The Schedule of Pay Items shown in the Proposal book.

101.30 Laboratory

The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

- 320 **101.31 Land-disturbing Activity**

Any man-made action to the land surface that exposes the underlying soil including clearing, grading, excavation operations, cutting and filling, or the movement and stockpiling of topsoil.

101.32 Major and Minor Contract Items

All contract items having an original contract value in excess of 5% of the original contract amount shall be considered as major items. Minor contract items shall be all items shown in the Schedule of Pay Items which constitutes 5% or less of the original contract amount.

330

101.33 Materials

All substances specified for use in the construction of the project and its appurtenances.

101.34 Notice to Proceed

Written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

101.35 Open to Unrestricted Traffic

- 340 The condition that exists when all pavement work is completed, including surface courses, and shoulders. All safety features including guardrail and signs are in place, and pavement markings are in the final marking pattern.

101.36 Pavement Structure

The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.37 Performance Bond

- 350 The approved form of security, furnished and executed by the bidder and its surety or sureties, guaranteeing complete execution of the contract, as defined herein, and for the payment of all legal debts pertaining to the construction of the project. The performance bond will be in effect after both parties have signed the contract and the contract has been approved by the Attorney General of the State.

101.38 Plans

The approved plans, profiles, typical cross sections, standard drawings, working

drawings, and supplemental drawings or exact reproductions thereof which show the location, character, dimensions, and details of the work to be done.

360 **101.39 Professional Engineer**

A person who is duly licensed by the Indiana Professional Licensing Agency to practice engineering in the State.

101.40 Profile Grade

The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

101.41 Project

370 The specific section of the highway where work is to be performed under the contract.

101.42 Proposal

The Schedule of Pay Items shown in the Proposal book.

101.43 Proposal Book

A document which includes the Proposal Sheet, Schedule of Pay Items, and contract forms which shall be completed or signed by the bidder.

380 **101.44 Qualified Products List**

Lists of preapproved manufacturers, materials, products, sources, or suppliers maintained by the Department.

101.45 Quality Assurances Adjustments

Monetary credits either to the Contractor or to the Department for material used outside specified tolerances but within allowable tolerances as indicated for QC/QA pay items or others that may apply.

101.46 Reasonably Close Conformance

390 Reasonably close conformance means conformance with reasonable and customary manufacturing and construction tolerances where working tolerances are not specified. Where working tolerances are specified, reasonably close conformance means conformance with such working tolerances. Without detracting from the complete and absolute discretion of the Engineer to insist on such tolerances as establishing reasonably close conformance, variations beyond such tolerances may be accepted as reasonably close conformance where they will not materially affect the value or utility of the work and the interest of the State.

400 Reasonably close conformance also means, for materials manufactured according to the English system of measures, that the materials are about the same size as nearly equivalent metric-sized materials. For materials manufactured according to the metric system of measures, reasonably close conformance means the materials are about the

101.47

same size as nearly equivalent English-sized materials. Nearly equivalent sized materials will be accepted unless the nearly equivalent material is outside specified working tolerances in the contract documents.

101.47 Recurring Special Provisions

Approved additions or revisions to the Standard Specifications with the intent to be used on multiple contracts.

410

101.48 Right-of-Way

A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a highway.

101.49 Road

A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.50 Roadbed

420

The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

101.51 Roadside

A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.52 Roadside Development

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That work necessary to the complete highway which provides for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; and such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

101.53 Roadway

The portion of a highway within limits of construction.

101.54 Schedule of Pay Items

440

A part of the Proposal book which shows pay items, quantities, and pay units for the contract. The bidder shall complete the document by filling in the unit prices and the bid amounts.

101.55 Shoulder

The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

101.56 Sidewalk

The portion of the roadway primarily constructed for the use of pedestrians.

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101.57 Special Provisions

Additions or revisions to the Standard Specifications that describe conditions and requirements for special situations on a specific project.

101.58 Specifications

A general term applied to all directions, provisions, and requirements pertaining to performance of the work.

101.59 Specified Completion Date460

The date on which the contract work is specified to be complete.

101.60 State

The State of Indiana acting through its authorized representative.

101.61 Street

A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.62 Structures470

Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end walls, buildings, sewers, service pipes, underdrains, foundation drains, and other features which may be encountered in the work and not otherwise classified herein.

101.63 Substantial Completion480

The date, as determined by the Department, when the construction of a project is sufficiently completed in accordance with the plans and specifications, as modified by any approved change orders, so that it can be used for its intended purpose. In order for a project to be used for its intended purpose, all lanes shall be, or have the ability to be, opened to traffic without further need for them to be restricted for any purpose except for the placement or maintenance of stormwater control or the maintenance or removal of temporary stormwater control. As a minimum, all of the following criteria shall be met: All lanes of the road or bridge shall be completed through its final roadway surface, including shoulders, with all the sidewalks, curbs, drainage features, markings, permanent safety appurtenances, lighting, traffic signals, and signing as shown in the contract documents.

101.64 Subcontractor490

An individual, partnership, firm, corporation, or combination of same to whom the Contractor sublets part of the contract.

101.65 Subgrade

The upper portion of a roadbed upon which the pavement structure and shoulders are constructed.

101.66 Substructure

The portion of the structure below the bearings of simple and continuous spans,

101.67

skewbacks or arches, and tops of footings of rigid frames together with backwalls, wingwalls, and wing protection railings.

500 **101.67 Superintendent**

The authorized representative of the Contractor in responsible charge of the work.

101.68 Superstructure

The entire structure except the substructure.

101.69 Surety

510 The corporate body bound with and for the Contractor for the full and complete performance of the contract and for the payment of all debts pertaining to the work. When applied to the Bid Bond, it refers to the corporate body which engages to be responsible in the execution of the contract by the bidder, within the specified time.

101.70 Technician or Inspector

The authorized representative of the Engineer assigned to make detailed inspections of contract performances.

101.71 Titles (Headings)

520 The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

101.72 Township, Town, City

A subdivision of a county used to designate or identify the location of the proposed work.

101.73 Traveled Way

The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.74 Unique Special Provisions

530 Additions or revisions to the Standard Specifications that pertain only to a specific situation on a contract that is not covered by an existing Recurring Special Provision or other standard contract document, and is intended only for a single use in a specific contract.

101.75 Wastewater

540 Water containing waste residue from paint, form release oils, curing compounds and other construction debris, as well as soaps, detergents or solvents used in vehicle, equipment and structure washing, or other material defined as illicit discharge in accordance with 327 IAC 15-13-5(28) including untreated sediment-laden stormwater.

101.76 Work

The furnishing of labor, materials, equipment, and incidentals necessary or

convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract.

101.77 Work Day

A calendar day, exclusive of Saturdays and State recognized holidays, on which weather and other conditions not under the control of the Contractor will enable work on the controlling operations for at least 50% of the day with the normal working force.
 550 However, if weather is unsuitable for work on the controlling operation at the normal starting time, and remains unsuitable for 2 h, a work day will not be charged if the Contractor does not work. No work days will be charged during the months of December, January, February, or March, unless otherwise specified.

101.78 Working Drawings

Supplementary bridge plans, stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcement, or any other supplementary plans, detailed drawings, design drawings, or similar data which the Contractor is required to submit for approval.
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SECTION 102 – BIDDING REQUIREMENTS AND CONDITIONS

102.01 Prequalification and Bidding

The bidder will be required to prequalify and follow the bidding procedures as set out in the rules for Prequalification of Contractors and Bidding, 105 IAC 11, now on file with the Indiana Secretary of State, copies of which are available upon request in the Contract Administration Division.

10 If apparent errors, discrepancies, or unclear statements are found in the contract documents prior to letting, the Department shall be contacted.

102.02 Certification Regarding Lobbying for Contracts, Grants, Loans, and Cooperative Agreements

This requirement will apply only to a federal aid contract. The bidder certifies to the best of its knowledge and belief, that it has complied with the requirements of FHWA-1273 Part XI, included in the Contract Information book.

20 If required, the bidder shall complete and submit Standard Form-LLL, Disclosure Form to Report Lobbying, in accordance with its instructions. Such form and its instructions are available from the Department.

SECTION 103 – AWARD AND EXECUTION OF CONTRACT

103.01 Disadvantaged Business Enterprise Program

This requirement will apply only to a federal aid contract.

(a) General Requirements

Failure to carry out the requirements set forth in 49 CFR Part 26, as outlined in the Department's DBE Program Manual, shall constitute a breach of contract and, after notification, may result in such contract sanctions as the Department or the Federal Highway Administration may determine to be appropriate, including, but not limited to: (a) withholding of payments to the Contractor under the contract until the Contractor complies, and/or (b) cancellation, termination or suspension of the contract, in whole or in part.

The above referenced CFR section requires the following policy and disadvantaged business enterprise obligation to be included in all subsequent agreements between the Contractor and all subcontractors as follows:

1. It will be the policy of the Department to create a level playing field on which DBE's can compete fairly for federally funded contracts. Consequently, the disadvantaged business enterprise requirements of 49 CFR Part 26, as outlined in the Department's DBE Program Manual, apply to this contract.
2. The Contractor shall not discriminate on the basis of race, color, national origin, religion, sex, sexual orientation or gender identity in the award and performance of this contract. The Contractor shall carry out the applicable DBE requirements in the award and administration of federally funded contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract which may result in the termination of this contract or such other remedy as the Department deems appropriate, which may include, but is not limited to: withholding progress payments; assessing sanctions; liquidated damages; and/or disqualifying the Contractor from future bidding as non-responsible. The Contractor shall include language prohibiting discrimination on the basis of race, color, national origin, religion, sex, sexual orientation or gender identity in the performance of this contract and all subcontracts.

(b) Definitions

The following definitions will apply.

1. DBE

A small business concern which is at least 51% owned by one or more socially and economically disadvantaged individuals, or, in the case of a publicly owned business, at least 51% of the stock of which is owned by one or more socially and economically disadvantaged individuals; and whose managements and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it.

2. Small Business Concern

A small business as defined pursuant to Section 3 of the Small Business Act and relevant regulations promulgated pursuant thereto, except that a small business concern shall not include a concern or group of concerns controlled by the same socially and economically disadvantaged individual or individuals which has annual average gross receipts in excess of \$16.6 million over the previous three fiscal years.

3. Socially and Economically Disadvantaged Individuals

60 Those individuals who are citizens of the United States or lawfully admitted permanent residents and who are women, black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Asian-Indian Americans, or other minorities or individuals found to be disadvantaged by the Small Business Administration pursuant to Section 8(a) of the Small Business Act.

4. Certified DBE

70 A business enterprise which has completed and filed a request for certification with the Department, and that the business enterprise has been reviewed and determined to comply with the guidelines established in 49 CFR Part 26. Business enterprises which are determined to be eligible will be certified as DBEs to perform specific types of work.

(c) Goal

80 A contract provision DBE goal may be shown on the Proposal sheet. Such goal, if required, has been established as the desired minimum amount to be contracted to DBEs. The Contractor shall meet or exceed the goal, or demonstrate that it could not be met despite good faith efforts. Achievement of the goal does not relieve the Contractor of the requirement for affirmative action on subsequent subcontracting on this contract. Only work with listed DBEs that are certified prior to the date of the letting will count toward the goal. Credit towards contract goals will be given only for work performed by certified DBEs in the work areas for which they have been certified. The same requirements with respect to obtaining the goal apply for a Contractor that is certified as a DBE. A DBE Contractor shall either achieve the goal utilizing other DBE firms or demonstrate that the goal could not be met despite good faith efforts.

90 Contracting may be in the form of a subcontract, lease agreement, or material supply agreement. Prime contractors will receive 100% credit for work done by the DBE under subcontracts and lease agreements. Credit for utilization of a DBE material supplier depends on whether the supplier is a manufacturer, regular dealer or broker. Full credit will be given for suppliers who manufacture the items and are certified as Supplier Manufacturer in the DBE repository. Credit will be limited to 60% of the expenditure for suppliers acting as a regular dealer and are certified as Supplier Regular Dealer in the DBE repository. Credit will be limited to fees and commissions for suppliers acting as a broker and are certified as Supplier Broker in the DBE repository. Suppliers shall also perform a commercially useful function in order for credit to be received.

100 The Contractor shall not terminate or reduce a commitment to a DBE, or an approved substitute DBE firm, that was listed on the Affirmative Action Certification without the prior written consent of the Department. This includes, but is not limited to, instances in which the Contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm. Unless the Department provides written consent, the Contractor shall not be entitled to any payment for work or materials unless it is performed or supplied by the listed DBE.

110 Written consent will only be provided by the Department if the Contractor has good cause to terminate or reduce its commitment to the DBE firm. Good cause shall consist of any of the following circumstances:

1. The listed DBE subcontractor fails or refuses to execute a written contract.
2. The listed DBE subcontractor fails or refuses to perform the work of its subcontract in a manner consistent with normal industry standards, unless such failure or refusal of the DBE subcontractor to perform its work on the subcontract results from the bad faith or discriminatory action of the Contractor.
- 120 3. The listed DBE subcontractor fails or refuses to meet the Contractor's reasonable, nondiscriminatory bond requirements.
4. The listed DBE subcontractor becomes bankrupt, insolvent, or exhibits credit unworthiness.
5. The listed DBE subcontractor is ineligible to work on public works projects because of suspension and debarment proceedings pursuant to 2 CFR Parts 180, 215 and 1200 or applicable state law.
- 130 6. The Department has determined that the listed DBE subcontractor is not a responsible contractor.
7. The listed DBE subcontractor voluntarily withdraws from the project and provides the Department written notice of its withdrawal.
8. The listed DBE is ineligible to receive DBE credit for the type of work required.
- 140 9. A DBE owner dies or becomes disabled with the result that the listed DBE contractor is unable to complete its work on the contract.

- 150 10. Other documented good causes, that the Department will determine, which compels the termination of the DBE subcontractor. Good cause does not exist, however, if the Contractor seeks to terminate a DBE it relied upon to obtain the contract so that it can self-perform the work for which the DBE contractor was engaged or so that the Contractor can substitute another DBE or non-DBE contractor after the contract has been awarded.

160 Before transmitting to the Department its request to terminate or reduce a commitment made to a listed DBE, the Contractor shall give written notice to the affected DBE, with a copy to the Department, of its intent to request termination or reduction and the reasons for the request. The DBE shall be given five days to respond to the Contractor and the Department of the reasons, if any, why it objects to the proposed termination or reduction, and why the Department should not approve the Contractor's action. If required in a particular case, as a matter of public necessity and safety, the Department may specify a response period shorter than five days.

170 When a DBE subcontractor is terminated as specified herein or fails to complete its work on the contract for any reason, the Department will require the Contractor to make good faith efforts to find another DBE subcontractor to substitute for the original DBE. These good faith efforts shall be directed at finding another DBE to perform at least the same amount of work under the contract as the DBE that was terminated, to the extent needed to meet the contract goal the Department established for the contract.

170 In order to receive DBE credit for commitments made as part of the prime contract award process, a DBE firm shall be certified before the due date for bids on the prime contract. There may be situations after the award of the prime contract in which it is appropriate to count DBE credit for the use of a DBE firm. To be eligible to obtain DBE credit in these situations, the DBE firm shall be certified prior to participation on the contract.

180 If a non-DBE contractor joint ventures with a DBE contractor, the portion of the joint venture which is performed by a DBE may be utilized to achieve the DBE goal. Two types of DBE joint ventures are allowed and are defined as follows:

1. DBE Joint Venture Type A

A DBE contractor and a non-DBE contractor bidding on specific pay items to be performed by each company.

2. DBE Joint Venture Type B

A DBE contractor and a non-DBE contractor combining resources and agreeing upon a percentage of the total work to be performed by each contractor.

190 DBE joint ventures type A do not require DBE joint venture certification. DBE

joint venture type B do require DBE joint venture certification. A request for DBE joint ventures type B certification shall be submitted no later than 9:00 a.m. local time the last business day before the letting and shall be approved prior to bidding in order to receive credit toward the DBE goal. The DBE shall be certified with the Department prior to requesting DBE joint venture certification. The work for the DBE shall be identified, performed, managed, and supervised by its forces.

(d) Affirmative Actions

200 The Contractor shall develop an affirmative action plan for a Disadvantaged Business Enterprise Program which shall include the minimum requirements as follows:

1. Appointment of a representative with authority to administer the Contractor's Disadvantaged Business Enterprise Program.
2. Documents of affirmative action methods and procedures intended to be used in seeking out and considering certified DBEs as subcontractors or suppliers.
- 210 3. A list of certified DBEs to be contacted prior to the selection of a potential subcontractor for the particular pay items within the capabilities of the DBEs. This list shall include but shall not be limited to the requirements as follows:
 - a. The name of each subcontractor or supplier and a notation as to their DBE certification status.
 - b. The potential type of work or services to be performed by each subcontractor or supplier.

220

(e) Determination of Good Faith Efforts

Appendix A of 49 CFR Part 26 has been used for guidance in preparing the Department's procedures to determine the adequacy of good faith efforts. Additional factors consistent with 49 CFR Part 26, and the Department's policies and procedures have also been utilized.

1. Good Faith Efforts Prior to Award

230 The following factors will be considered in determining good faith efforts prior to award of a contract. The Contractor, including DBE Contractors, shall submit evidence on each of the factors.

- a. The Contractor shall make reasonable effort to contact all ready, willing, and able DBEs who express a desire to work on any of the pay items of the contract.
- b. To effectively participate, the DBE shall have the opportunity to analyze the contract and submit quotations

- 240 prior to letting. Information provided by the Contractor to the DBEs shall include, at a minimum, the contract number, pay items, quantities for those pay items to be subcontracted, and the date the subcontract bid is desired.
- c. The Contractor shall select the portions of the work to be performed by DBEs in order to increase the likelihood of DBE participation. This shall include, where appropriate, an attempt to break down the contract into economically feasible units to facilitate DBE participation.
- 250 d. The Contractor shall provide the interested DBEs with complete information about the plans, specifications, and requirements of the contract. Attempts shall be made to have plans available or to notify the DBE of the location of available plans. The Contractor shall notify the DBE of revisions to the contract.
- e. It will be considered unacceptable to avoid subcontracting to DBEs if such subcontracting to DBEs results in the need to further subdivide remaining work items.
- 260 f. The Contractor shall negotiate in good faith with interested DBEs and not reject such DBEs as unqualified without sound reasons based on thorough investigation of their capabilities. Confirmed documentation that a DBE has not been able to perform previous work through no fault of others will be considered to be sound reason. Unacceptable criteria include, but are not limited to, unsubstantiated oral statements and unsigned documentation.
- 270 g. The Contractor shall make efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance required by the State. However, the Contractor shall affirmatively consider waiving requirements it may have in order to assist the DBE.
- h. Only firms certified as DBEs prior to the letting date can be used to meet the contract goal for the Department's DBE program.

280 The Contractor will be considered to have made good faith efforts if it either:

- a. Documents that it has obtained enough DBE participation to meet the goal, or
- b. Documents that it made adequate good faith efforts in

accordance with the factors set out above to meet the goal even though it did not succeed in obtaining enough DBE participation to do so.

290 If a DBE goal has been established for the contract, the Contractor shall take good faith efforts to achieve the established goal prior to the bid opening. The Affirmative Action Certification shall be completed and submitted with the Proposal Book to indicate both race/gender conscious and race/gender neutral proposed DBE utilization.

The award of the contract will be made to the lowest and best bidder when all other requirements have been met and good faith efforts have been taken toward meeting the DBE goal, if required, in accordance with these requirements.

300 If the apparent low bidder has not achieved the contract DBE goal, the bidder shall respond by email or in writing within five business days after notification by the Department of the failure to meet the DBE goal. The response shall provide evidence identifying the bidder's good faith efforts and all affirmative actions taken prior to letting to achieve the required DBE goal. Failure to respond within the five business day period will result in rejection of the bid, and may result in forfeiture of the bid bond, and the referral of the bidder to the Prequalification Committee.

Responses shall be sent to the Department's Division of Contract Administration. The Department will review the bidder's good faith efforts for compliance with these requirements.

310 If the Department determines that adequate good faith efforts have been made, and the bidder has met all other bidding requirements, the contract will be awarded.

If the Department determines that good faith efforts were inadequate, the Department will notify the bidder of the determination by email. The determination will outline the reasons for determination of non-compliance with good faith effort requirements.

320 The bidder may request a review of a determination of non-compliance by email or written submittal within five business days of the bidder's receipt of notification of non-compliance from the Department. The request for review shall include evidence disputing the Department's reasons for issuing a determination of non-compliance. The request shall be sent to the Department's Division of Contract Administration.

330 Upon receipt of a request, the Department will contact the bidder to schedule a review. The review will be held by the Department's Deputy Commissioner and Chief Legal Counsel, or a designee who did not participate in the original determination of non-compliance. The review will be conducted in accordance with the Department's policy for review of good faith efforts requirements. A copy of the policy is available on the Department's website or through the Division of Contract Administration.

If the Deputy Commissioner's finding determines that the bidder's good faith efforts were adequate, and the bidder has met all other bidding requirements, the contract will be awarded and the Department will adjust the contract time by the number of calendar days from the date of the original determination of non-compliance to and including the date of the Deputy Commissioner's findings.

If the Deputy Commissioner's finding determines that the bidder's good faith efforts were inadequate, the finding will be forwarded to the Commissioner. The Commissioner will review the Deputy Commissioner's finding and issue a written
340 Contract Award Determination.

If the Commissioner's Contract Award Determination finds that the bidder's good faith efforts were adequate, and the bidder has met all other bidding requirements, the contract will be awarded and the Department will adjust the contract time by the number of calendar days from the start of the original determination of non-compliance to and including the date of the Commissioner's determination.

If the Commissioner's Contract Award Determination finds that the bidder's good faith efforts were inadequate, at the Commissioner's sole option and without further
350 proceedings, either all bids will be rejected or the contract will be awarded to the next lowest and qualified bidder. An apparent low bidder who has not met the DBE goal and requirements for good faith efforts may be requested not to rebid on this contract during subsequent lettings.

The Commissioner's Contract Award Determination will be the final decision of the Department.

2. Good Faith Efforts for Extra Work

When extra work in accordance with 104.03 is added to a contract with a DBE
360 goal, the Contractor shall hire or make good faith efforts to hire a DBE subcontractor to perform significant extra work.

For purposes of DBE good faith efforts, significant extra work is defined as new pay items added to a Contract that result in a new contracting opportunity not reasonably related to existing pay items being performed by the Contractor or a subcontractor.

When significant extra work related to existing pay items being performed by a DBE subcontractor is added to a contract with a DBE goal, the Contractor shall offer
370 that same DBE subcontractor the opportunity to perform the extra work whether or not the existing pay items are counted toward the DBE goal. The Contractor shall consider other DBE subcontractors if the extra work would result in the original DBE subcontractor exceeding its prequalification limits. The Department may consider an exception to a DBE subcontractor's prequalification limit. If the DBE subcontractor is unable to perform the extra work, the Contractor shall hire or make good faith efforts to hire an alternate DBE subcontractor to perform the work.

380 When significant extra work related to existing pay items being performed by a non-DBE subcontractor is added to a contract with a DBE goal, the non-DBE subcontractor may perform the extra work. If the non-DBE subcontractor is unable to perform the extra work, the Contractor may self-perform the extra work. If the Contractor chooses not to self-perform the extra work, the Contractor shall hire or make good faith efforts to hire a DBE firm to perform the work.

390 When significant extra work related to existing pay items being performed by the Contractor is added to a contract with a DBE goal, the Contractor may self-perform the extra work. If the Contractor chooses not to self-perform the extra work, the Contractor shall hire or make good faith efforts to hire a DBE firm to perform the work.

The Contractor shall forward documentation of good faith efforts to hire a DBE subcontractor to perform extra work to the District Equal Employment Opportunity Officer (EEO Officer) for review. The EEO Officer will determine if good faith efforts have been met in accordance with 103.01(e)1.

400 If the EEO Officer determines that the Contractor failed to make good faith efforts to hire a DBE firm when required as a result of significant extra work, written notice will be sent to the Contractor. The Contractor may appeal the determination in accordance with 103.01(e)1.

(f) Affirmative Action Certification

410 The Affirmative Action Certification, included in the Proposal book, shall be completed when the Proposal book is submitted to the Department. The certification shall list all DBE firms the Contractor plans to utilize, either race/gender consciously or race/gender neutrally. Blank certifications shall cause the bid to be rejected. If a portion of a pay item is to be performed by a DBE, an explanation shall be included stating exactly what the DBE is performing or supplying. Failure to do so may affect the award of the contract. The Contractor shall ensure that DBE firms listed on the Affirmative Action Certification are certified DBE firms as listed in the Department's DBE directory at the time of letting. In addition to the listing of DBE firms that will be used race/gender consciously to meet the goal, the Contractor shall also provide a total for the amount of work that it anticipates will be performed by other DBE firms used race/gender neutrally on the contract beyond the goal requirements.

Race/gender neutral awards involve the utilization of a DBE firm because the DBE firm is the best firm to perform the work. Race/gender conscious awards involve the utilization of a DBE firm primarily to achieve the contract DBE goal.

(g) Subcontracts

420 If the Contractor intends to subcontract a portion of the work, affirmative action shall be taken to seek out and consider DBEs as potential subcontractors prior to the subcontractual commitment.

The contacts made with potential DBE subcontractors and the results thereof shall be documented and made available to the Department and the FHWA upon request.

If the Contractor originally did not intend to subcontract a portion of the work and later circumstances dictate subcontracting a portion of the work, the affirmative action contacts described herein shall be performed.

430

Upon receipt of notification from the Department, a Disadvantaged Business Enterprise Utilization Affidavit, Form DBE-3, shall be completed by the Contractor and returned to the Department. The Contractor and the subcontractor/lessor/supplier shall certify on Form DBE-3 that specific amounts have been paid and received. A DBE-3 Form certification shall be completed and submitted for every DBE utilized on the contract, whether or not there was a DBE contract goal.

(h) Leases and Rentals

440 Hauling leases made with DBEs shall be submitted to the Department for approval before beginning work. Leases for hauling, when used, shall be submitted when borrow, subbase, compacted aggregate, HMA mix, cement concrete mix, or a combination of the above is to be hauled by a DBE. The lease shall show the dollar amount of anticipated work before the work is started. The actual dollar amount shall be reported to the Department after the work has been completed.

450 In order to perform a commercially useful function on a contract, the dollar volume of hauling by a DBE trucking firm that is counted toward the DBE goal is limited to the total value of transportation services provided by the DBE's own trucks; the total value of transportation services a DBE lessee provides with its own trucks; and the total value of transportation services a non-DBE lessee provides with its own trucks, not to exceed the value of transportation services provided by DBE-owned trucks. In addition, DBE credit will also be given for any fee or commission the non-DBE lessee receives as a result of the lease arrangement for any additional non-DBE trucks.

460 In order to count leased trucks toward the goal, the lease must indicate that the DBE has exclusive use of and control over the truck. This does not preclude the leased truck from being used by others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE. The DBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting the DBE goals.

The Contractor shall provide the Engineer copies of any lease agreements between DBE trucking subcontractors and any DBE or non-DBE trucking firms or owner/operators that will be used to supplement the DBE trucking subcontractor's trucks for the purpose of meeting the DBE goal. Copies of these lease agreements shall be provided by the time of use of any supplemental trucks on the Contract.

103.02

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In addition to delivery ticket information required by Section 106, the name of trucking firm shall be included on each ticket for material delivered to the job site by a DBE trucking subcontractor or lessee.

The Contractor shall notify the Department when purchases or rental of equipment, other than leases for hauling, are made with DBEs. The information submitted shall include the name of the business, the dollar amount of the transaction, and the type of purchase made or type of equipment rented.

480

If a subcontract agreement between the Contractor and a majority subcontractor requires that the majority subcontractor sublease a portion of its hauling to a DBE, the Contractor may receive credit toward the contract goal. The Contractor shall notify the Department when sublease agreements exist, the name of the DBE, the dollar amount of anticipated hauling before the work is started, and the actual dollar amount after the work is completed. The subcontractor shall certify actual utilization of the DBE at the end of the work and provide such certification to the Contractor for submission to the Department.

(i) Records and Reports

490

The Contractor shall keep such records as necessary to determine compliance with its DBE utilization obligations and compliance with the Guidelines for Determining of Good Faith Efforts. The records kept by the Contractor shall indicate the minimum requirements as follows:

1. The number of disadvantaged, non-minority, and women subcontractors and suppliers and type and dollar value of work or materials services being performed on or incorporated into this contract.
2. The progress and efforts being made in seeking out disadvantaged contractor organizations and individual disadvantaged contractors for work on this contract.
3. Documentation of all correspondence, contacts, or telephone calls to obtain the services of DBEs on this contract.

500

Reports shall be submitted as required by the Department for those contracts and other business agreements executed with DBEs with respect to the records referred to above.

510

All such records shall be maintained for a period of three years following acceptance of final payment and shall be available for inspection by the Department and the FHWA and their authorized representatives.

103.02 Specific Equal Employment Opportunity Responsibilities

This requirement will apply only to a federal aid contract.

520 The Contractor and all subcontractors not including material suppliers, holding
subcontracts of \$10,000.00 or more, shall comply with the following minimum
specific requirement activities of equal employment opportunity. The equal
employment opportunity requirements of Executive Order 11246, included in the
Contract Information book, will be applicable to material suppliers as well as
contractors and subcontractors. The Contractor shall include these requirements in
each subcontract of \$10,000.00 or more with such modification of language as is
necessary to make them binding on the subcontractor.

103.02.1 Record Keeping

530 All firms performing work on Department contracts, bidding on Department
contracts, or offering quotes for subcontract or trucking services shall register with the
Department, annually, by submitting the following information to the Department's
Prequalification Engineer:

- (a) firm's name
- (b) firm's address
- (c) firm's status as a DBE or non-DBE
- (d) the age of the firm and
- (e) the annual gross receipts of the firm
- (f) in which of the following markets has the firm participated?

- 540
- 1. prime Contractor
 - 2. subcontractor
 - 3. hauler
 - 4. consultant
 - 5. supplier.

103.03 Blank

103.04 Insurance

550 Prior to commencing the work, the Contractor shall obtain and thereafter keep in
force, the following insurance coverages provided by insurance companies acceptable
to the Department and authorized to transact business under the laws of the State of
Indiana. Certificates of insurance shall be filed with the Department. The Department
may temporarily accept an insurance binder pending receipt of the certificate of
insurance. When Railroad's Protective Liability insurance in accordance with
103.04(d) is required, the original policy shall be submitted to the railroad company
with a copy transmitted to the Department. In addition, certificates of insurance shall
be provided to the railroad, on forms satisfactory to the railroad, covering the
Contractor's Commercial General Liability and Business Automobile Liability
insurance.

560 The Contractor may purchase insurance for the full limits required by 103.04(b),
or 103.04(c) or by a combination of primary policies for lesser limits and remaining
limits provided by a Commercial Umbrella Liability policy.

Proof of renewal shall be furnished 15 days or more in advance of the policy expiration. If subject to cancellation, the insurance company shall provide at least 30 days prior notice, and the insurer shall immediately notify the Department in writing of such impending cancellation.

570 In the event of cancellation or expiration, all work on the contract shall be suspended except that necessary for traffic maintenance and the protection of life and property. No extension in the contract completion time or additional payment will be allowed on account of this requirement and contract time charges will continue.

Nothing contained herein shall modify the Contractor’s obligation of indemnification and exculpation of the State and its representatives in accordance with 107.17.

(a) Worker’s Compensation and Employer’s Liability

580

1. Worker’s compensation shall be provided according to the provisions of the Indiana Worker’s Compensation and Occupational Diseases Act as amended.
2. A certificate from the Worker’s Compensation Board of Indiana shall be furnished as evidence of compliance with the provisions of the Indiana Worker’s Compensation and Occupational Diseases Act.

(b) Commercial General Liability

590

Required liability insurance coverage shall provide coverage for operations of the Contractor and operations of subcontractors. Coverages shall include premises operations; independent contractors; products; completed operations; broad form property damage; hazards of explosion, collapse, and underground damage; and contractual liability. The general aggregate limit shall be endorsed so as to provide coverage for each contract as follows:

- | | | |
|-----|----------------------------------|--------------|
| | 1. General Aggregate Limit..... | \$2,000,000 |
| | 2. Products-Completed Operations | |
| 600 | Aggregate Limit | \$2,000,000 |
| | 3. Each Occurrence Limit..... | \$1,000,000. |

(c) Business Automobile Liability

This policy shall cover owned, non-owned, and hired vehicles. The combined single limit of liability for bodily injury and property damage liability per each accident shall be \$1,000,000.

(d) Railroad’s Protective Liability

610 When required, the Contractor shall carry, with respect to the operations performed and those performed by others, for and in behalf of each railroad company,

Railroad Protective Liability insurance providing for a limit of not less than a combined single limit of \$2,000,000 per occurrence for damages arising out of bodily injury, death, and property damage with an aggregate limit of \$6,000,000 for the term of the policy.

In addition, the limits specified in 103.04(b)3 shall be increased to \$2,000,000.

(e) Owner's and Contractor's Protective Liability Insurance Coverage for Operations of Designated Contractor

620 The named insured in this policy shall be the State of Indiana, c/o Indiana Department of Transportation. If specified elsewhere in the contract, the named insured shall also include a local governmental agency.

The limits of coverage shall be not less than \$1,000,000 for all damages arising out of bodily injury or death in one occurrence, and for all damages arising out of injury to or destruction of property in any one occurrence. Subject to the limit per occurrence, an aggregate limit for the contract of not less than \$3,000,000 shall be provided during the policy period.

630 In addition to the limits specified herein, the policy and the binder shall also include the endorsements to the Owner's and Contractor's Protective Liability Insurance as follows:

1. Wherever used in this policy, the term "named insured" shall include the Indiana Department of Transportation, its officers, and employees. If so specified in the contract, the term "named insured" shall also include a local governmental agency, its officers, and employees.
- 640 2. Wherever used in this policy, the term "general supervision" shall include on-site inspection, field engineering, field testing, and activities incidental thereto.
3. Exclusion (c) is amended to read as follows:
 - 650 (c) To bodily injury or property damage occurring after all work on the project to be performed by or on behalf of the State at the site of the covered operation has been completed, and the Contractor designated herein has been relieved of further maintenance, as set out in the final acceptance letter of the Indiana Department of Transportation.
4. Notwithstanding other terms or conditions, this policy provides the minimum insurance coverages as of the latest filing with the Indiana Department of Insurance by the Insurance Services Office with the endorsements and amendments specified by

660 103.04(e) of the Indiana Department of Transportation Standard Specifications. The policy is identified as the latest edition of form CG 00 09 as copyrighted by the Insurance Services Office, Inc.

(f) Basis of Payment

No direct payment will be made for insurance. The cost thereof shall be included in the cost of the pay items.

103.05 Waiver of Damages

670 At the time the contract is ready for final execution, all of the necessary right-of-way may not have been secured. In order to expedite prompt execution of the contract, the Contractor may sign a waiver of damages. This will waive all damages that might accrue to the Contractor for delay, expense, inconvenience, loss of profits, or for all other causes occasioned to the Contractor by the failure of the Department to secure such right-of-way. The waiver shall be binding upon each subcontractor of the principal Contractor. This waiver provision will not apply on Federal Aid projects.

103.06 Wage and Labor Requirements

680 These requirements apply to all contracts let by the Department. These requirements will apply to all work performed by the Contractor with its own organization and with the assistance of workers under its immediate superintendence, and to all work performed by piecework, station work, subcontract, or lease.

(a) Non-discrimination of Employees

The Contractor and its subcontractors shall not discriminate against an employee or applicant for employment, to be employed in the performance of the contract work, with respect to hire, tenure, terms, conditions, or privileges of employment or matters directly or indirectly related to employment, because of race, religion, color, sex, sexual orientation, sexual identity, disability, national origin, or ancestry. Breach of this covenant may be regarded as a material breach of the contract.

690 **(b) Affidavits and Payrolls**

All labor shall be paid weekly. The payroll and related records of the Contractor and all subcontractors shall be preserved for a period of three years after completion of the project work and shall be open to the inspection of the Department.

700 The wages of labor shall be paid in legal tender of the United States. However, this condition will be considered satisfied if payment is made by means of a negotiable check, on a solvent bank, which may be cashed readily by the employees in the local community for the full amount, without discount or collection charges. If checks are used for payment, the Contractor shall make all necessary arrangements for them to be cashed and shall give information regarding such arrangements.

The Contractor on each contract let by the Department shall be responsible for electronically filing certified payroll for its employees and any subcontractors on a

weekly basis with the appropriate Department personnel and in a format acceptable to the Department. Failure of the Contractor to timely file certified payroll for its employees or any subcontractors, may result in the withholding of progress estimate payments until the certified payroll is properly submitted.

710 No fee shall be asked or accepted by the Contractor or its agents from a person as a condition of the contract.

No laborers shall be charged for tools used in performing their respective duties except for reasonable avoidable loss or damage thereto.

720 Each employee on the work covered by the contract shall be allowed to lodge, board, or trade where or with whom he or she elects. Neither the Contractor nor its agents, nor its employees shall directly or indirectly require as a condition of employment that an employee shall lodge, board, or trade at a particular place or with a particular person.

No charge shall be made for transportation furnished by the Contractor or its agents to a person employed on the work.

No individual shall be employed as a laborer on the contract except on a wage basis. This shall not be construed to prohibit the rental of trucks or other equipment from individuals. No such rental agreement, or charges for fuel, supplies, or repairs on account of such agreement shall cause deduction from the wages accruing to an employee except as authorized by the regulation cited herein.

730 **(c) Wage Stipulations**

No person employed on a federally funded contract shall be paid less than required by the rate of wages set forth for labor classifications listed in the General Decision as required by the Davis Bacon Act and related Acts. No person employed on a state funded contract shall be paid at a rate of less than \$11.25 per hour, as required by IC 8-23-9-22 or the rate of wages set forth for labor classifications listed in the General Decision, whichever is greater.

1. General Decision Included in Contract Information Book

740 The Contractor shall pay the workers who are employed in performance of the contract work, rates of wages which are not less than the rates set forth for labor classifications listed in the General Decision.

The computations used in arriving at the contract unit prices shall be based on the hourly rates shown in the General Decision and as shown above. The wages herein stipulated shall become and be a part of the contract as provided by law.

The following statement, shown in the General Decision, will not apply to state funded contracts.

103.07

750 “Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29 CFR 5.5(a)(1)(ii)).”

2. General Decision Not Included in Contract Information Book

If the General Decision is not included in the Contract Information book, the requirements of 103.06(c)1 will not apply.

103.07 Accident Prevention and Safety

760 In the performance of the contract work, the Contractor shall comply with all applicable federal, State, and local laws governing safety, health, and sanitation. The Contractor shall provide all safeguards, safety devices, and protective equipment. The Contractor shall take all reasonably necessary actions to protect the life and health of employees on the project site and the safety of the public, and to protect property in connection with the performance of the contract work.

770 It is a condition of the contract, and shall be made a condition of each subcontract entered into pursuant to the contract, that the Contractor and all subcontractors shall not require a laborer or mechanic employed in performance of the contract work to work in surroundings or in working conditions which are unsanitary, hazardous, or dangerous to his or her health or safety, as determined under construction safety and health standards 29 CFR 1926, as amended at the time the work is performed.

SECTION 104 – SCOPE OF WORK

104.01 Intent of Contract

The intent of the contract is to provide for the construction and completion in every detail of the work described.

The Contractor shall furnish all labor, materials, equipment, tools, safety equipment, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

10

It is understood by all concerned that the apparent silence of the specifications as to a detail or the apparent omission of a detailed description concerning a point shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the first quality is to be used. All interpretations of these specifications shall be made on this basis.

20

In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever any thing is, or is to be done, if, as, when, or where contemplated, required, determined, directed, specified, allowed, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, rejected, or

condemned, it shall be understood as if the expression were followed by the words “by the Engineer” or “to the Engineer”.

It is further provided that all work including the furnishing of materials, equipment, tools, labor, and incidentals required to carry out the terms of the contract shall be done by the Contractor, its employees, or subcontractors unless specifically set out otherwise in the Proposal book. The words “by the Contractor” will not
 30 necessarily be used to so indicate. All work shall be carried out in a thorough, careful, effective, and satisfactory manner without specifically using these words to describe the action.

Reports and other documents that are determined to be pertinent and necessary to the effective monitoring of the contract shall be submitted by all applicable contractors and subcontractors in accordance with appropriately issued instructions.

104.02 Changed Conditions

A changed condition causes the work to substantially differ in kind or nature from
 40 the work as required in the original contract. The Department will adjust the contract for changed conditions as described herein. A contract adjustment may revise one or more of the following:

- (a) the work to be performed
- (b) the time required for the work
- (c) the amount of compensation due the Contractor.

50 Changed conditions that will be considered as reason for a contract adjustment are differing site conditions, suspensions of work ordered by the Engineer, and significant changes in the character of the work. A request by the Contractor for a contract adjustment shall be based on one or more of the changed conditions described herein.

(a) Differing Site Conditions

During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the contract or if
 60 unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before the site is disturbed and before the affected work is performed.

Upon written notification, the Engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding anticipated profits, will be made and the contract modified in

70 writing accordingly. The Engineer will notify the Contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice of a changed condition in accordance with 105.16.

No contract adjustment will be allowed under this clause for any effects caused on unchanged work.

(b) Suspensions of Work Ordered by the Engineer

80 If the performance of all or any portion of the work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation, and/or contract time is due as a result of such suspension or delay, the Contractor shall submit to the Engineer in writing a request for adjustment within seven calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

90 Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly. The Contractor will be notified of the Engineer's determination whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed in accordance with 105.16.

100 No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided or excluded under any other term or condition of this contract.

(c) Significant Changes in the Character of Work

110 The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the Contractor agrees to perform the work as altered.

If the alterations or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause such

other work to become significantly different in character, an adjustment, excluding anticipated profit, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.

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If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice of a changed condition in accordance with 105.16.

The term "significant change" shall be construed to apply only to the following circumstances:

130

1. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or
2. When a major item of work, as defined elsewhere in the contract, is increased in excess of 125% or decreased below 75% of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125% of the original contract item quantity, or in case of a decrease below 75%, to the actual amount of work performed.

140

(d) Pre-established Remedies to Changed Conditions

The Contractor and the Department shall cooperatively work to resolve a request for a contract adjustment due to a changed condition by means of the pre-established remedies described herein.

After receipt of a notice of a changed condition in accordance with 105.16, the Engineer will determine if the Contractor's request for a contract adjustment is justified. The Engineer will respond to the Contractor in writing within two business days of the receipt of notification, or other time as mutually agreed, as to whether the request is justified and as to how the changed condition will be remedied.

150

If the Engineer determines that a request for a contract adjustment is justified, the changed condition will be remedied by means of a contract adjustment based on one or more of the following pre-established remedies.

1. Calculations and payment involving existing pay items in the contract.
2. Payment for extra work in accordance with 104.03.

160

3. Extension of contract time in accordance with 108.08.
4. Payment for delay costs in accordance with 109.05.2 as allowed by 108.08(b).

170 If the impact of a changed condition will not be known for some length of time, the following procedure shall be followed in order to expedite a contract adjustment until the impact of the change can be determined.

1. After submitting notification of the changed condition, the Contractor shall keep daily records, apart from other records, of all labor, material, and equipment costs incurred for the work affected. The daily records shall identify each operation affected and the location where work is affected.
2. The Engineer will also maintain daily records of the work affected from the date of the notification.
- 180 3. Beginning the week following notification of a changed condition, the Contractor shall meet weekly with the Engineer to exchange and discuss each party's daily records of the work affected during the preceding week.
4. The Contractor shall notify the Engineer in writing within three work days of any disagreements with the Engineer's records and include the specific points of disagreement. These points will be addressed by the Engineer at the next weekly meeting.
- 190 5. Refusal by the Contractor to attend any weekly meeting or to submit daily records at a weekly meeting will constitute a waiver to any objections to the accuracy of the Engineer's records and the Engineer's records will control for purposes of computing any contract adjustment for the changed condition.

200 If the Contractor accepts the Engineer's remedy for a changed condition, the contract adjustment will be considered to be full and complete compensation for the changed condition and no further contract adjustment will be made for the circumstances that gave rise to the Contractor's request.

If the Contractor disagrees with the Engineer's remedy for a changed condition, and decides to further pursue compensation, a written notification of a claim may be submitted in accordance with 105.16.

Pre-established remedies to a changed condition have the following conditions.

1. Acceleration

210 If the Department gives written direction for the Contractor to accelerate the work, a contract adjustment will be made specifying the work to be accelerated, the time to be saved by acceleration and the amount of compensation due the Contractor for the acceleration.

The Department assumes no liability for constructive acceleration unless the Contractor has provided written notice of the intent to accelerate the work, there is an excusable delay for which the Department has either improperly rejected the Contractor's request for an extension of contract time or failed to act on the request, and the Contractor has incurred additional costs for the acceleration.

2. Inefficiencies

220 If a claimed loss of productivity due to a changed condition cannot be isolated and remedied separately, the Department will consider payment for inefficiency costs on the basis of a measured mile analysis performed by the Contractor or other analysis method approved by the Engineer.

If the claimed inefficiency is that work was performed out of scheduled sequence due to the changed condition, the current accepted schedule will be analyzed to determine if the work was performed out of sequence.

3. Unrecoverable Costs

230 The Department will not make payment for any of the following:

- a. Loss of anticipated profits.
- b. Consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities and insolvency.
- 240 c. Expense of claim preparation and submission, including but not limited to attorney's fees, consultant's fees and expenses and litigation expenses.
- d. Interest.
- e. Home office overhead in excess of that provided for in the contract.

4. Unacceptable Cost Calculation Methods

250 The Department will not make any payments for costs calculated using any of the following methods:

- a. Total cost methods based on calculation of costs as the difference between the Contractor's bid for the work and the Contractor's calculation of the costs for the work.

- b. Calculation of home office overhead using the Eichleay Formula or other formulas used to calculate home office overhead due to delay.

260 **104.03 Extra Work**

Unforeseen work, for which there is no price included in the contract, shall be performed whenever it is deemed necessary to fully complete the contract within its intended scope, or it is in the best interest of the State to complete the unforeseen work under the contract. Such work shall be performed in accordance with the specifications and as directed, and will be paid for in accordance with 109.05.

104.04 Maintenance of Traffic

270 Unless otherwise provided, the road shall be kept open to all traffic while undergoing improvements. Where so provided on the plans, the traffic may be bypassed over an approved detour route. The detour route markings shall be erected, maintained, and removed by the Contractor.

Maintenance of traffic shall be in accordance with the details as shown on the plans or as directed. If an alternate plan for maintaining traffic is requested, it shall be submitted in writing as soon as possible for consideration. Such submittal shall include the complete details of the alternate maintenance of traffic scheme including all traffic control devices to be incorporated. If approved, the alternate plan shall not increase the cost of maintaining traffic to the Department.

280 The portion of the roadway being used by public traffic shall be kept in such condition that such traffic will be adequately accommodated. Drums in accordance with 801.09 shall be placed at 200 ft intervals where drop-offs of greater than 3 in. are adjacent to the shoulder until the aggregate or earth wedge is placed. Temporary approaches to businesses, parking lots, residences, garages, farms, and crossings and intersections with trails, roads, and streets shall be provided in a safe condition.

290 All traffic control devices shall be maintained with no additional payment, except as set out in 107.18. Regulatory controls shall not be changed by the Contractor without prior approval. Regulatory control devices may be relocated in order to enable necessary construction, provided these control devices remain effective and convey the intended meaning after relocation to a position which complies with the requirements of the MUTCD. After completion of the construction, regulatory control devices which were relocated to facilitate construction shall be permanently installed with no additional payment, in accordance with the plans, or as otherwise directed. All traffic control devices damaged, while being moved or handled, shall be replaced with no additional payment. All other traffic control devices necessary to maintain safe traffic operation and routings shall not be removed, changed, or relocated, except as authorized. Traffic control devices removed without authorization shall be replaced with no additional payment.

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The cost of maintaining traffic over the section of road undergoing improvement and the cost of the construction and maintenance of such necessary features as approaches, crossings, and intersections shall be included in the contract unit price bid for maintenance of traffic pay items as set out in the Schedule of Pay Items, except as provided in 104.04(a), 104.04(b), and 107.18.

(a) Special Detours

310 When the Schedule of Pay Items contains a pay item for maintenance of detours or removing existing structures and maintaining traffic, the payment for such pay item shall cover all cost of constructing and maintaining such detour or detours, including the construction of temporary bridges and accessory features and the removal of the same in accordance with 713.08.

(b) Maintenance Directed by the Engineer

If special maintenance is directed for the benefit of the traveling public, payment will be made on the basis of unit prices or in accordance with 104.03 or 105.13. The Engineer will be the sole judge of whether special maintenance shall be performed.

320 Except as otherwise expressly provided in the contract, existing Department maintained roads and other public roads and streets within the limits of the contract shall be kept open to two-way traffic between the dates of December 1 and April 1.

330 Where the surface on an existing road or street is disturbed by the Contractor and the entire depth of the new surface is not completed prior to December 1, two-way traffic shall be maintained between the above dates on the partially completed new surface or on a temporary surface satisfactory for two-way traffic. Such surfaces shall be maintained between the above dates with no additional payment. Precautions shall be taken to prevent unnecessary damage to partially completed surfaces. All portions which become damaged shall be repaired with no additional payment.

Public roads, commercial and private drives, and mailbox approaches which are disturbed, and on which the surfacing has not been completed, shall be maintained in a condition satisfactory for use during the time work is suspended.

340 Where such approaches have been constructed to grade and drainage structures installed, the approaches shall be surfaced with compacted aggregate, No. 53, to a depth as directed. Such surfacing material, which is incorporated in the finished work, will be paid for at the contract unit price. The following season, the surfacing on the approaches shall be completed to the compacted depth shown on the plans by the addition of the surfacing material specified in the contract. During suspension of the work where such approaches have not been constructed to grade, a satisfactory temporary surface shall be provided with no additional payment.

(c) Blank

(d) Traffic Control for Patching on a Two-Lane Roadway

The work specified shall be arranged and prosecuted in accordance with the

104.05

applicable requirements of 107 and 801, and as shown below.

350 Only one lane may be closed at a time.

A minimum of two drums shall be placed on the traffic approach side of each concrete patch or opened hole.

Patching on a two-lane roadway shall be in accordance with 305 and the details shown on the plans. Traffic restrictions will be allowed during daylight hours only. If the Contractor is unable to fill an area to be patched with concrete during daylight hours, the patch shall be filled with No. 53 aggregate for the times other than daylight hours. Drums in accordance with 801.09 shall be placed at the side of the roadway at the patch locations. If an opened hole cannot be patched for two or more calendar days, a 6 in. HMA cap shall be placed in the hole if concrete cannot be obtained. A watcher will be required while the roadway is temporarily patched.

104.05 Removal and Disposal of Structures and Obstructions

Unless otherwise provided, any existing structure or parts thereof, fence, building, or other encumbrance or obstruction upon or within the limits of the right-of-way which interferes in any way with the new construction shall be removed with no additional payment.

370 All removal of structures and obstructions the Contractor is directed to perform outside the construction limits for the benefit of the Department, including work needed for utility relocation, and not simply for the Contractor's convenience, will be paid for in accordance with 104.03 or 109.03.

Materials belonging to abutting property owners shown to be retained for the property owner shall be stockpiled in an acceptable manner at a designated area off the right-of-way. Materials not shown to be retained, except those materials mentioned in 104.06 or 805.03, shall become the property of the Contractor and shall be removed or disposed of according to the contract.

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Materials to be salvaged for Department use shall be removed without damage in sections that can be readily transported. These materials shall be stockpiled neatly at locations identified on the plans or identified by the Engineer.

104.06 Removal and Disposal of Regulated Materials

The removal, testing, transportation, or disposal of regulated materials, except for paint removal and disposal operations described in 619, shall be in accordance with the requirements included herein and the applicable Federal, State, and local laws, regulations, and rules. These include, but will not be limited to, the requirements of the Federal Toxic Substances Control Act, the Federal Resource Conservation Recovery Act, the Federal Comprehensive Environmental Response Compensation Liability Act, OSHA, IDEM, and State rules requiring certification of underground storage tank removal firms.

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Regulated materials will consist of those as follows:

- 400
- (a) materials which are classified as a hazardous waste, hazardous substance, or hazardous material under the regulations of the EPA or the United States Department of Transportation; and
 - (b) materials which contain more than 1% asbestos and are friable, or have high probability of becoming friable as per 326 IAC 14-10.

410 The Contractor shall be responsible for proper handling, storage, transportation, and disposal of all regulated materials which are brought onto the site by the Contractor. This shall include those materials which are required under the contract. The Contractor shall comply with all applicable laws, regulations, and rules regarding such materials. All spills of regulated materials, caused by the negligence of the Contractor shall be cleaned up in accordance with the applicable laws, regulations, and rules.

Except as provided herein, the Department will be responsible for proper handling, storage, cleanup, removal, testing, transportation, and disposal of all regulated materials, which are located within the project limits including materials that have spread beyond the project limits except for those materials brought onto the site by the Contractor. The following procedure shall be used for regulated materials under 42 U.S.C. 6921 et seq, 42 U.S.C. 9601 et seq, 40 CFR 260, 49 CFR 171-179, IC 13-7, 329 IAC 2-21, or other applicable environmental laws, regulations, or rules:

420 **(a) For Such Materials which are Identified in the Proposal Book as Being Present on the Project Site**

- 430
1. The Department will provide in the Proposal book all known information of all such materials known or suspected to exist within or adjacent to the project limits.
 2. The Contractor shall act only under the written direction of the Department regarding the removal, testing, transportation, or disposal of all such materials. Such written instructions may be provided in the Proposal book or in accordance with 104.03.
 3. Except as provided herein, the Contractor shall follow the construction requirements shown in 200.
 4. The Department will be listed as the owner or the generator on all regulated material manifests. If disposal is required for such materials, the Department will approve, in writing, the appropriate licensed disposal site. The Department will retain title to all such regulated materials which are being disposed.

104.06

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Payment for all work relating to removal, testing, transportation, or disposal of all regulated materials will be made in accordance with 202.14.

(b) For Such Materials which are not Identified in the Proposal Book as Being Present on the Project Site

Materials suspected of being regulated and discovered by either the Contractor or the Department shall be subject to the procedure described below.

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1. If such materials are discovered by the Contractor, the Contractor shall cease all operations in the immediate vicinity and shall promptly notify the Engineer. If the material discovered is being released to the surrounding environment or if there is a perceived health threat, the Contractor shall immediately notify the State Police, IDEM's Office of Environmental Response, the local fire department, the county emergency management coordinator, and the Engineer.

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2. If the Contractor determines that a tank now contains, or previously contained, a listed hazardous waste as defined by the RCRA, the Engineer shall be notified. No further work shall be done with such tank until directed.

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3. If such materials are discovered by the Department, the Engineer will promptly notify the Contractor. The Contractor shall immediately cease all operations in the immediate vicinity.

4. If the substance is unknown, the Contractor shall take no action to identify the substance until receiving written instructions from the Department to conduct tests necessary to identify the material.

5. The Contractor shall test those areas for materials and products as directed by the Department.

6. All required sampling and testing shall be performed by an environmental engineer or hazardous materials manager, environmental specialist, qualified laboratory, or other person experienced in such work.

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7. Once an unknown material has been identified and emergency response is concluded, the Contractor shall follow written instructions from the Department regarding removal, additional testing, transportation, or disposal of the regulated material, subject to the requirements as follows:

- 490 a. Except for testing which the Contractor has been directed to perform, the Contractor shall not resume work in the vicinity of the hazardous condition or in such affected area until after the Department has obtained all required permits, approvals, notices of intent, or other submittals including, but not limited to, the following, as applicable:
- (1) Air emissions registration or permit.
 - (2) Stormwater NPDES permit.
 - (3) Sewer discharge permit/local POTW approval.
 - 500 (4) Regulated material characterization.
 - (5) Treatment/disposal facility profiles and approvals.
 - (6) Notification of hazardous waste activity as a generator and EPA identification number.
 - (7) Submittal of a waste analysis plan to the EPA for treatment on-site in tanks and containers.
 - 510 (8) Hazardous waste permit for on-site treatment or storage of hazardous waste.
 - (9) Advanced notification to IDEM for asbestos removal.
- b. The Department will provide written notice to the Contractor specifying the hazardous conditions and that the affected area is, or has been, rendered safe for the resumption of work, or specifying the conditions under which work may be safely resumed.
- 520 Payment for all work relating to removal, testing, transportation, or disposal of such materials will be in accordance with 104.03 utilizing pay items in 202.14.
- c. Adjustments, as warranted by the specific circumstances, will be made to the contract price, contract time, or both as a result of such work stoppage or such special conditions under which the Contractor agrees to resume work. Contract time will not be adjusted on completion date contracts.
- 530 d. The Department will be listed as the owner or the generator on all regulated material manifests or documents.

104.07

- e. If disposal is required for such materials, the Department will approve, in writing, the appropriate licensed disposal site.
- f. The Department will retain title to all such regulated materials, which are being disposed.

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- 8. Except as provided herein, the Contractor shall follow the construction requirements shown in 202.

104.07 Rights in and Use of Materials Found in the Project Site

550 Except for hazardous wastes, hazardous substances, hazardous materials, and asbestos which are subject to 104.06, and lead and zinc bridge painting debris which is subject to 619, all materials designated to be removed from the project and not used in the work shall become the property of the Contractor, unless otherwise set out in the Proposal book. The value of these materials shall be taken into account when the bid is being prepared.

Construction materials such as gravel, stone, or sand found in the excavation shall not be used for purposes other than indicated on the plans without written approval. When such approval is given, it shall state explicitly the provisions under which it is granted.

560 On all contracts involving construction within the corporate limits of cities and towns in which items such as drainage structure castings, or other items having a salvage value, are to be removed, the removed items shall remain the property of the governmental bodies involved as specified in the Proposal book or as shown on the plans. Otherwise, these items shall be disposed of in accordance with these Standard Specifications. The cost of such disposal shall be included in the contract unit prices of the various pay items of the contract, unless otherwise provided.

Archaeological artifacts encountered during construction shall be addressed in accordance with 107.10.

104.08 Final Clean-Up

570 Before acceptance and final payment, the right-of-way, borrow and disposal areas, and all ground occupied in connection with the work shall be cleaned of rubbish, excess materials, temporary buildings, structures, and equipment. Waterways shall be left unobstructed.

All property which may have been damaged in the prosecution of the work shall be restored in an acceptable manner. All parts of the work shall be left in a neat and presentable condition.

All equipment shall be removed from the right-of-way.

580 Unless otherwise provided, all falsework, piling, concrete or timber mudsills, or

similar material placed during construction and not required in the completed work, shall be removed entirely or cut off at least 2 ft below the finished ground. Within a low water channel they may be removed or cut off even with the stream bed.

SECTION 105 – CONTROL OF WORK

105.01 Authority of the Engineer

The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work, which may arise as to the interpretation of the plans and specifications, and as to the acceptable fulfillment of the contract on the part of the Contractor.

10 The Engineer will have the authority to suspend the work wholly or in part for failure to carry out provisions of the contract; for failure to carry out orders; for such periods as may be deemed necessary due to unsuitable weather; for conditions considered unsuitable for prosecution of the work; or for any other condition or reason deemed to be in the public interest. Any contract adjustments for suspension of work will be in accordance with 104.02(b). Work shall not be suspended without written authority from the Engineer.

105.02 Plans and Working Drawings

20 Road plans will show in detail structures of up to and including 20 ft spans, lines, grades, typical cross sections of the improvement, and general cross sections. They may also show general features of bridges. Bridge plans will show general plans and details of bridges.

Working drawings as defined in 101.78 shall be furnished.

All working drawings and design calculations shall include the contract number, the Contractor's name, and contact person.

30 Working drawings shall be submitted as soon as practical after contract award in a format acceptable to the Engineer. Working drawings will be reviewed for design features only. The Contractor shall be responsible for dimensions, accuracy, and fit of work. Welding symbols used on working drawings shall be those shown in AWS A2.4 standards.

Design calculations required for approval for construction purposes shall be submitted as soon as practical after contract award in a format acceptable to the Engineer. When requested, a longhand example of the design methodology shall be furnished if the design calculations are in a computer-printout format.

40 Working drawings and design calculations for permanent work items shall be signed by and shall bear the seal of a professional engineer. Design calculations and drawings shall be checked for accuracy by a second qualified individual. This

individual shall include their initials on the drawings and calculations. The qualifications of the checker shall be commensurate with the items being reviewed.

Working drawings for temporary work items shall be signed by and shall bear the seal of a professional engineer.

50 Working drawings shall be furnished for commercially available patented devices that appear on a QPL as published by the Department. Drawings shall be signed by and shall bear the seal of a licensed professional engineer. However, the professional engineer signing and stamping these drawings may be licensed in any state. Manufacturer's installation manuals shall be provided with the working drawings and will remain the property of the Department.

Working drawings and design calculations will be returned either approved or showing changes or corrections required within 14 calendar days of receipt. If required to be changed or corrected, the drawings shall be resubmitted until they receive approval.

60 Fabrication or construction shall not start on an item of work before working drawings are approved. Authorized alterations will be endorsed on approved plans or shown on supplementary sheets. All work done or material ordered prior to the approval of such plans and drawings shall be at the risk of the Contractor. Department approval of working drawings will not release the Contractor from the responsibility for errors, adequacy or safety of falsework, cofferdams, or other temporary work or risk in connection with the work. Prior to final acceptance, the Contractor shall provide a copy of all approved working drawings, including all approved modifications.

105.03 Conformance with Plans and Specifications

70 All work performed and all materials furnished shall be in reasonably close conformance with the lines, grades, cross sections, dimensions, and material requirements, including tolerances, as shown on the plans or indicated in the specifications. Any deviation from the plans or specifications that may be required by the constraints of construction will be determined by the Engineer and authorized in writing.

80 Plan dimensions and contract specifications values are to be considered as the target value to be strived for and complied with as the design value from which any deviations are allowed. It is the intent of the specifications that the materials and workmanship shall be uniform in character and shall conform as nearly as realistically possible to the prescribed target value or to the middle portion of the tolerance range. The purpose of the tolerance range is to accommodate occasional minor variations from the median zone that are unavoidable for practical reasons. When a maximum or minimum value is specified, the production and processing of the material and the performance of the work shall not be preponderantly of borderline quality or dimension.

90 When construction equipment, office equipment, production equipment, or testing equipment are specified in metric sizes, any such equipment that has been built to nearly equivalent English system dimensions will be accepted. When such equipment is specified in English system sizes, any such equipment that has been built to nearly equivalent metric sizes will be accepted.

100 If the Engineer finds the materials or the finished product in which the materials used are not within reasonably close conformance with the plans and specifications but that reasonably acceptable work has been produced, the Engineer will determine if the work will be accepted and remain in place. In this event, the basis of acceptance will be documented by an appropriate adjustment in the contract price for such work or materials as deemed necessary to conform to the determination based on engineering judgment.

If the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformance with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected with no additional payment.

105.04 Coordination of Plans, Standard Specifications, and Special Provisions

110 The Standard Specifications, the plans, special provisions, and all supplementary documents are essential parts of the contract. A requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; and the following relationships apply:

Instruction to Bidders and description of pay items listed in the Schedule of Pay Items	hold over:	Unique Special Provisions Plans Recurring Special Provisions Standard Specifications
Unique Special Provisions	hold over:	Plans Recurring Special Provisions Standard Specifications
Plans	hold over:	Recurring Special Provisions Standard Specifications
Recurring Special Provisions	hold over:	Standard Specifications

In case of discrepancy relative to other contract documents, the QPL will be regarded the same as Recurring Special Provisions. Notes on the plans which are not

105.05

120 also included in either the special provisions or among the general notes portion of the plans, and refer to payment, non-payment, or cost to be included in that of other pay items, will not govern over specifications. The precedence outlined herein shall not absolve the Contractor of its responsibility in accordance with 107.17.

Advantage shall not be taken of any apparent error or omission in the plans or specifications. In the event such an error or omission is discovered, the Engineer shall be notified immediately. Such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications will then be made.

105.05 Cooperation by Contractor

130 The Department will furnish the Contractor all contract documents in electronic format without charge. The Contractor shall be responsible for supplying all necessary information for use by contractor and subcontractor personnel.

The work shall be given the constant attention necessary to facilitate the progress thereof. The Contractor shall cooperate with the Engineer, technicians, inspectors, and other contractors in every way possible.

140 Where new work is to be fitted to old work, the Contractor shall check all dimensions and conditions in the field prior to ordering material and assume responsibility for fit of new work to old.

The Contractor shall have available at all times, and on the work site when work is in progress, as its agent, a competent superintendent capable of reading and understanding the plans and specifications and experienced in the type of work being performed. The superintendent shall receive instructions from the Engineer or its authorized representatives and shall have full authority to execute orders or directions without delay. They shall promptly supply such materials, equipment, tools, labor, and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet.

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105.06 Cooperation with Utilities

Prior to letting the contract, the Department will notify all known utility companies, all pipeline owners, or other parties affected. The Department will endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of construction completed.

160 Waterlines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, except as otherwise provided for in the special provisions or as noted on the plans.

The plans show all known utilities located within the limits of the contract according to information obtained from the various utility companies. The accuracy

of the plans in this respect is not guaranteed by the Department. All of the permanent and temporary utility appurtenances in their present or relocated positions as shown on the plans shall have been considered in the bid.

170 If work by one or more utilities is contingent on work by the Contractor or another utility, the Contractor shall keep all parties informed of the status and estimated completion date for the advance work in order to give each utility as much notice as possible to schedule crews and material for their relocation work.

180 The contract documents identify each known utility and describe all known necessary work and an anticipated schedule for completion. However, if a utility fails to relocate or adjust their facilities as provided for in the contract documents and the Contractor sustains delays, losses, or both, that could not have been avoided by the Contractor's judicious handling of forces, equipment, and plant or by reasonable revisions to the schedule of operations, and the Contractor has documented its utility coordination efforts and sustained delays and losses, and if the sustained delays and losses were not caused by the negligence of the Contractor, the Contractor may pursue appropriate compensation under 104.02 or from the documented offending party in accordance with Public Law 35-2005.

If the Contractor is delayed and it provides the aforementioned information to the Engineer, the time for completion may be extended in such amount as the conditions justify or the Contractor may be compensated for an accelerated construction schedule.

190 **105.07 Cooperation Between Contractors**

The Department may at any time contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of a project, each contractor shall conduct its work so as to not unnecessarily interfere with or hinder the progress or completion of the work being performed by other contractors.

Contractors working on the same project shall cooperate with each other as directed.

200 Each contractor involved shall assume all liability, financial or otherwise, in connection with its contract and shall protect and save harmless the Department from all damages or claims that may arise because of inconvenience, delay, or loss experienced by such contractor because of the presence and operations of other contractors working within the limits of the same project.

210 Work shall be arranged and the materials being used shall be placed and disposed of so as to not interfere with the operations of the other contractors within the limits of the same project. Work shall be joined with that of the others in an acceptable manner. It shall be performed in proper sequence to that of the others.

105.08 Construction Stakes, Lines, and Grades

(a) Construction Engineering by the State

Unless otherwise provided, the Engineer will set construction stakes establishing lines, slopes, continuous profile-grade, centerline of roadway, centerline of piers and abutments, a benchmark adjacent to the work, and vertical control elevations for items including but not limited to flow lines, footings, caps, bridge seats, and screed elevations. In addition, all necessary information will be furnished relating to lines, slopes, and grades. Using the control lines and grades as established, the Contractor shall be responsible for completing the layout and performing the work.

The Contractor shall be responsible for the accuracy of transfer from the control lines and grades and layout of the work. The Contractor shall notify the Engineer to locate all existing underground traffic signal and lighting wiring. The Engineer will only perform this locate service once per construction season per contract. The Contractor shall also be responsible for the preservation of all stakes and marks. If the construction stakes or marks are carelessly or willfully destroyed or disturbed by the Contractor or its employees, the cost to the Department for replacing them will be charged against the Contractor. Such costs will be deducted from payment for the work.

All stakes, templates, straightedges, and other devices necessary for checking, marking, and maintaining points, lines, and grades shall be furnished with no additional payment.

The Department will be responsible for the accuracy of control lines and grades established by the Engineer. If there is an error in the establishment of the original construction or survey stakes set, and discovered after the work has been fully or partially completed in compliance with the erroneous stakes, payment for such additional work as may be required because of such error will be made at the contract unit price for the class of work involved.

(b) Construction Engineering by the Contractor

If set out as a pay item, the construction engineering, including all staking and layout usually done by the Department, shall be performed by the Contractor. Construction engineering shall include re-establishing the survey points and survey centerlines; referencing the necessary control points; running a level circuit to check or re-establish plan benchmarks; running a level circuit to establish elevations on new benchmark tablets; setting stakes for right-of-way, culverts, slopes, subbase, underdrains, paving, subgrade, bridge piers, abutments, and all other stakes required for control lines and grades; setting vertical control elevations, such as footings, caps, bridge seats, and screed elevations; and obtaining flowline elevations. Construction engineering shall also include documenting the underground wiring as located by the Department.

The Contractor shall notify the Engineer to locate all existing underground traffic signal and lighting wiring. The Engineer will only perform this locate service once per

260 construction season per contract. The required documentation shall be performed and
a copy provided to the Engineer as soon as practical after the locations have been
marked. Documentation which is not provided to the Engineer in a timely manner shall
not be considered valid for the purpose of resolving conflicts related to the accuracy
of the location markings. The documentation may be digital pictures, regular photos,
or sketches of the areas marked. The documentation shall be such that the underground
wiring can be easily and accurately re-established in the field by the Contractor, if
needed.

270 The Contractor shall schedule its construction engineering operation, including
staking, in a timely fashion so as to assist the utilities in the relocation or adjustment
of their facilities as early as possible in the contract. All staking the Contractor is
directed to perform to assist the utilities' relocation and which is considered to be in
addition to the normal staking required, will be paid for in accordance with 104.03 or
109.03.

280 A complete cross section shall be taken at each 500 ft interval. Horizontal control
shall be checked at the beginning and ending of the mainline and all "S" lines. This
information shall be used to verify that the planned alignment and elevations will
match existing conditions. Required alignments and elevations will be shown on the
plans.

Prior to incorporating established grades, the Contractor will be required to
determine that all other planned elevations are in accordance with field conditions.
The profiling of existing pavements beyond tie-in points for proper ride, profiling of
existing ditches for proper flow, and visual observations that driveways or sidewalks
may be constructed satisfactorily, will be required.

290 Interstate routes and other divided lane pavements shall be checked for the vertical
clearance under structures to ensure that a minimum of 16 ft is maintained over the
traffic lanes and paved shoulder. Ramps which connect to the above type pavements
shall provide the same clearance. All other pavements shall be checked for the vertical
clearance under a structure to ensure that a minimum of 14 ft is maintained over the
traffic lanes and paved shoulders. Grade transitions shall be tapered to meet the grade
of the pavement under a structure a minimum of 100 ft away from the structure and
at a rate not to exceed 0.14%. All discrepancies shall be brought to the immediate
attention of the Engineer. All changes in the design will be provided by the
Department. Field adjustments that do not affect the design shall be made by the
Contractor and the Engineer shall be notified. Adequate control stationing shall be
maintained throughout the length of the project. At the end of the contract all survey
control points that fall within the right-of-way shall be established. At the end of the
300 contract, the Contractor shall provide the necessary centerline layout so that the final
sections may be taken by the Department.

The re-establishment of the centerline control points shown on the plans, right-of-
way points used for fence or markers, and section corners shall be performed by a land

surveyor who is registered in the State or by people under the direct supervision of said land surveyor, per the requirements of IAC Title 865 of the State Board of Registration for Professional Surveyors Statutes and Rules.

Benchmarks and elevations shall be established on new or rehabilitated bridges.

310 The elevations shall be tied to the United States Geodetic Survey system providing there is an existing monument within a radius of 3 mi of the bridge site. If a monument is not within this distance, the elevation of the new benchmark shall be established from the benchmarks shown on the plans. Tablets will be furnished by the Department and shall be set in the new concrete at the locations directed. The Contractor shall document the elevation on the proper forms furnished by the Department. The forms shall be signed, sealed, and dated by a land surveyor or engineer who is registered in the State. The work shall be performed in accordance with Part 1, Chapter 106 of the Department's Design Manual. Copies of the forms shall be provided to the Engineer for distribution.

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All stakes, templates, straightedges, and other devices necessary for checking, marking, and maintaining points, lines, and grades shall be furnished.

On a road contract, the level circuit to check the plan benchmarks shall be run for the full length of the project. Intermediate benchmarks shall be established approximately every 500 ft through the project. On a bridge contract, the circuit shall include four plan benchmarks, if available, two on each side of the structure.

330 Field notes shall be kept in hard covered field books in a clear, orderly, and neat manner consistent with standard engineering practices and in accordance with the Department's prescribed field book procedure, including titles, number, and indexes. Such field books shall be furnished by the Contractor and shall adequately document all survey information. Copies of field book shall be furnished to the Engineer upon request during the life of the contract. The original field notes shall become the property of the Department upon completion of the work. Such field notes shall be bound. All pages shall be numbered before submission to the Department.

340 After the grade stakes have been set for earthwork, an elevation on the top of each stake shall be taken. Such elevation shall be tied into a permanent plan benchmark. Using this information in conjunction with the plans, a grade sheet shall be prepared. Grade sheets shall also be prepared for special ditches.

When staking culverts, the Contractor shall perform the necessary checking to establish the proper location, length, skew, and grade. Prior to culvert installation the Engineer will approve adjustments in the location, length, skew, and grade to fit best the conditions on the site. The Contractor will not be responsible to verify that the culvert is of adequate opening.

350 Where sumping is shown on the plans, the Contractor shall obtain the existing flowline elevation. This information will be used to verify that the planned sump depth

matches existing conditions. Prior to culvert or bridge working drawing design the Engineer will determine adjustments in footing or invert elevation necessary to provide the appropriate sump depth.

360 The Engineer will make all measurements and surveys that involve the determination of final pay quantities, including original and final cross sections for all earthwork. The accuracy of the construction engineering may be checked as necessary, but responsibility for the accuracy of engineering layout or the final result of construction accuracy will not be assumed. The staking by the Contractor shall be done similar to the standard procedure for Department engineering personnel. All inspection and testing will be performed by Department personnel.

The supervision of the Contractor's construction engineering personnel shall be the responsibility of the Contractor. All errors resulting from the operations of such personnel shall be corrected with no additional payment.

370 The Contractor shall not engage, on full-time, part-time, or other basis during the contract time, professional or technical personnel who are or have been, during the contract time, in the employment of the Department, except regularly retired employees, without the written consent of the Commissioner.

Construction engineering as specified herein will be paid for at a contract lump sum price. The cost of furnishing all necessary personnel, equipment, and supplies to accomplish the work shall be included in the cost of this work. A change in plans or scope of work which causes the Contractor's construction engineering cost to increase or decrease by \$500.00 or more per occurrence will be paid for or deducted from the original lump sum price bid for construction engineering. An amount of less than \$500.00 per occurrence will not be considered for price adjustments.

380 **(c) Production Staking by the Contractor**

When specified, production staking shall be performed by the Contractor. Production staking shall include staking for finishing subgrade and placing subsurface drains, subbase, adjacent curbs or curbs and gutters, and all types of pavement, including base and surface. It shall also include the furnishing of all labor, equipment, and supplies except field books required to complete the work and the staking and re-staking involved in any authorized alteration of the plans or added work in the specified items. It does not include staking right-of-way, setting slope stakes, referencing points, and preparing grade sheets for rough grading. Rough grade staking will be performed by the Department.

390 Notes for production staking shall be prepared in standard field books in a clear, orderly, and neat manner consistent with good engineering practices and in accordance with the Department's prescribed note book procedure. Notes shall be kept in a manner which can be checked readily and shall be available upon request. Grades and other information, which are obtainable from the plans, shall be computed and transcribed to the books. The Contractor shall be responsible for the accuracy of the transfer of

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the information to the finished work. Errors caused by inaccurate staking of grades and lines shall be corrected with no additional payment. The method of staking will be subject to approval. Stakes shall be set and marked in a manner that will enable checking. Completed staking shall be preserved as long as required for inspection and checking of the work.

Standard field books will be furnished which will remain the property of the Department and shall be returned at the completion of the work. Point references, required benchmark data, and information which is not obtainable from a complete set of contract documents will be furnished. The Department will be responsible for errors in the plans or other information furnished for layout purposes. If an error is discovered after the work is fully or partially completed and the error is the result of erroneous information, payment will be made for additional required work at the contract unit price for the work involved.

Production staking will not be paid for directly. The cost thereof shall be included in the cost of the pay items involved.

105.09 Duties of Technician and Inspector

The technicians and inspectors employed by the Department are stationed on the work to:

- (a) keep the Engineer informed as to the progress of the work and the manner in which it is being done;
- (b) report whenever it appears that the materials furnished and the work performed fail to fulfill the requirements of the specifications and contract; and
- (c) call to the attention of the Contractor, as the work progresses, all known deviations from, or infringement upon, the plans and specifications with respect to materials and workmanship.

Technicians and inspectors will be authorized to inspect all work done and materials furnished and to exercise such additional authority as may be delegated to them in writing. Such inspection may extend to all of the work done and material furnished. They shall have authority to reject defective materials and to suspend any work that is being improperly done, subject to the final decision of the Engineer.

Such inspection will not relieve the Contractor from any obligation to furnish acceptable materials or to perform all work strictly in accordance with the requirements of the plans and specifications.

Technicians and inspectors will not be authorized to revoke, alter, enlarge, relax, or release any requirements of the specifications; not to approve or accept any portion of the work; not to issue instructions contrary to the plans and specifications.

Technicians and inspectors will not, in any case, act as foremen or perform other duties for the Contractor, nor interfere with the management of the work. Any advice which technicians and inspectors may give the Contractor will not be construed as binding the Engineer or the Department in any way or as releasing the Contractor from the fulfillment of the terms of the contract.

450 **105.10 Inspection of Work**

All materials and each part or detail of the work will be subject to inspection. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance as is required to make a complete and detailed inspection. Such inspection may include preparation and manufacture of the materials at the plant.

460 At any time before acceptance of the work, such portions of the finished work shall be removed or uncovered as may be directed. After examination, said portions of the work shall be restored to the standard required by the specifications. If the work thus exposed or examined proves to be acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for in accordance with 109.05. If the work so exposed or examined proves to be unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be with no additional payment.

470 All work done or materials used without supervision or inspection by an authorized Department representative may be ordered removed and replaced with no additional payment unless the Department representative failed to inspect after having been given reasonable notice in writing that the work was to be performed.

When work covered by the contract is being done under an agreement with a unit of government or political subdivision, or a railroad corporation, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make such unit of government or political subdivision or such railroad corporation a party to the contract, and shall in no way interfere with the rights of either party hereunder.

105.11 Removal of Unacceptable and Unauthorized Work

480 All work which is not in accordance with the contract will be considered as unacceptable work, subject to conditions set out in 105.03.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner.

No work shall be done unless lines and grades have been given or approved. Work done contrary to instructions, work done beyond the lines shown on the plans or as

490 given, except as herein specified, or any extra work done without authority will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced with no additional payment.

If the Contractor fails to comply forthwith with any order made under the provisions of this subsection, the Engineer will have authority to cause unacceptable work to be remedied or removed and replaced; to cause unauthorized work to be removed; and to deduct the costs from any monies due or to become due.

105.12 Load Restrictions

500 Legal load restrictions shall be complied with on public roads beyond the limits of the project. A special permit will not relieve the Contractor of liability for damage which may result from the moving of equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or the roadway or to any other type of construction will not be allowed. No loads will be allowed on concrete pavement, concrete bases, or structures before the expiration of the curing period. The Contractor shall be responsible for all damage done by the Contractor, its employees, agents, or subcontractors.

510 This requirement will serve as written notice that hauling or handling of materials on completed or partially completed structures, pavement structures, or paved shoulders in excess of legal weight limits will not be allowed unless approved in advance of the operation. Approval shall be obtained from the authority having jurisdiction over the structures, pavement structures, or paved shoulders.

105.13 Maintenance During Construction

520 The work shall be maintained during construction and until the contract is accepted. This maintenance shall constitute continuous and effective work prosecuted day by day with adequate equipment and forces to the end that the roadway, structures, barricades, and construction signs are kept in satisfactory condition at all times.

Once construction operations have begun within the project limits, and through traffic is required to be maintained, the Contractor shall repair areas as directed which require special maintenance. If the repair work is determined to be required during construction and is due to the Contractor's operations, the cost of such work shall be included in the cost of other pay items. If the areas of the roadway which require repair are due to use by the traveling public or the elements of nature, and are not the fault of the Contractor, the Contractor will be paid to repair those areas of the roadway. Such work will be paid for under the appropriate pay items or in accordance with 104.03.

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If the contract includes work for the placing of a course upon a course or subgrade which the Contractor has constructed previously, such previous course or subgrade shall be maintained during all construction operations. The cost of maintaining this work shall be included in the cost of other pay items.

105.14 Failure to Maintain Roadway, Structures, Barricades, and Construction Signs

540 If the Contractor at any time fails to comply with the requirements of 105.13 and 107.12, it will immediately be notified of such non-compliance. If satisfactory maintenance is not furnished or unsatisfactory maintenance is not remedied within 24 h after receipt of such notice, the Engineer may order suspension of work and proceed to maintain the project, and all progress estimates will be withheld until the Contractor complies. The entire cost of this maintenance will be deducted from the money due or to become due on the contract. No additional contract time will be considered.

550 The Contractor may be assessed damages for failure to maintain the required traffic control devices or markings, except for construction warning lights, in accordance with 801.03. For each day, or portion thereof, during which a type of traffic control device or marking is in non-compliance, damages will be assessed at a rate of \$40.00 for each day, per non-compliant unit within a device or marking. If the pay unit for a traffic control device is per day, the damage assessment will equal twice the unit price.

Non-compliance caused by events beyond the control of the Contractor may not be assessed damages. Immediate repairs shall be made to protect the traveling public.

Assessment of damages for non-compliance of construction warning lights will be in accordance with 801.14.

560 **105.15 Acceptance and Final Inspection**

(a) Partial Acceptance

The Contractor may request a final inspection and partial acceptance if:

- 1. a usable portion of the contract one mile or more in length is completed;
- 2. a portion of the contract designated therein as a project is completed; or
- 570 3. a portion of the contract physically and functionally separate from other work areas is completed.

If the inspection shows the completed portion to be satisfactory and in accordance with the contract, that portion may be accepted and the Contractor may be relieved of further responsibility. Such partial acceptance shall in no way void or alter any of the terms of the contract.

(b) Final Acceptance

580 When the Contractor gives notice of presumptive completion of the entire

contract, an inspection will be made. If all construction provided for and contemplated by the contract is found completed satisfactorily, that inspection shall constitute the final inspection and the Contractor will be notified in writing of final acceptance. The date of final acceptance shall be the date the Contractor is relieved of further maintenance in accordance with 107.18 and as set out in the final acceptance letter. This date shall not be prior to the date of the final inspection or the date of last work. The date of last work will normally be the date the Contractor removes the last construction traffic control device.

590 If the work is not acceptable at the time of such inspection, the Contractor will be advised in writing as to the particular defects to be remedied before final acceptance. If, within a period of 10 days after such notice, steps have not been taken to complete the work speedily as outlined, the Department, acting through the Commissioner, may, without further notice and without in any way impairing the contract, make such other arrangements as may be necessary to have the work completed in a satisfactory manner. The cost of so completing the work may be deducted from money due or which may become due the Contractor on the contract.

105.16 Notice of Changed Conditions and Claims

600 Nothing in this subsection shall be construed as establishing a claim contrary to the terms as set out in 104.02.

(a) Contractual Notice of a Changed Condition

If the Contractor requests a contract adjustment for a changed condition in accordance with 104.02 notification shall be made in writing before the work is begun or expenses relating to the request are incurred.

The written notification of a changed condition shall be submitted to the Engineer and shall include the following minimum information.

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1. A statement that the submittal is notification of a changed condition.
2. The date the circumstances believed to have caused the changed condition were discovered and an explanation of how and by whom the changed condition was discovered.
3. A detailed and specific statement describing the nature and circumstances of the changed condition.

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4. A statement of the estimated effect of the changed condition on the controlling operation and the cost and contract time of the project.

If written notification of a changed condition is not given and the Engineer is not afforded the opportunity to remedy the changed condition, then no request for a

contract adjustment will be considered. Notification of a changed condition and the estimate of the cost of the change shall not be construed as validation of a changed condition. If the Engineer determines that a contract adjustment is due, payment will
630 be made as provided for herein.

No contract adjustment will be made for work performed or for expenses incurred prior to the date of notification of a changed condition. The Contractor shall diligently prosecute the work unaffected by the changed condition to the maximum extent possible.

(b) Claims

When the Contractor disputes the Engineer's determination of a remedy for a changed condition and decides to pursue further relief, a written notification of a claim
640 shall be submitted to the Engineer within 15 days of receipt of the Engineer's notification of the remedy. If the Contractor fails to submit a notice of a claim within the time specified, the Contractor shall waive any further rights to a contract adjustment due to the circumstances from which the claim arose.

1. Required Documentation

The Contractor shall submit a claim in writing to the Engineer within 30 days, or other time as mutually agreed, of when the circumstances giving rise to the claim have ended or otherwise been resolved.

650 The claim shall contain sufficient detail to enable the Engineer to determine the basis and amount of the claim. At a minimum, the following information shall be included in a claim in a format that can readily be analyzed by the Engineer. The format shall include, but not be limited to, document length page numbering, a table of contents and cross references as applicable throughout the claim documentation.

- a. A detailed factual statement of the claim providing all necessary dates, locations, and items of work affected by the changed condition.
- 660 b. The date on which the changed condition resulting in the claim occurred or became evident and an explanation of how and by whom the changed condition was discovered.
- c. A copy of the notification of changed condition as originally submitted by the Contractor.
- d. Copies of the Contractor's daily records of the changed condition as kept in accordance with 104.02(d).
- 670 e. The name and function of each individual involved in or knowledgeable about the claim.
- f. The specific provisions of the contract which support the

claim and a statement of the reasons why the provisions support the claim.

- g. A detailed factual statement of any actions taken by the Contractor to mitigate the claim.
- 680 h. The identification of documents and the substance of communications relating to the claim.
- i. A detailed factual statement supporting the Contractor's contention that the Department's decision was a breach of contract if the claim is related to a decision that the contract leaves to the Department as discretionary or final.
- 690 j. The specific amount and basis of costs sought broken down in the categories specified for force account in 109.05, including a separate calculation of markup as allowed in 109.05.
- k. The specific amount of contract time extension sought and the basis for the request, including approved and as-built bar chart or critical path method schedules depicting the affected work.
- 700 l. A notarized statement, signed by an officer of the Contractor, under the penalties of perjury, that the claim is made in good faith, that no portion of the claim has previously been paid, and that the amount of the claim and the supporting documents are true, accurate, and reflect what the Contractor believes to be the Department's liability.

The Engineer will provide a written notice to the Contractor of receipt of a claim. If the information provided by the Contractor with a claim does not contain sufficient detail to enable the Engineer to determine the basis and amount of the claim, the Engineer will notify the Contractor in writing of the specific details required. The
710 Contractor shall provide the required details within 14 days, or other time as mutually agreed, of receipt of the Engineer's request. If the Contractor fails to provide the requested details within the time frame, the Engineer's original remedy for the changed condition will be the final determination by the Department and the Contractor shall waive any further right to contest the remedy.

2. Auditing of Claims

Claims filed by the Contractor against the Department shall be subject to audit at any time following the filing of such claim, whether or not such claim is part of a suit in the courts of the State. The audit may begin a minimum of 30 days after written
720 notice to the Contractor, subcontractor, or supplier and may be extended as mutually

agreed by all parties. The Contractor, subcontractor, or supplier shall make a good faith effort to cooperate with the auditors. Failure to cooperate shall constitute a waiver by the Contractor of the claim in its entirety. Failure of the Contractor, subcontractor, or supplier to maintain and retain sufficient records to allow the Department's auditor to verify the claim shall constitute a waiver of that portion of the claim that cannot be verified and shall bar recovery.

(c) Claim Resolution Process

730 1. Project Level Review

The Contractor shall submit the claim to the Engineer at the project level. The Engineer will review the claim and make an effort to resolve the claim at the project level within 30 days of receipt of the claim, or other time as mutually agreed. Meetings may be requested by either the Engineer or the Contractor to discuss the claim in an effort to reach resolution. The Engineer will make a project level ruling on the claim and notify the Contractor in writing of the ruling.

740 If the Contractor disagrees with the project level ruling or if a ruling is not issued within the specified or agreed upon time, a written request for a District Office review may be submitted to the Engineer within 30 days of receipt of the project level ruling or the end of the time for the ruling to be issued. Failure to submit a request for District Office review within the specified time will constitute an acceptance of the project level ruling by the Contractor and a contract adjustment will be made in accordance with the ruling. The contract adjustment will be considered as full and complete compensation for the changed condition and the Contractor shall waive any right to further contest the ruling.

750 When a District Office review of the project level ruling is requested, the claim will be sent from the project office to the District Office for the review. The Contractor shall not modify the basis of the claim or the method for calculating the amount claimed after submittal to the District Office.

2. District Office Review

The Engineer will review the claim as submitted to the District Office. Meetings may be requested by either the Engineer or the Contractor to discuss the claim in an effort to reach resolution.

760 For claims with a total value less than or equal to \$150,000, 20% of the original contract amount and 100 days of contract time extension, the Engineer will review the project level ruling and issue a written District Office ruling within 45 days, or other time as mutually agreed, of the Contractor's request for a District Office claim review. A claim review by the District may affirm, overrule, or modify the project level ruling. The District ruling will specify the portions, if any, of the project ruling that are being overruled or modified and the rationale supporting the portions overruled or modified.

The Contractor may accept or reject a claim review ruling made by the District Office. If the Contractor accepts the ruling, it will be considered as the final decision

by the Department and a contract adjustment will be made in accordance with the ruling.

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If a District ruling is rejected, the Contractor may submit a written request for a final hearing before a District Claim Review Board. The request shall be submitted to the Chief Engineer within 30 days of the Contractor's receipt of the District ruling. The Chief Engineer will respond in writing to the Contractor and will convene a Board to review the claim. Failure to submit a request for a hearing within the specified time will constitute an acceptance of the District Office ruling by the Contractor and a contract adjustment will be made in accordance with the ruling. The contract adjustment will be considered as full and complete compensation for the changed condition and no further claim shall be made for the circumstances that gave rise to the claim.

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The District Claim Review Board will consist of three Department personnel selected by the Chief Engineer and will include one member from District Construction in the District involved in the claim and two members from the Division of Construction Management. The Chief Engineer will assign one member as the chairperson who will then schedule a hearing with the Contractor at a mutually agreed time and location. The Contractor will be given sufficient time at the hearing to present arguments and exhibits in support of the claim. The Board will issue a written decision within 30 days of the hearing and the decision will be considered as the final decision by the Department and no further appeal will be considered by the Department. A contract adjustment will be made in accordance with the decision of the Board and will be considered as full and complete compensation for the changed condition and no further claim shall be made for the circumstances that gave rise to the claim.

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For claims with a total value greater than \$150,000 or 20% of the original contract amount or 100 days of contract time extension, the District will forward the claim, along with the project level ruling and a District Office written opinion to Central Office for a ruling. The Contractor shall not modify the basis of the claim or the method for calculating the amount claimed after submittal to Central Office.

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3. Central Office Review

The Engineer will review the claim as submitted to Central Office from the District. Meetings may be requested by either the Engineer or the Contractor to discuss the claim in an effort to reach resolution.

The Engineer will review the claim and issue a written final ruling within 60 days, or other time as mutually agreed, of receipt of the claim from the District. A claim review ruling by Central Office may affirm, overrule, or modify the ruling made at the project level. The ruling will specify the portions, if any, of the project ruling that are being overruled or modified and the rationale supporting the portions overruled or modified.

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The Contractor may accept or reject a claim review ruling made by Central Office. If the Contractor accepts the ruling, it will be considered as the final decision by the

Department and a contract adjustment will be made in accordance with the ruling.

820 If a Central Office ruling is rejected, the Contractor may submit a written request that the matter be discussed before a civil mediator. The request shall be submitted to the Chief Engineer within 30 days of the date of the Central Office ruling. Failure to request mediation within the specified time shall constitute acceptance of the Central Office ruling by the Contractor and a contract adjustment will be made in accordance with the ruling. The contract adjustment will be considered as full and complete compensation for the changed condition and no further claim shall be made for the circumstances that gave rise to the claim.

830 Upon receipt of the request for civil mediation, the parties will select a mutually agreed upon certified mediator from the list of mediators eligible to perform civil mediations in the State of Indiana. The mediator shall be familiar with the highway and bridge construction industry but shall not have any financial interests in the parties. The mediation shall be conducted in Indianapolis, Indiana pursuant to the applicable rules of the Indiana Supreme Court governing civil mediations in the State of Indiana. The mediator will schedule the mediation as soon as practicable, preferably within 60 days of selection. In the event settlement is reached, a summary of agreement will be prepared. Either party or the mediator may declare the mediation to be unsuccessful. By requesting mediation, it is agreed that, as with other civil mediations, the discussions and proceedings at mediation are considered part of settlement negotiations and are inadmissible in any civil proceeding.

840 The Contractor and the Department mutually agree that use of the claim resolution process up to and including the utilization of a mediator is a condition precedent to the filing of any lawsuit concerning claims or alleged breaches of the Contract. The costs and expenses associated with use of the mediator shall be borne by both parties equally. Each party to the mediation shall bear its own costs in preparation and participation.

SECTION 106 – CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements

The Contractor shall furnish the Engineer a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work at the preconstruction conference. If, during the course of the contract, changes or additions to the statement are required, the Contractor shall provide the information five calendar days prior to the source supplying materials to the project.

10 (a) Approved or Prequalified Materials

Certain materials and equipment require pre-approval by brand name or source of manufacture. The lists of qualified products, QPL, are maintained by the Department as provided in the specifications. The Department will review all QPLs prior to January 1 of even numbered years. Unless otherwise provided, any item listed for three

years prior to the review without being supplied to a contract will be removed from the list.

20 The materials used shall be those prescribed for the items which constitute the finished work and shall comply with all the requirements for such materials in accordance with this specification and 900. In any combination of materials, even though the individual components meet the specifications, such combination shall also meet the specifications and produce the required results. Failure to do so will be cause for rejection.

30 Approval of a material at its source will not necessarily constitute acceptance of materials from that source. All materials tested at the source may be subjected to further testing from production to after incorporation into the work. Approval will be based on the results of tests made nearest to incorporation into the work. Material tested prior to incorporation into the work and found not to be in accordance with the requirements will be rejected. Material tested after incorporation into the work and found not to be in accordance with the requirements will be governed by 105.03.

40 If a material from a source has a continued approval as shown by five or more consecutive tests, it may, if allowed, be placed on an immediate usage basis and while on that basis may be incorporated into the work prior to the receipt of test results. If any subsequent test reveals non-conformance with the specifications, material from that source shall be removed at once from the immediate usage basis and shall not be used until tests indicate conformance. If, after any test showing non-conformance, five or more consecutive tests show conformance, the material may be restored to an immediate usage basis.

If a material on an immediate usage basis has been incorporated into the work and later is found not to be in accordance with the specifications, the Engineer may, in accordance with 105.03, require its removal from the work or allow it to remain. If allowed to remain, the appropriate contract unit price will be reduced.

All packaged materials shall be marked plainly showing the amount and nature of contents and shall be delivered intact.

50 (b) Material Records

The Engineer will prepare the material record from the documentation provided by the Contractor. The Engineer will submit the completed forms to the Contractor by the end of the fifth business day of each month for the preceding month. The Contractor shall distribute this information to the appropriate subcontractors as required. The Contractor shall review, sign, and return the material record to the Engineer by the 28th day of each month, along with documentation to support the Contractor's recommended adjustments to the record.

1. Documentation of Material Delivery

60 The Contractor shall provide a copy of each delivery ticket and certifications, if

required, to the Engineer not later than the next business day. If providing this information on the next business day is not possible, the Contractor and the Engineer will agree upon other arrangements for the receipt of the necessary documentation prior to the event.

2. Delivery Ticket Information

70 The material delivery ticket shall include an itemized quantity of all materials delivered, the date of delivery, and the contract number. The material delivery ticket shall document the source of supply and source code, if known, and shall contain information necessary to obtain a basis for use as required by Department specifications. All required certifications shall be in accordance with 916 or as directed.

3. Payment Procedures

80 If the Contractor does not provide the necessary documentation for the materials, such materials will not be paid for. The Engineer will notify the Contractor of those materials held from the estimate with the justification for withholding payment. If corrective action has not been taken within six weeks of the materials delivery to the project site, the entire estimate payment may be withheld.

(c) Buy America Requirement

All contracts shall be supplied with steel and iron products that are made in the United States and shall comply with IC 5-16-8 and the 23 CFR 635.410.

90 All steel or iron products incorporated permanently into a contract shall be made of steel or iron produced in the United States and all subsequent manufacturing shall be performed in the United States except for pig iron and processed, pelletized, and reduced iron ore. Manufacturing is any process that modifies the chemical content; physical shape or size; or final finish of a product. Manufacturing begins with the initial melting and mixing and continues through the bending and coating stages. If a domestic product is taken out of the United States for any process, it becomes a foreign source material.

Manufactured products that are partially or predominantly steel, shall be entirely produced with domestic steel. If a product has miscellaneous foreign steel incorporated, such as fasteners or brackets, then those miscellaneous pieces shall be replaced or substituted.

1. Exceptions

100 The Engineer may grant specific written permission to use foreign steel or iron products when both of the following conditions apply:

- a. The total cost of all foreign products to be used does not exceed 0.1 percent of the total Contract cost, or \$2,500, whichever is greater. The cost is the value of the product as delivered to the project.

106.02

- 110 b. The specified products are not produced in the United States in sufficient quantity or otherwise are not reasonably available to meet the requirements of the Contract Documents. The Engineer may require the Contractor to obtain letters from three different suppliers documenting the unavailability of a product from a domestic source if the shortage is not previously established by the Department.

A Buy America Certification shall be submitted and received for each product or source of material prior to being incorporated into the contract in accordance with 916.02(g) and 916.03(a).

120 **106.02 Samples, Tests, Cited Specifications**

Such facilities as may be required for collecting and forwarding samples shall be provided and the materials represented by the samples shall be held until tests have been made and such materials found to have the qualities required in the specifications. All samples required and additional material required to replace samples shall be furnished without charge.

130 To facilitate the sampling and testing of materials, the Engineer shall promptly be advised when orders for materials are placed and when such materials are received. The quantity, source of supply, and the locations where the materials have been stored shall be included in the notice.

All tests of materials will be made in accordance with the methods described or designated in these specifications. When tests are made at places other than the laboratory, every needed facility shall be furnished for the verification of all scales, measures, and other devices which are used.

140 If the Contractor elects to supply materials other than structural steel and prestressed structural members which require on-site sampling or testing as they are manufactured in out-of-state manufacturing plants located more than 60 mi outside a State line, the Contractor shall provide the sampling or testing services required. No additional payment will be made for such services. Such services shall be conducted by a Department-approved testing laboratory.

150 The standards for materials and methods of tests of AASHTO and ASTM or other specification referred to herein or elsewhere shall be the standard, interim, or tentative specifications included in the latest published edition which is on file on January 1, unless otherwise specified. Indiana Test Methods will become effective immediately upon approval by the ITM Committee unless otherwise directed. In case of discrepancy, the following relationships apply:

Special Provisions	hold over:	ITM, AASHTO and ASTM or other specification for materials and methods of tests
	ITM	hold over: AASHTO and ASTM or other specification for materials and methods of tests
	AASHTO	hold over: ASTM or other specification for materials and methods of tests

Tests will be made by and at the expense of the Department unless otherwise specified. The minimum required number of samples and tests will be as set out in the Frequency Manual. Samples will be taken by or under the supervision of a representative of the Department. All materials being used are subject to inspection, test, or rejection at any time.

106.03 Plant Inspection

The Engineer may undertake the inspection of materials at the source.

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If plant inspection is undertaken, the following conditions shall be met:

- (a) The Engineer shall have the cooperation and assistance of the Contractor and the material supplier. All reasonable facilities to assist in determining whether the materials meet the requirements of the specifications shall be furnished without additional payment.
- (b) The Engineer shall have entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.
- (c) Adequate safety measures shall be provided and maintained.

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106.04 Blank

106.05 Storage of Materials

Storage of materials shall be such that will assure the preservation of their quality and fitness for the work. When considered necessary, materials shall be placed on raised, clean platforms, constructed of wood or other hard surfaced material, and under cover. Stored materials shall be located to facilitate proper inspection. Materials to be used for all contracts shall be stored separately and intact and, after being tested for such work, shall not be used for other purposes except unless otherwise approved.

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The portion of the right-of-way not required for public travel may be used for storage purposes and for placing the Contractor's plant and equipment, subject to

106.06

requirements set out in 107.08 and only by written request. Approval will be based on compliance with 107.08 and the Contractor's proposed procedure for re-establishing vegetation in the affected area to its original condition or better. Except as provided in 105.07 and except where necessary for drainage, if storage limits are shown on the plans, the right-of-way within such storage limits will be available for construction operations and storage of materials. Private property shall not be used for storage purposes without written permission of the owner or lessee. If requested, copies of such written permission shall be furnished. All storage sites shall be restored to their original condition with no additional payment. This shall not apply to the stripping and storing of topsoil, or to other materials salvaged from the work.

106.06 Handling of Materials

All materials shall be handled in such manner as to preserve their quality and fitness for the work.

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106.07 Unacceptable Materials

All materials not in accordance with the specifications shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work unless otherwise instructed. No rejected material, the defects of which have been corrected, shall be used until approval has been given.

If rejected materials are not removed within the time specified, the Department may order their removal with no additional payment or complete the contract in accordance with 108.09.

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106.08 Hazard Communication Program

The Contractor and all subcontractors will be required to furnish the Engineer with Safety Data Sheets for each hazardous material which each firm uses or stores on the project site for Department maintained roadways. Such sheets shall be generated by each hazardous material manufacturer and shall be in accordance with Indiana OSHA requirements.

106.09 Department Furnished Materials

The Contractor shall furnish all materials required to complete the work except those specified to be furnished by the Department. Materials furnished by the Department will be delivered or made available at the locations specified. The cost of handling and placing materials after they are delivered to the locations specified shall be included in the contract price for the item in connection with which they are used. The Contractor will be held responsible for all materials delivered. Deductions will be made from any monies due to the Contractor to make good all shortages or deficiencies and for all damage which might occur after delivery or for demurrage charges.

106.10 Proportioning Materials

All materials used shall be proportioned as specified for each type of work, kind of unit, or item of work required by the contract. No change in the source, or kind of materials, or blending of asphalt materials will be allowed during construction without

written consent. Application for such consent shall be in writing. Material which is not in accordance with the quality requirements set out in these specifications shall not be blended with a better quality material to upgrade the end product.

Where not explicitly set out, the size and amount of aggregate as well as the grade and amount of asphalt material to be used shall be as ordered.

106.11 Sample Asbestos Exclusion Letter

240 Asbestos-containing materials shall not be used in the construction or reconstruction of buildings or bridges. A letter of exclusion for each building or bridge shall be submitted by the Contractor to the Engineer prior to acceptance of work and final payment. Such letter shall indicate that no asbestos-containing material was used as a building material during the project using the exclusion form in 916.03(f).

SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01 Laws to be Observed

The Contractor shall keep fully informed of Federal and State laws; local laws; ordinances; and rules, regulations, orders, and decrees of bodies or tribunals having any jurisdiction or authority which in any manner affect those engaged or employed on the work or which in any way affect the conduct of the work. The Contractor shall at all times observe and comply with all such laws, ordinances, rules, regulations, orders, and decrees. The Contractor shall protect, indemnify, and exculpate the State and its representatives, in accordance with 107.17, against civil claim or civil liabilities arising from or based on the violation of such law, ordinance, rule, regulation, order, or decree, whether by itself or its employees, even if such violation is due wholly or in part to violation of said law, ordinance, rule, regulation, order, or decree by the State or its representatives.

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Certain counties in the State are considered by the United States Department of Agriculture to be generally infested with various harmful pests such as, but not limited to, various types of beetles. In an effort to prevent these pests from being spread by shipments of infested materials, quarantines have been imposed. Under the regulations, materials and equipment that may be infested must be treated before they are moved from an infested area. Such items as hay, straw, fodder, small grains, corn, sod, earth moving equipment, and other articles that might be infested are subject to these regulations. All State, Federal, and local regulations and quarantines pertaining thereto shall be observed. No additional allowance or compensation will be made for any delay or inconvenience incurred conforming to such requirements, but the cost thereof shall be included in the various pay items.

20

It shall be a condition of each contract let for the construction of a State maintained highway or bridge, financed entirely with state funds that all unskilled laborers employed on such work shall be residents of the county or counties in which such highway or bridge is being constructed, if such labor is available. The Department

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will designate the class of labor which is unskilled. This provision will not apply to any contract on which federal funds are to be used.

The Contractor and its subcontractors shall not discriminate against an employee or applicant for employment to be employed in the performance of any contract with respect to his or her hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of race, color, sex, disability, religion, national origin, or ancestry. Breach of this covenant may be registered as a material breach of the contract.

Water wells or test wells to be drilled shall be in strict accordance with the Indiana Code. Such wells shall be drilled only by a water well driller licensed in the State. A copy of the driller's license shall be furnished prior to commencement of work.

The Contractor may hire only citizens and nationals of the United States, and aliens authorized to work in the United States. The Contractor shall verify the identity and employment eligibility of all employees, in accordance with the Immigration and Nationality Act.

Maintaining a drug-free workplace will be required in accordance with Executive Order 90-5, as follows:

- (a) The Contractor shall agree to make a good faith effort to provide and maintain a drug-free workplace during the contract time. It shall give written notice to the Department within 10 days after receiving actual notice that an employee of the Contractor has been convicted of a criminal drug violation occurring on the project site.
- (b) If the total bid amount shown in the Schedule of Pay Items is in excess of \$25,000.00, the Contractor shall further agree that the contract is expressly subject to the terms, conditions, and representations contained in the Drug-Free Workplace certification executed by the Contractor in conjunction with the contract, and which is included in the Proposal book.
- (c) The failure of the Contractor to comply in good faith with the terms of (a) above, or falsifying or otherwise violating the terms of the certification referenced in (b) above, shall constitute a material breach of the contract. Such failure shall entitle the Department to impose sanctions against the Contractor including, but not limited to, suspension of contract payments, termination of the contract, or debarment of the Contractor from doing further work for the Department for up to three years.

Indiana Code 4-13-18-5 requires all bidders to submit an employee drug testing plan which complies with the requirements of the cited Code. The Contractor is

directed to implement the employee drug testing plan as submitted. Material breaches of this requirement may constitute an independent basis to invoke 108.10.

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107.02 Permits, Licenses, and Taxes

All permits and licenses which may be required due to construction methods such as, but not limited to, borrow or disposal pits, stream crossings, causeways, work bridges, and cofferdams, but which are not part of the contract documents, shall be procured by the Contractor prior to beginning the work which requires the permit. All charges, fees, and taxes shall be paid. All notices necessary and incidental to the due and lawful prosecution of the work shall be given.

The Department is exempt from State, Federal, and local taxes and will not be responsible for any taxes levied on the Contractor as a result of the contract.

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The Department may have acquired waterway permits, including, but not limited to, U.S. Army Corps of Engineers Permit, IDNR Certificate of Approval of Construction in a Floodway, IDEM Section 401 Water Quality Certification, or a permit for construction of temporary pavement across a state line. If the Department has acquired one or more of such permits, the restrictions or conditions which were issued with such permits will be made available to bidders prior to letting. The Contractor shall prosecute the work in accordance with all such restrictions or conditions.

100

107.03 Patented Devices, Materials, and Processes

If a design, device, material, or process covered by letters of patent or copyright is employed by the Contractor, such use by suitable legal agreement with the patentee or owner shall be provided. The Contractor and the surety shall indemnify and save harmless the State, affected third party, or political subdivision from all claims for infringement by reason of the use of such patented design, device, material, process, trademark, or copyright. The State shall be indemnified for costs, expenses, and damages which it may be obliged to pay by reason of infringement during the prosecution or after the completion of the work.

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107.04 Restoration of Surfaces Opened by Permit

The right to construct or reconstruct utility service in the highway or street or to grant permits for same is hereby expressly reserved by the Department for the proper authorities of the municipality in which the work is done.

An individual, firm, or corporation wishing to make an opening in the highway shall obtain a permit from the Department. Parties bearing such permits, and only those parties, will be allowed to perform work on the right-of-way.

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107.05 Federal Aid Provisions

When the United States Government pays all or a portion of the cost of a project, the Federal laws and the rules and regulations made pursuant to such laws shall be observed. The work shall be subject to inspection by the appropriate Federal agency.

Such inspection will in no sense make the Federal Government a party to the contract and will in no way interfere with the rights of any party.

The U.S. Department of Labor has designated the Administrator of the Wage and Hour and Public Contracts Division to conduct investigations with the compliance and enforcement of labor standards. However, the administration and enforcement of labor standards remain the responsibility of the U.S. Department of Transportation.

107.06 Equal Employment Opportunity Trainees

Equal Employment Opportunity trainees will be required if the Equal Employment Opportunity Trainees hours are shown in the Proposal book. The number of trainees required will be one trainee for each 1,000 h shown.

When the project is funded in total or in part by the United States Government and no Equal Employment Opportunity hours are shown in the Proposal book, the Contractor shall participate in the Department's Equal Employment Opportunity Trainee Program. Requirements for participation in the program are available on the Department's website or from the Department's Equal Opportunity Division. Failure by the Contractor to comply with this requirement may result in reduction or loss of prequalification to bid for future work.

As part of the Contractor's equal opportunity affirmative action program, training shall be provided as on-the-job training aimed at developing full journeymen in the type of trade or job classification involved.

If the Contractor subcontracts a portion of the work, it shall determine as to how many, if any, of the trainees are to be trained by the subcontractors, provided, however, that the Contractor shall retain the primary responsibility for meeting the training requirements imposed herein. The Contractor shall also ensure that these requirements are made applicable to such subcontract. Where feasible, 25% of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

The trainees shall be distributed among the work classifications on the basis of the Contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment. Prior to commencing construction, the Contractor shall submit to the Department for approval the number of trainees to be trained in each selected classification and training program to be used. Furthermore, the Contractor shall specify the starting time for training in each of the classifications. The Contractor will be credited for each trainee employed on the contract work that is currently enrolled or becomes enrolled in an approved program.

Training and upgrading of minorities and women toward journeymen status is the primary objective. Accordingly, the Contractor shall make every effort to enroll minority and women trainees, for example, by conducting systematic and direct recruitment through public and private sources likely to yield such minority and women trainees to the extent that such persons are available within a reasonable area

170 of recruitment. The Contractor will be responsible for demonstrating the steps taken
in pursuance thereof, prior to a determination as to whether the Contractor is in
compliance with this provision. This training commitment is not intended, and shall
not be used, to discriminate against an applicant for training, whether a member of a
minority group or not.

No employee shall be employed as a trainee in a classification in which he or she
has successfully completed a training course leading to journeyman status or in which
he or she has been employed as a journeyman. The Contractor shall satisfy this
requirement by including appropriate questions in the employee application or by
180 other suitable means. Regardless of the method used, the Contractor's records shall
document its findings in each case.

The minimum length and type of training for each classification will be as
established in the training program selected by the Contractor and approved by the
Department. The Department and the FHWA will approve a program if it is reasonably
calculated to meet the equal employment opportunity obligations of the Contractor and
to qualify the requirement for journeyman status in the classification concerned by the
end of the training period. Furthermore, apprenticeship programs registered with the
U.S. Department of Labor, Bureau of Apprenticeship and Training, or with a State
190 apprenticeship agency recognized by such Bureau, and training programs approved
but not necessarily sponsored by the U.S. Department of Labor, Manpower
Administration, Bureau of Apprenticeship and Training shall also be considered
acceptable provided they are being administered in a manner consistent with the equal
employment obligations of the contract. Approval or acceptance of a training program
shall be obtained from the State prior to commencing work on the classification
covered by the program. Training shall be provided in the construction crafts rather
than clerk-typists or secretarial-type positions. Training programs for other than
traditional training programs may be submitted for consideration where the training is
oriented toward construction applications. Training in the laborer classification may
200 be allowed provided that significant and meaningful training is provided and approved
by the Department. Some offsite training is allowable as long as the training is an
integral part of an approved training program and does not comprise a significant part
of the overall training.

It is normally expected that a trainee shall begin his or her training on the project
as soon as feasible after start of work utilizing the skill involved and shall remain on
the project as long as training opportunities exist in his or her work classification or
until he or she has completed the training program. It is not required that all trainees
be on board for the entire contract time. The Contractor shall have fulfilled its
210 responsibilities if it has provided acceptable training to the number of trainees
specified. The number trained shall be determined on the basis of the total number
enrolled on the contract for a significant period.

Trainees will be paid at least 60% of the appropriate minimum journeyman's rate
paid by the Contractor for the first half of the training period, 75% for the third quarter

107.07

of the training period, and 90% for the last quarter of the training period, unless apprentices or trainees in an approved existing program are enrolled as trainees on the project. In that case, the appropriate rates approved by the United States Department of Labor or Transportation in connection with the existing program shall apply to all
220 trainees being trained for the same classification who are covered by this specification. However, the salary shall never be less than specified in IC 8-23-9-22.

The trainee shall be furnished a copy of the program to be followed in providing the training. Each trainee shall be provided with a certification showing the type and length of training satisfactorily completed.

The maintenance of records and the furnishing of periodic reports documenting its performance shall be in accordance with these requirements.

230 **107.07 Sanitary Conditions Requirements**

Accommodations for the use of employees shall be provided and maintained in a neat and sanitary condition as may be necessary to comply with the requirements of the Federal, State, and local Boards of Health, or of other bodies or tribunals having jurisdiction.

107.08 Public Convenience and Safety

All safeguards, safety devices, and protective equipment shall be provided. Responsibility reasonably necessary to protect the lives of employees on the job, the safety of the public, and property in connection with the performance of the work,
240 shall be taken.

(a) Worker Safety

All workers within the right-of-way who are exposed either to traffic or construction equipment within the work area shall wear high visibility safety apparel in accordance with Section 6D.03 of the MUTCD.

If a trench, 5 ft or more in depth, is constructed on a project, the requirements for trench safety systems as specified in OSHA regulations 29 CFR 1926, Subpart P, shall be performed. Unless otherwise specified, trench safety systems work will not be paid
250 for separately, but the cost thereof shall be included in the cost of the pay item covering the trench excavation work.

(b) Dust and Air Pollution

Provision shall be made for prompt removal from traveled roadways of all dirt and other materials that have been deposited thereon by operations concerned with the project whenever the accumulation is sufficient to cause the formation of dust or mud, interfere with drainage, damage pavements, or create a traffic hazard. Construction methods and means shall be employed to keep flying dust and air pollution to a minimum. Provision shall be made for the control of dust on the project and on roads,
260 streets, and other areas affected by the project wherever traffic or buildings, or construction materials are affected by such dust. The materials and methods used for

dust control shall be subject to approval. The cost of controlling dust and air pollution shall be included in the cost of other pay items and no additional payment will be made.

(c) Protection to Traffic

270 The work shall be arranged so that all operations on the pavement will be held to a minimum by using the new grade insofar as possible. The work shall be conducted in a manner that will ensure the least obstruction to traffic. Materials stored on the right-of-way shall be placed so as to cause only such inconvenience to the traveling public and residents as is considered unavoidable. Non-operating construction equipment, worker’s vehicles, materials, field offices, field laboratories, and temporary offices may be stored on the right-of-way no less than 30 ft from the edge of pavement lanes open to traffic except, storage may be allowed closer to such lanes if traffic is protected by guardrail in good condition or other suitable barrier. However, if the area has a posted speed limit of 40 mph or less prior to the start of construction, this distance may be reduced to 10 ft, if approved.

280 Temporary crossings and approaches in passable condition shall be provided and maintained as shown on the plans and in accordance with 104.04, with no additional payment.

(d) Notice to Local Public Officials

On construction work, the chief administrative officer of the local governmental unit shall be given 24 h notice, in writing, before it becomes necessary to blockade a cross street.

290 If it is desired to use water from public hydrants, application shall be made to the proper authorities and in accordance with the city ordinances, rules, and regulations concerning their use. Fire hydrants shall be accessible at all times to the fire department. No material or other obstruction shall be placed closer to a fire hydrant than specified by ordinances, rules, or regulations, or within 5 ft of a fire hydrant in the absence of such ordinances, rules, or regulations.

The local governmental agencies for each jurisdiction in the State have the legal authority to establish load limits on their roads. Prior to submitting a bid, each bidder shall contact the local governmental agency in which the use of roads is contemplated and confirm allowable routing of bidder’s equipment.

300 **(e) Convenience to Traffic and Property Owners**

Frontage roads, public roads, and private and mailbox approaches which are disturbed shall be reconstructed as soon as possible to avoid unreasonable inconvenience to traffic and adjacent property owners.

The grading of all approaches and frontage roads shall be completed and the drainage structures shall be placed concurrently with the roadway excavation and embankment construction except as directed or specified. It is the general intent to construct frontage roads, public roads, and private drive approaches, including at least

310 the grading, structures, and base course, as soon as possible to minimize inconvenience to the abutting property owners when their access to existing outlets is being cut off by the construction.

If postponement of the above construction causes unreasonable inconvenience to traffic and adjacent property owners, the Contractor shall construct an adequate, approved, temporary surface on all such frontage roads, public roads, and private approaches with no additional payment. All cost thereof shall be considered as included in the various pay items of the contract.

320 If the contract involves widening, one-lane traffic shall be maintained across all public, private, and commercial approaches either by leaving gaps in the widening or by use of temporary crossing bridges.

107.09 Railroad-Highway Requirements

Whenever it is necessary or required for personnel or construction equipment to be on operating railroad right-of-way, all necessary arrangements shall be made with the railroad company regarding a temporary or existing railroad grade crossing for this purpose. Such railroad grade crossing shall be in accordance with these specifications and shall meet all requirements of the railroad company. All cost involved in establishing the crossing shall be included in the contract price for various pay items and will not be paid for directly.

All work on the railroad right-of-way shall be performed at such times and so as not to interfere unnecessarily with the movement of trains or traffic upon the tracks of the railroad company. All care and precautions shall be used in order to avoid accidents, damage, or unnecessary delay or interference with the trains or other property of the railroad company.

340 When necessary, adjacent structures, embankments, and tracks of the railroad company shall be protected and shored adequately. The Contractor shall assume all risks and liability for damage done to such property as a result of its operations or negligence. No method of work which affects the tracks, movement of trains, or other operations of the railroad shall be used without the approval of the railroad company.

When bridge deck work is being performed over railroad property, including tracks and wires, and the bridge floor slab is penetrated, the work shall be stopped in the area of the penetration. Both the Engineer and the railroad company shall be notified. The railroad property shall be protected as approved before resuming work.

(a) Protection of Track Ballast

350 Operations shall be conducted both on and off railroad right-of-way so that earth, mud, silt, or other foreign matter shall not be allowed to foul railroad track ballast. Temporary earth dikes, sheeting, tie cribbing, silt fences, or other precautions to prevent the fouling of railroad track ballast shall be installed as directed.

Where demolition work, concreting, or hauling along or across tracks, in the opinion of the railroad company, will result in ballast becoming fouled, preventive measures shall be taken to protect the entire ballast section. This may be accomplished by nailing canvas, plywood, or similar material to the ties in the entire area likely to be affected. This protective material shall remain in place until there is no further possibility of fouling the ballast. At that time, it shall be removed.

These protective measures shall be performed with no additional payment under the supervision and to the satisfaction of the chief engineer of the railroad company or its authorized representative. The railroad company will assume no responsibility for the adequacy of the protective measures. However, in addition to the aforementioned protective measures, if the railroad track ballast does become fouled, the railroad company, with its own forces, will remove the fouled ballast and replace it with clean ballast. The charges for this work will be billed by the railroad company against the Contractor.

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(b) Hold Harmless Clause

The Contractor shall indemnify and save harmless the Railroad Company and the State from all suits, actions, or claims of any character brought for or on account of any injuries or damages received or sustained by any person, persons or property from the acts of the Contractor or its forces, or in consequence of any neglect in safeguarding the work, or on account of any claims or amounts recovered for any material furnished or labor performed, or for any infringement of patent, trademark or copyright, or any claims arising or amount recovered under the Worker's Compensation Laws, Federal Employer's Liability Act, or under any other laws, by-laws, ordinances, orders or decrees.

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107.10 Archaeological Artifacts

If archaeological artifacts, including cultural features or skeletal remains are discovered, all work within a minimum 100 ft radius of the discovery shall cease immediately, the area shall not be further disturbed, and the Contractor shall notify the Engineer immediately.

In accordance with IC 14-21-1-27, if skeletal remains are encountered, the Contractor shall notify the local law enforcement agency immediately and the Engineer immediately thereafter. The Department will notify IDNR within two days. Work within the area of the discovery shall not resume without written authorization.

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For discoveries other than skeletal remains, the Department will coordinate with IDNR to mitigate impacts to the discovery. Work within the area of the discovery shall not resume without written authorization.

In no event shall an employee of the Contractor or the State of Indiana share in ownership or profit from salvaged archaeological findings.

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107.11 Bridges over Navigable Waters

All work on navigable waters shall be conducted so as not to interfere with free

navigation of the waterways nor to impair the existing navigable depths. Exceptions may be allowed by permit issued by the authority having jurisdiction over the navigable waters.

107.12 Traffic Control Devices

All necessary barricades, suitable and sufficient lights, danger signals, signs, and other traffic control devices shall be provided, erected, and maintained. All necessary precautions shall be taken for the protection of the work and safety of the public.

410 Highways closed to traffic shall be protected by effective barricades. Obstructions shall be illuminated during hours of darkness. Suitable warning signs shall be provided to control and direct traffic. All construction vehicles and equipment shall have amber lights in accordance with 801.14(d) when in the work area and located on the pavement, sidewalk, or shoulder with the road open to traffic. Vehicles delivering materials to the job site, if displaying headlights, clearance lights and hazard warning lights which are in compliance with Indiana statutes, shall be exempt from this requirement.

Warning signs shall be erected in advance of any location on the project where operations may interfere with the use of the road by traffic and at all intermediate points where the new work crosses or coincides with an existing road. Such warning signs shall be constructed and erected in accordance with the plans. Temporary pavement markings, when required, shall be placed in accordance with 801.12 or as directed.

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Barricades, warning signs, lights, signals, markings, and other protective devices shall be in accordance with the plans and the MUTCD current on the date of advertisement for bids.

All signs, barricades, and other protective devices shall be maintained in good condition and in accordance with 105.13, 801, and 802. Barricades and the backgrounds and messages of all signs shall be kept clean and bright. They shall be renewed or replaced as often as necessary to keep them effective. Failure to maintain these devices may result in the assessment of damages in accordance with 105.14 and 801.14.

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Pavements and shoulders having an edge drop of more than 3 in. shall be delineated with drums in accordance with 801.09. Delineation shall be at a maximum spacing of 200 ft. The use of cones in accordance with 801.08 will be allowed as shown on the plans except cones shall not be used for interstate lane restrictions.

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At least 14 days before a road is to be closed to traffic, notification shall be given of such intention. Detour route marker assemblies shall be erected and maintained along the detour route designated by the Department. Barricades shall not be erected nor the traffic interfered with until the posted detour or the temporary runaround is approved.

If it is necessary to close a road for the purpose of replacing a drainage structure,

the road shall not be closed until the pipe structure is at the project site.

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Sufficient barricades, supplemented by watchers or flaggers when necessary, shall be provided continuously to protect any and all parts of the work and to promote safe and orderly movement of traffic. When a road is closed or posted for official detour but is still usable by local traffic, barricades and road closure sign assemblies, in addition to the closure barricades, required at the beginning and end of the portion of such road being detoured, shall be erected at the site of bridge removals, pipe removals, or other high hazard locations. Such barricades shall be located within 150 ft of the removal location. These barricades shall be of the type shown on the plans, and in accordance with 801.07. Such barricades shall extend from shoulder to shoulder, or to

460 the limit of area that is readily traversable by a motor vehicle, as directed. During non-working hours, no opening shall exist in the barricades. The road closure sign assembly shall be placed at or near the center of the roadway. If these requirements are violated, operations shall be suspended until adequate measures are taken for full compliance. The use of hand signaling flags will not be allowed except for emergency situations. The Stop/Slow paddle shall be required as a primary hand signaling device to control traffic through work areas. The Stop/Slow paddle shall be in accordance with section 6E.03 of the MUTCD, except it shall be at least 24 in. wide.

Unless otherwise specified, sufficient watchers shall be furnished and be on duty

470 24 h a day during the time widening or patching is in progress. These workers shall have adequate transportation facilities to patrol the entire portion under construction. They shall maintain the signs, barricades, and lights at all times for the safety of pedestrian and vehicular traffic.

107.13 Use of Explosives

When the use of explosives is necessary for the prosecution of the work, the utmost care shall be exercised not to endanger life or property, including new work. The Contractor shall be responsible for all damage resulting from the use explosives.

480 All explosives shall be stored in a secure manner in accordance with all laws and ordinances. All such storage places shall be clearly marked in large black letters on a red background "Dangerous Explosives". Where no local laws or ordinances apply, satisfactory storage shall be provided no closer than 1,000 ft from the road or from a building or camping area or place of human occupancy. Detonators shall not be stored with explosives.

Each public utility company having structures in proximity to the site of the work shall be notified of intentions to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps necessary to protect their property from injury. The notification shall in no way relieve responsibility for damage

490 to the structures.

107.14 Protection and Restoration of Property and Landscape

Private property shall not be entered for any purpose in connection with the work, without first obtaining proper permission. The Contractor shall be responsible for the preservation of all public and private property. All land monuments and property

marks shall carefully be protected from disturbance or damage until the Engineer has witnessed or otherwise referenced their location and approved their removal. All areas on the right-of-way that are used for storage of any kind shall be restored to their original condition, or to that set out in the Proposal book, when no longer required for that purpose.

The Contractor shall be responsible for damage or injury to property resulting from defective work or materials and from any act, omission, or misconduct in its manner or method of executing the work. When direct or indirect damage or injury is done, such property shall be restored with no additional payment to a condition similar or equal to that existing before such damage or injury, or such damage or injury shall be made good in an acceptable manner.

Construction equipment shall not be stored in wetland replacement sites shown on the plans. Such sites shall not be used for purposes other than for the creation of wetlands.

On those portions of the project where fence is required on the right-of-way, the required permanent fence shall be erected and maintained at locations where the property owner desires to use the adjacent area for pasturage or livestock. If the permanent fence has not been erected by the time the adjacent property owner desires to use such pasturage, a temporary fence shall be erected and maintained. The fence shall be sufficient to prevent encroachment of livestock onto the right-of-way until the permanent fence is erected.

At locations involving temporary right-of-way where it is necessary to remove existing fence, unless otherwise directed, a temporary fence shall be erected and maintained along the temporary right-of-way. The fence shall be sufficient to prevent encroachment of livestock on the right-of-way. Except when included as a bid item in the contract, temporary fence will not be measured and paid for directly, but will be included in the cost of various pay items.

On those portions of the project where a fence is not required, but the removal of an existing fence from the right-of-way is required, the property owner and tenant, if any, must be notified at least 10 days before the fence is removed from the right-of-way.

107.15 Erosion Control Plan and Proof of Publication

The Department will prepare the necessary information to initiate the submittal requirement of 327 IAC 15-5. The Contractor shall supply all remaining requirements of 327 IAC 15-5 in accordance with 108.04.

The Department will prepare a preliminary Erosion Control Plan as required by 327 IAC 15-5 and will submit it to the appropriate Soil and Water Conservation District.

No construction activity shall begin until the Notice of Intent is filed by the Department. The Engineer will notify the Contractor of such filing.

107.16 Forest Protection

In carrying out work within or adjacent to State or National Forests and other wooded areas, the Contractor shall comply with all regulations or the State Fire Marshal, Natural Resources Commission, Forestry Department, or other authority having jurisdiction, governing the protection of forests and the carrying out of work within forests. The Contractor shall observe all sanitary laws and regulations with respect to the performance of work in forest areas. The Contractor shall keep the areas in an orderly condition, dispose of all refuse, and obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures in accordance with the requirements of the forest supervisor.

Reasonable precautions shall be taken to prevent and suppress forest fires. The Contractor's employees and subcontractors shall be required, both independently and at the request of forest officials, to do all reasonably within their power to prevent and suppress and to assist in preventing and suppressing forest fires and to make every possible effort to notify a forest official at the earliest possible moment of the location and extent of all fires seen by them.

107.17 Responsibility for Damage Claims

The Contractor shall indemnify, defend, exculpate, and hold harmless the State of Indiana, its officials and employees from all liability due to loss, damage, injuries, or other casualties of whatsoever kind, or by whomsoever caused, to the person or property of anyone on or off the right-of-way arising out of or resulting from the performance of the contract or from the installation, existence, use, maintenance, condition, repairs, alteration, or removal of any equipment or material, whether due in whole or in part to the negligent acts or omissions:

- (a) of the State, its officials, agents, or employees;
- (b) of the Contractor, its agents or employees, or other persons engaged in the performance of the contract;
- (c) the joint negligence of any of them, including any claim arising out of the Worker's Compensation law or any other law, ordinance, order, or decree.

The Contractor also agrees to pay all reasonable expenses and attorney's fees incurred by or imposed on the State in connection herewith in the event that the Contractor shall default under the provisions of this section. As much of the money due the Contractor under and by virtue of its contract as the Department may consider necessary for such purpose may be retained for the use of the State. If no money is due, the Contractor's surety may be held until such suit or suits, action or actions, claim or claims for injuries or damages as aforesaid shall have been settled and suitable

590 evidence to that effect furnished to the Department. Money due will not be withheld when the Contractor produces satisfactory evidence that it is protected adequately by public liability and property damage insurance. The obligation of the Contractor under this section and 107.01 shall not extend to the indemnification or exculpation against claims arising out of the preparation or approval of plans, specifications, or special provisions unless furnished by the Contractor.

600 It is specifically agreed between the parties executing the contract that it is not intended by the provisions of any part of the contract to create the public or any member thereof a third party beneficiary hereunder, or to authorize anyone not a party to the contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the contract.

107.18 Opening Sections of Project to Traffic

Shoulders shall be graded and shaped to assure reasonable safety to traffic before opening any completed pavement to traffic.

Work which is in suitable condition for travel, or any portion thereof, shall be opened to traffic as directed. Such opening shall not be construed as acceptance of the work or any part thereof, or as a waiver of any of the provisions of the contract.

610 When it is desirable to open a structure or portion of a highway to traffic, such opening shall be delayed until traffic will cause no injury to completed portions of the work. When opening to traffic is required or allowed, the Contractor shall make provisions for the safety of the public as specified or directed. Opening to traffic will not relieve the Contractor of its liability and responsibility during the period the work is so opened prior to final acceptance.

620 When a contract time has expired, the Contractor shall be responsible for all damage resulting from traffic and any other cause occurring on the incomplete portions of the project, whether these portions have been opened to traffic by order of the Department or not.

On those portions of an incomplete contract that have been ordered opened to traffic or are constructed under traffic and the contract time has not yet expired, the Department will assume the responsibility for repairs of damages resulting directly from traffic, provided that such damage is not the direct or indirect result of the operations of the Contractor and provided the Contractor is unable to collect damages from the responsible party or parties.

630 The Department will only assume such responsibility

- (a) if the Contractor documents those damages with all available information, including but not limited to photos and investigative materials, and

- (b) if the Contractor preserves all documentation, evidence, photos and information regarding the nature, extent and cause of such damage.

Also, the Department will only assume such responsibility if, within 90 days from the date such damage is discovered by the Contractor or the Contractor receives notice
640 of that damage, whichever is earlier,

- (a) the Contractor demonstrates to the Department that despite its good faith, vigorous efforts, it has been unable to collect those damages from the responsible party or parties, and
- (b) the Contractor provides to the Department all documentation, evidence, photos and information regarding the nature, extent and cause of such damage.

650 Ordered repairs for damage for which the Department assumes responsibility will be paid for at the contract unit price for the item involved in making the repairs, where such items are applicable.

Opening a portion of a project to traffic does not preclude the responsibility of the Contractor for providing necessary safety measures, as required in these Standard Specifications, to protect persons using the highway.

107.19 Contractor's Responsibility for Work

660 Until the date the Contractor is relieved of further maintenance as stated in the final written acceptance of the project, or portion thereof in accordance with 105.15, the Contractor shall have the charge and care thereof. The Contractor shall be responsible for injury or damage to any part thereof, by the action of the elements or from any other cause except as set out in 107.18, whether arising from the execution or from the non-execution of the work. All portions of the work occasioned by the above causes shall be rebuilt, repaired, and restored. All injuries or damages shall be made good before final acceptance. The Contractor shall bear the expense thereof except as otherwise provided in these specifications or otherwise determined.

670 In case of suspension of work, the Contractor shall be responsible for the contract work and shall take such precautions as may be necessary to prevent damage to the contract work. Normal drainage shall be provided, and all necessary temporary structures, signs, or other facilities shall be erected with no additional payment. During such period of suspension of work, newly established plantings, seedlings, and sodding furnished under the contract shall be properly and continuously maintained in an acceptable growing condition.

107.20 Contractor's Responsibility for Utility Property and Services

680 At points where the Contractor's operations are adjacent to properties of railroad, telegraph, telephone, and power companies or are adjacent to other property, damage to which might result in considerable expenses, loss, or inconvenience, work shall not

be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall coordinate and cooperate with the owners of all underground or overhead utility lines in their removal and relocation operations in order that this work may progress in a reasonable manner, that duplication of relocation work may be reduced to a minimum, and that services rendered by those parties are not unnecessarily interrupted.

- 690 If it is necessary to place pipes or conduits through structures, sheet metal sleeves shall be provided around the pipe or conduit to make a sliding joint or provide suitable openings as required, with no additional payment.

If there is an interruption to water or utility services as a result of accidental breakage or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority, and shall cooperate with the said authority in the restoration of service. If water service is interrupted, repair work shall be continuous until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

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The Contractor shall establish and maintain open communication with each utility affected by the construction and document and report all communication to the Engineer. The Contractor shall prepare its construction schedule to accommodate all the utility work plans included in the contract documents including some allowance for unexpected minor variation in the anticipated utility work plan and schedule.

- 710 Regardless of previous notification by the Department, the Contractor shall give notice to the owners of each utility located within the contract limits, or which might be affected by the work, in sufficient time before beginning work for the owners to relocate or protect their property. No work shall be done which injures or damages such property until satisfactory arrangements have been completed with the owner for its protection, relocation, or reconstruction.

Prior to any work which penetrates any existing soil or pavement surface, the Contractor shall notify both the Indiana Underground Plant Protection Service, IUPPS, in accordance with IC 8-1-26 requirements and the Engineer in accordance with 105.08 prior to commencing construction operations in an area that may affect underground utilities.

- 720 If abandoned underground utilities are encountered during construction, sections of which are to be removed, ends of pipes that remain in place shall be sealed with class A concrete as directed. Concrete used for this purpose will be paid for at the contract unit price per cubic yard for concrete, A, in structures. Cutting of abandoned gas lines shall be by mechanical methods. A cutting torch shall not be used.

If a permit is issued to a city or other governmental unit for the installation of conduits, poles, or other appurtenances for artificial lighting of the structure, it may be

necessary or desirable to revise the plans or make structural changes as needed to accommodate such installation. In this event, the provisions of 104.02 shall apply to all changes in quantities of work.

107.21 Furnishing Right-of-Way

The Department will be responsible for securing necessary right-of-way in advance of construction. Exceptions will be indicated in the contract.

107.22 Personal Liability of Public Officials

In carrying out any of the provisions of these specifications, or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Department, Commissioner, Engineer, or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.23 Waiver of Legal Rights

Upon completion of the work, the Department will expeditiously make final inspection and notification of acceptance. Such final acceptance, however, shall not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Department be precluded or estopped from recovering from the Contractor or its surety, or both, such overpayment as it may sustain by failure on the part of the Contractor to fulfill its obligations under the contract. A waiver on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, or with regard to the rights of the Department under any warranty or guaranty.

107.24 Governing Law

This contract shall be construed by the laws of the State of Indiana. Suit, if any, shall be brought in the State of Indiana.

107.25 Severability

The invalidity in whole or in part of a provision of the contract shall not void or affect the validity of all other provisions.

SECTION 108 – PROSECUTION AND PROGRESS

108.01 Subletting of Contract

The contract, contracts, or portions thereof; or the right, title, or interest therein shall not be sublet, sold, transferred, assigned, or otherwise disposed of without written consent. In case such consent is given, the Contractor will be allowed to sublet a portion thereof, but shall perform with its own organization, work amounting to not

less than 50% of the original or revised contract amount, whichever is less. All items designated in the contract as specialty items may be performed by subcontract. The cost of such specialty items so performed by subcontracts may be deducted from the total cost before computing the amount of work required to be performed by the Contractor with its own organization. No subcontracts or transfer of contracts will release the Contractor of liability under the contract and bonds. Approved subcontractors will not be allowed to further subcontract their work.

Unless the Department provides written consent, the Contractor shall not be entitled to any payment for subcontracted work or materials unless it is performed or supplied by a subcontractor approved on the contract prior to the work being performed.

The minimum wage for labor as stated in the Proposal book shall apply to all labor performed on all work sublet, assigned, or otherwise disposed of in any way.

The Contractor or subcontractor may enter into leases or rental agreements for equipment with operators or trucks with drivers. When certified payrolls are required, they shall be submitted for all such equipment operators and truck drivers who perform work. This payroll shall verify that these employees have been paid not less than the predetermined wage rate set out elsewhere in the contract for the classification of work performed.

The subcontractor shall be in accordance with the requirements of 105 IAC 11-2-10, Subcontractors.

The Contractor shall submit payment records through the Department's Subcontractor Payment Tracking System (<http://itap.indot.in.gov>) of all payments made to subcontractors and DBE, MBE, WBE, and IVOSB firms approved by the Department. Reports shall be submitted no later than 10 days after the end of each month in which a subcontractor is paid for work on the contract. Reports shall include any release of retainage payments made to subcontractors.

All subcontractors and DBE, MBE, WBE, and IVOSB firms approved by the Department shall verify all payments made to them through the Department's Subcontractor Payment Tracking System (<http://itap.indot.in.gov>). All payments received for work on the contract shall be verified no later than 20 days after the end of the month in which payment was received.

108.02 Release of Retainage to Subcontractors

If the Contractor is withholding portions of payments due subcontractors as retainage, the Contractor shall release such retainage to the subcontractor within 30 calendar days after satisfactory completion of the work performed by the subcontractor.

For the purposes of this section, satisfactory completion will be interpreted as when the subcontractor has completed all physical work and completed other contract requirements, including the submission of all submittals required by the specifications and the Department.

108.03 Notice to Proceed

60 Unless otherwise provided, the Contractor will be expected to start active and continuous work on the contract within 15 calendar days after the date of the notice to proceed. Work shall not begin prior to the date of the notice to proceed.

If a delayed starting date is indicated in the proposal, the 15 calendar day limitation will be waived. Work day charges will then begin on a date mutually agreed upon, but not later than the delayed starting date specified. If the contract is canceled after an award has been made but prior to the issuing of the notice to proceed, no reimbursement will be made for any expenses accrued relative to this contract during that period.

70 If the contract involves demolition work, the Contractor shall not enter the parcel or proceed with the demolition without written authority from the Engineer. The Contractor will be compensated only for those houses and buildings which are actually removed from the right-of-way. Time of commencing demolition work and time of completion shall be in accordance with 108.08.

108.04 Prosecution of the Work

A pre-construction conference will be held at the earliest possible date, at which time it will be determined at what point the Contractor's operations will start.

80 The Contractor shall furnish the Engineer with a bar graph type schedule which shows the estimated times required to prosecute the major or critical items of work for acceptance unless the contract has less than 60 calendar days completion time, less than 35 work days, or less than 60 days between the date of the notice to proceed and the calendar completion date. This schedule shall incorporate all contract requirements regarding the order of performance of work and each activity. The schedule shall graphically show the calendar time for which each activity is scheduled for work. The schedule may be used as the basis for establishing major construction operations and as a check on the progress of the work. Sufficient materials, equipment, and labor shall be provided to guarantee the completion of the project in accordance with the plans and specifications within the specified completion time. The Engineer shall be notified at least three days in advance of the date on which the work is expected to begin. The schedule shall be submitted at the pre-construction conference.

90

The Department and the Contractor shall meet at least once each month to review actual and proposed schedules. The Contractor shall submit the correspondence to the district after each monthly meeting addressing each item of work that is behind schedule and as to what action will be taken to get the work back on schedule.

100 If, in the opinion of the Engineer, construction progress has been or will be materially affected by changes in the plans or in the quantities of work, or if performance has failed to conform to the accepted schedule, a revised schedule shall be submitted when requested. Acceptance of the schedules will in no way justify them, but will simply indicate concurrence in their reasonableness and feasibility on the assumption that every effort shall be made to meet them. Existence of a current and accepted schedule will be a condition precedent to the processing and payment of a partial pay estimate.

110 If the prosecution of the work is discontinued, the Engineer shall be notified at least 24 h in advance of resuming operations.

During the progress of the work, the Engineer shall be notified at least 24 h in advance of undertaking construction operations. This advance notification shall also apply anytime a DBE is scheduled to work on a project or deliver material or supplies to a project site.

120 If the plans for a road contract provide for the construction of an interchange, interchanges, or approaches at bridge locations, regardless of the actual date of completion on the bridge contract or contracts, the road contractor will be required, unless otherwise directed, to complete the planned pavement, including approaches and interchanges, as planned and set out in the road contract. The road contract may be modified to allow additional compensation or time if the bridge contract has delays which affect the work of the road contractor and was not under the control of, or caused by, the road contractor.

For those contracts not requiring waterway permits, or a Construction Stormwater General Permit, or a 327 IAC 15-5 permit, the Contractor shall submit a written site plan to the Engineer describing the following:

- 130
1. A description of the contract site.
 2. The locations of all equipment storage areas, fueling locations, construction trailers, batch plants, and designated concrete truck washout locations.
 3. A material handling and spill prevention plan.

140 Based on changes in scope, in accordance with 104.02 and 104.03, the Engineer may request a cost breakdown of the stormwater management implementation item, when the item exists within the contract.

The site plan shall be submitted for acceptance seven calendar days prior to the start of any construction activity. Construction activities shall not begin until the written site plan has been approved by the Engineer.

The cost of preparation of the site plan described above shall be included in the

cost of other items of the contract. The cost of the stormwater management implementation of the site plan will be paid for in accordance with 205.11.

150 For contracts not requiring waterway permits but having a Stormwater Management Budget, the Contractor shall locate, install, maintain and remove temporary stormwater, sediment, and erosion control BMPs, for land-disturbing activity areas in accordance with 205. An SWQCP will not be required for these contracts.

For contracts requiring waterway permits, a Construction Stormwater General Permit, or a 327 IAC 15-5 permit, an SWQCP shall be developed and submitted to the Engineer for review, in accordance with 205.03.

160 Borrow and disposal sites shall be in accordance with 203.08. When required by a Construction Stormwater General Permit or 327 IAC 15-5, stockpile and storage sites shall have their own permit. The Contractor shall submit an NOS to the Engineer prior to the beginning of operations at those locations. An NOI with an IDEM time stamp 48 h prior to the beginning of operations at these locations shall also meet these requirements.

170 When temporary construction materials are no longer required or used for maintenance of traffic or for other temporary purposes, such materials shall be removed and disposed of as provided herein. If temporary roadbed or asphalt pavement materials are used for embankment construction, such materials will be classified as excavation and paid for at the contract unit price per cubic yard for the type of excavation shown in the Schedule of Pay Items. No allowance will be made for overhaul or added haul. If temporary HMA pavement materials are used in the work for subbase, base, approaches, or for new shoulder construction, such materials will be paid for as salvaged road material in accordance with 613.

180 Temporary concrete pavement, temporary concrete base, or temporary concrete widening, when no longer required for maintenance of traffic, shall be removed and disposed of in accordance with 202.05. Such removal and disposal will be paid for in accordance with 202.14.

Temporary drainage structures, temporary concrete median barriers, and other temporary devices required and used for the maintenance of traffic shall remain the property of the Contractor. All costs for furnishing, placing, maintaining, removal, and disposal of temporary drainage structures shall be included in the contract lump sum price for maintaining traffic. If there is no pay item for maintaining traffic, these costs shall be included in the various pay items listed in the proposal, unless otherwise provided.

108.05 Pre-phase Site Construction Meetings

190 A pre-phase site construction meeting shall be scheduled and conducted by the Contractor prior to the beginning of work on each major work phase. These meetings are intended to help improve the quality of construction, personnel safety on the

project site, and safety of the traveling public. These meetings shall include all subcontractors connected with the particular phase. When the conditions described in 105.07 are possible during a particular phase, the other Contractors shall be invited to attend. The Department's project staff and the Area Engineer shall be invited to attend.

200 At each meeting, the Contractor shall indicate its current schedule for the phase, discuss maintenance of traffic control, project site personnel safety, compliance with the plans and specifications including quality construction, and all other pertinent subjects.

The number of pre-phase site construction meetings will be determined at the pre-construction conference. No additional payment will be made for these meetings.

108.06 Limitation of Operations

210 The work shall be conducted in such a manner and in such sequence as ensures the least interference with traffic. Due regard shall be given to the location of detours and to the provisions for handling traffic. Work shall not be started to the prejudice or detriment of work already begun. The completion of a section on which work is in progress may be required before work is started on additional sections, if opening such section is essential to public convenience.

220 Except as hereinafter specified, no load of material for any construction shall be dispatched so late in the day that it cannot be placed, finished, and protected within the specification's limits and provisions during daylight of that same day. Daylight will be defined as the period between sunrise and sunset as established by the National Weather Service. When it is important that construction shall be completed at an early date, work may be allowed at times other than daylight hours provided sufficient illumination is available and that work performed under these conditions complies in every respect with the terms and conditions of the contract.

108.07 Character of Workers, Methods, and Equipment

Sufficient labor and equipment for prosecuting the several classes of work shall be employed at all times to full completion in the manner and time required by these specifications.

230 All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Each person employed by the Contractor or by each subcontractor who does not perform in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the employer of such person. The person shall not be employed again in any portion of the work without approval. If the person is not removed as required herein, or if suitable and sufficient personnel for proper prosecution of the work are not furnished, all estimates may be withheld or the work suspended by written notice until these requirements have been met.

240

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment which was originally developed to be used in performing work in International System measurements may be used in performing work in English System measurements. Where possible, such equipment shall be adjusted to the English System measurements. Where equipment cannot be adjusted, it shall then be made compatible, as required, to satisfactorily be used for performing work in English System measurements in accordance with 101.46, 105.03, 109.01(a), and 109.01(i). Equipment used on the project shall be such that no injury to the roadway, adjacent property, or other highways will result from its use.

250

Construction equipment, which is used in recreational areas, shall not be left parked in existing parking areas or on existing park road pavements except as may be necessary during the time construction work is in progress. All damage to such roadways or parking lot pavements caused by equipment, such as gouge marks or petroleum leakage, shall be repaired with no additional payment in accordance with the applicable requirements of 107.14 or as directed.

260

When the methods and equipment to be used in accomplishing the construction are not prescribed in the contract, any methods or equipment that will accomplish the work in accordance with the contract may be used.

270

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized. If the use of a method or type of equipment other than those specified in the contract is desired, authority to do so may be requested. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing construction work in accordance with contract requirements. If, after trial use of the substituted methods or equipment, it is determined that the work produced does not meet contract requirements, the use of the substitute methods or equipment shall be discontinued and the remaining construction shall be completed with the specified methods and equipment. The deficient work shall be removed and replaced with work of specified quality or other corrective action shall be taken as directed. No change will be made in basis of payment for the construction items involved or in contract time as a result of authorizing a change in methods or equipment under these provisions.

280

108.08 Determination and Extension of Contract Time

The number of days allowed for the completion of the work included in the contract will be stated in the Proposal book and will be known as the contract time.

If the contract time is on a work day basis, as defined in 101.77, a weekly statement showing the number of days charged to the contract to date and for the

preceding week, the number of days specified for completion of the contract, and the days remaining and the controlling operation will be furnished. The Contractor will be allowed one week from the date it receives the statement in which to file a written protest setting forth in what respect said weekly statement is incorrect. Otherwise, the statement will be deemed to have been accepted by the Contractor as correct. For the purpose of computation, work days will be considered as beginning on the fifteenth calendar day after the date of the notice to proceed. All calendar days elapsing between the effective dates of orders to suspend work and to resume work for suspensions which are not the fault of the Contractor will be excluded.

If the contract time is on a calendar day basis, it shall consist of the number of calendar days stated in the contract including all Sundays, holidays, and non-work days counting from the date of the notice to proceed. All calendar days elapsing between the effective dates of any orders to suspend work and to resume work for suspensions not the fault of the Contractor will be excluded. A weekly statement showing the controlling operation will be furnished. The Contractor will be allowed one week from the date it receives the statement in which to file a written protest setting forth in what respect said weekly statement is incorrect. Otherwise, the statement will be deemed to have been accepted by the Contractor as correct.

If the contract time is a fixed calendar date, it shall be the date on which all work on the contract shall be completed. For such contracts, an extended date of completion will be considered for delay in the issuance of the notice to proceed if the notice to proceed is not issued within 30 days of the letting, except if the delay is due to the failure of the Contractor to furnish requested forms or information. Unless otherwise determined, an extension to the contract completion date and intermediate completion date will be allowed for each calendar day from 30 days after the date of the letting to and including the date of the notice to proceed. A weekly statement showing the controlling operation will be furnished. The Contractor will be allowed one week from the date it receives the statement in which to file a written protest setting forth in what respect said weekly statement is incorrect. Otherwise, the statement will be deemed to have been accepted by the Contractor as correct.

The number of days for performance shown in the contract as awarded will be based on the original quantities as defined in 104.02.

- (a) For a completion date contract, unless otherwise determined, an increase in quantities will not increase the time specified for the performance of the contract.
- (b) If intermediate completion times are specified, unless otherwise determined, an increase in quantities will not increase the time specified.

If an intermediate completion time is specified for road closure or restriction, the first day or portion thereof of the closure or restriction will constitute the first chargeable day. The date the road is opened

to unrestricted traffic will be counted as a chargeable day, regardless of the time of day when the roadway is opened. Open to unrestricted traffic shall be as defined in 101.35. Temporary pavement marking materials in accordance with 801.12 shall be placed if the final marking materials cannot be placed in accordance with 808.07(b).

340 If the Contractor finds it impossible for reasons beyond its control to complete the work within the contract time as specified prior to the expiration of the contract time, a written request in accordance with 105.16 may be made for an extension of time setting forth therein the reasons which will justify the granting of the request. A plea that insufficient time was specified is not a valid reason for extension of time. If the Engineer finds that the contract controlling operation was delayed due to an excusable delay under 108.08(a) or 108.08(b), the Department will extend the contract time for completion in such amount as the conditions justify. The extended time for completion shall then be in full force and effect, the same as though it were the original time for completion. The Department will not extend contract time for a non-excusable delay under 108.08(c).

350

Contractors shall not work during the following holiday periods unless prior written approval is received from the Engineer. All deliveries and traffic coming from suppliers shall cease during the Department-ordered suspensions of work listed below. No time extensions to closure periods, intermediate completion dates, or contract completion dates will be granted for suspending work during these holiday periods.

360

(a) New Year's Day. If New Year's Day falls on a Sunday, work shall be suspended from noon December 31 until sunrise January 3. If New Year's Day falls on a Monday through Saturday, work shall be suspended from noon December 31 until sunrise January 2.

(b) Good Friday. Work shall be suspended from noon on Good Friday until sunrise Monday.

(c) Memorial Day. Work shall be suspended from noon the Friday before Memorial Day until sunrise Tuesday, the day after Memorial Day.

370

(d) Independence Day. If Independence Day falls on a:

Sunday - Work shall be suspended from noon Friday, July 2, until sunrise Tuesday, July 6.

Monday - Work shall be suspended from noon Friday, July 1, until sunrise Tuesday, July 5.

Tuesday - Work shall be suspended from noon Friday, June 30, until sunrise Wednesday, July 5.

380 Wednesday - Work shall be suspended from sunset on Tuesday, July 3, until sunrise Thursday, July 5.

Thursday - Work shall be suspended from noon Wednesday, July 3, until sunrise Monday, July 8.

Friday - Work shall be suspended from noon Thursday, July 3, until sunrise Monday, July 7.

390 Saturday - Work shall be suspended from noon Thursday, July 2, until sunrise Monday, July 6.

(e) Labor Day. Work shall be suspended from noon the Friday before Labor Day until sunrise Tuesday, the day after Labor Day.

(f) Thanksgiving Day. Work shall be suspended from noon the Wednesday before Thanksgiving Day until sunrise the Monday after Thanksgiving Day.

400 (g) Christmas Day. Work shall be suspended from noon December 24 until sunrise December 27.

The Department may order the suspension of work, either wholly or in part, for a period of time for certain holidays not already specified herein. For such orders, if the contract suspension is not stated in the contract documents, the contract completion time will be adjusted as follows:

410 (a) If the contract completion time is on a work day basis, no work days will be charged on those days that work on the controlling operation is suspended.

(b) If the contract completion time is on a calendar day basis, all calendar days on which work on the controlling operation is suspended will be excluded.

(c) If the contract completion time is a fixed calendar date, the contract will be extended by the number of days that work on the controlling operation is suspended.

420 (d) If the contract contains an intermediate completion time, said time will be adjusted in accordance with the requirements of (a) or (b), above as appropriate, provided that the suspension occurs within the time period while the intermediate completion time is in effect.

If the Department does not order the suspension of work for certain holidays, work

may be performed on those holidays. On a work day contract, a work day will be charged for each holiday worked. On a completion date contract, the contract completion time will not be shortened by the number of holidays worked.

430 Contract time will not be charged during the required cure period for concrete surfaces requiring a sealer, provided all other contract work is completed and all lanes are open to traffic. Charging of contract time will resume after the required cure period. The contract time will be adjusted as follows:

- (a) If the contract completion time is on a work day basis, work days will not be charged for those days on which work is suspended.
- (b) If the contract completion time is on a calendar day basis, all calendar days on which work is suspended will be excluded.
- 440 (c) If the contract completion time is a fixed calendar date, the contract will not be extended.

If an extension of time on a calendar day contract or a calendar completion date contract extends the completion date past November 30, the days remaining after November 30 will be added to April 1, of the following year for the contract completion date, providing the project could be suitably opened to traffic in accordance with 107.18.

450 Completion of the removal of houses and buildings on time, if specified, shall be in accordance with the requirements herein.

Not all parcels shown in the Schedule of Pay Items will be available for demolition at the time of the letting. Houses and buildings shall be removed as soon as they are vacated in accordance with the procedure as follows:

- (a) The 15 calendar days limitation after the date of notice to proceed as specified in 108.03 will not apply.
- 460 (b) The contract time extension consideration for 30 days delay in issuing the notice to proceed as specified in 108.08 will not apply to a contract for which demolition is the majority of the contract work.
- (c) When parcels become available for demolition, the Engineer will notify the Contractor of the availability of such parcels. The Contractor shall commence work within five calendar days from the date of receipt of such notification. Inspection and testing for asbestos presence, or filing a notification of demolition with the IDEM will be considered as part of the work.
- 470 (d) If the Contractor fails to commence work within five calendar days

of the date of receipt of notification, \$100.00 will be assessed as liquidated damages, not as a penalty, but as damages sustained for each calendar day after five on which work has not commenced.

480 (e) Once work has commenced, in accordance with (c) and (d) above, the work shall progress continuously and shall be completed within 60 calendar days. If such work is not completed within 60 calendar days, \$100.00 will be assessed as liquidated damages, not as a penalty, but as damages sustained for each calendar day after 60 on which work is not completed.

(f) Each notification received by the Contractor shall establish a separate five calendar day starting period and 60 calendar day completion time, regardless of the number of parcels which are shown in each notification.

(a) Excusable, Non-Compensable Delays

490 Excusable, non-compensable delays are delays that are not the fault or responsibility of the Contractor or the Department. The following are excusable, non-compensable delays:

1. Delays due to acts of the public enemy, civil disturbances, acts of Government or political subdivision other than the Department.
2. Delays due to floods, lightning strikes, tornadoes, earthquakes or other cataclysmic phenomena of nature.
- 500 3. Delays due to fires or epidemics.
4. Delays due to labor strikes that are beyond the Contractor's reasonable power to settle.
5. Extraordinary delays in material deliveries the Contractor or its suppliers cannot foresee or avoid resulting from freight embargoes, government acts or wide-area material shortages. Delays due to the Contractor's, subcontractor's or supplier's insolvency or mismanagement are not excusable.
- 510 6. Delays due to above normal inclement weather as defined in 101.02.
7. Delays due to changes in quantities that are not significant changes as defined in 104.02(c).

The Department will extend the contract time for completion but will not pay for any costs associated with an excusable, non-compensable delay.

(b) Excusable, Compensable Delays

520 Excusable, compensable delays are delays that are not the fault or responsibility of the Contractor and are the fault or responsibility of the Department. The following are excusable, compensable delays:

1. Delays due to differing site conditions in accordance with 104.02(a), significant changes in the character of work in accordance with 104.02(c), or extra work in accordance with 104.03.
- 530 2. Delays due to suspension of work ordered by the Engineer in accordance with 104.02(b).
3. Delays due to work that utilities or other third parties perform within the project limits.

The Department will extend the contract time for completion and will pay for delay costs covered under item 1 above in accordance with 104.03.

The Department will make payment for delay costs under items 2 and 3 above in accordance with 109.05.2.

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(c) Non-Excusable Delays

Non-excusable delays are delays that are the fault or responsibility of the Contractor. The Department will not extend the contract time or compensate the Contractor for delay costs due to non-excusable delays.

(d) Concurrent Delays

550 Concurrent delays are separate delays to the controlling operation or critical path that occur at the same time. When an excusable, non-compensable delay is concurrent with an excusable, compensable delay, the Department will extend the contract time but will not make payment for delay costs. When a non-excusable delay is concurrent with an excusable delay, the Department will not extend the contract time and will not make payment for delay costs.

108.09 Failure to Complete on Time

560 For each calendar day, as specified, that work shall remain incomplete during the months of April through November inclusive, after the control time specified for the completion of the work provided for in the contract, the sum specified in the schedule below will be deducted, as liquidated damages, from any money due the Contractor. Account will be taken of adjustment of the contract time for completion of the work granted in accordance with 108.08. Calendar days will not be charged while waiting for final inspection as defined in 105.15 provided all contract work has been satisfactorily completed. However, five work days will be allowed after notification from the Department to complete all corrective or clean up work necessary for final inspection. Thereafter, time will be charged for each day the work remains

uncompleted. Further, 10 calendar days will be allowed after notification by the Department to remove all construction signs and temporary traffic control devices. Thereafter, time will be charged for each day the signs and devices remain.

570 For each calendar day, as specified, that any work shall remain incomplete during the months of December through March inclusive, liquidated damages will be deducted. However, when the project is open for its intended purpose or modified for safe use, liquidated damages will not be deducted, and payment for the field office and field laboratory, if set out as a pay item in the itemized proposal, will not be made. Intended purpose will include all pavement lanes, sidewalks, trails, drainage features, and all safety appurtenances. The Contractor may be required to make temporary repairs to the pavement or structures. Liquidated damages will be assessed until temporary repairs are made. No payment will be made for such temporary repairs.

580 If the contract is not completed, or the pavement or structure is not opened to traffic within the stipulated time as set out in the Proposal book, the Department may reduce the qualified rating of the Contractor for bidding on future contracts.

Allowing the Contractor to continue and finish the work or a part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

Schedule of Liquidated Damages for
Each Day of Overrun in Contract Time

Original Contract Amount		Daily Charge
From Greater Than	To Less Than or Equal To	Calendar Day or Fixed Date
\$0	\$500,000	\$500.00
\$500,000	\$2,000,000	\$1,000.00
\$2,000,000	\$5,000,000	\$1,500.00
\$5,000,000	\$10,000,000	\$2,000.00
\$10,000,000	and higher	\$2,250.00

590 When the contract time is on either the calendar day or fixed calendar date basis, the schedule for calendar days shall be used.

Adjustments to the contract payment with respect to liquidated damages will be included in a liquidated damages pay item. The unit price for this pay item will be \$1.00 and the quantity will be in units of dollars. The quantity is the total calculated in accordance with the above schedule.

108.10 Default and Termination of Contract

600 Notice in writing will be given to the Contractor and its surety of delay, neglect, or default if the Contractor:

- (a) fails to begin work under the contract within the time specified;
- (b) fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work;
- 610 (c) performs the work unsuitably, neglects or refuses to remove materials or performs anew such work as may be rejected as unacceptable and unsuitable;
- (d) discontinues the prosecution of the work;
- (e) fails to resume work which has been discontinued within a reasonable time after notice to do so;
- (f) becomes insolvent or is declared bankrupt, or commits an act of bankruptcy or insolvency;
- 620 (g) allows final judgment to stand against it unsatisfied for a period of 10 days;
- (h) makes an assignment for the benefit of creditors;
- (i) for other causes whatsoever, fails to carry on the work in an acceptable manner; or
- 630 (j) fails to implement the employee drug testing plan as submitted with the bid; or fails to provide information regarding the implementation of the employee drug testing plan when requested by the Department; or provides false information regarding implementation of the employee drug testing plan.

640 If the Contractor or surety does not proceed in accordance therewith within a period of 10 days after such notice, then the Department will, upon written notification from the Engineer of the fact of delay, neglect, default, or the failure of the Contractor to comply with such notice, have full power and authority, without violating the contract, to take the prosecution of the work away from the Contractor. The Department may appropriate or use materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof. Other methods required for the completion of the contract in an acceptable manner may be used.

All costs and charges incurred by the Department, together with the cost of completing the work under the contract, will be deducted from any monies due or which may become due. If such expense exceeds the sum which would have been payable under the contract, the Contractor and the surety shall be liable and shall pay to the Department the amount of such excess.

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108.11 Termination of Contractor's Responsibility

The contract shall be considered as completed after all work provided for therein has been accepted. The Contractor shall then be released from all further obligations except as provided in 107.23 and 109.08.

The Department may, by written order, terminate the contract or a portion thereof only after a meeting with the Contractor, and after determining that termination would be in the public interest. Reasons for termination will include, but will not be limited to, the following:

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- (a) executive orders of the President relating to prosecution of war or national defense;
- (b) national emergency which creates a serious shortage of materials;
- (c) budgetary concerns of the Department;
- (d) errors in the plans or Proposal book which make the project unbuildable;

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- (e) orders from duly constituted authorities relating to energy conservation;
- (f) restraining orders or injunctions obtained by third-party citizen action resulting from national or local environmental protection laws, or where the issuance of such order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor;

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- (g) when it is the finding of the Department that the Contractor is unable to complete the contract and the construction covered thereby within a reasonable length of time on account of inability to obtain materials or satisfactory substitutes therefore which do not change the general type of construction or labor.

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In such cases, work performed, including partially completed items, will be paid for in full at the contract unit prices for the actual quantities of work done, which prices will not be subject to change if the quantity for a pay item or items is increased or decreased more than 20%. Should such relief from performance of a portion of the contract or such elimination of a portion of the contract directly cause the loss of work or material already furnished under the terms of the contract, the actual cost of such work or of salvaging such material will be reimbursed. All such material may, at the option of the Department, be purchased at its actual cost. Anticipated profit on work not performed will not be allowed. Final settlement will depend upon the merits of the individual case. All actual damages will be paid following a meeting with the

Contractor to determine if payment of actual damages is appropriate and in accordance with applicable laws.

108.12 Contract Documentation

700 The Contractor shall furnish upon request, all documentation relating to its performing as a Contractor or subcontractor on a contract. The requested information may be, but is not limited to the following: payroll records, material invoices, subcontract agreements with pertinent attachments, lease agreements, and Equal Employment Opportunity documentation.

SECTION 109 – MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities

(a) General Requirements

All measurements of work completed under the contract will be according to the English System unless otherwise specified.

10 The standard measures shown in this publication are primarily in the English System of Units such as feet and inches, pounds, gallons, and acres. Any metric equivalents, shown in parentheses, are intended only for those contracts in which they are specified, or to maintain consistency with industry standards. No guarantee is provided, explicit or implicit, that the units are accurate conversions.

20 The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice. Results are to be determined using the standard “5” up procedures as defined in General Note 9 on Page vi herein. When the quantities to be measured are shown in English System units, and the Contractor uses equipment or materials that were originally developed to be used in performing work in the International System measure, there will be no allowance if the International System dimensions exceed the English System measurements. When the quantities to be measured are shown in International System measure, and the Contractor uses equipment or materials that were originally developed to be used in performing work in the English System units, there will be no allowance if the International System dimensions exceed the English System measurements.

30 Unless otherwise specified, longitudinal measurements for base, surface, and shoulder area computations will be made along the centerline of the actual surface of the roadway. No deduction will be made for individual fixtures having an area of 10 sq ft or less. Unless otherwise specified, transverse measurements for area computations will be the neat line dimensions shown on the plans or ordered in writing.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

When a complete structure or structural unit, in effect lump sum work, is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

All work which is measured by the linear foot will be measured parallel to the base or foundation upon which such work is placed, unless otherwise specified.

A station when used as a definition or term of measurement in the English System will be 100 linear feet. A station when used as a definition or term of measurement in the International System will be 1 km.

When metric dimensioned materials are specified, the Contractor shall convert to metric all weigh tickets, delivery receipts, or other material documentation before submitting the documentation.

The term gauge, when used in connection with the measurement of metal plates or sheets, will mean the U.S. Standard Gauge except when the referenced AASHTO, ASTM, or other specification for a material specifies that it be ordered and measured in terms of thickness.

When the term gauge refers to the measurement of wire, it will mean the U.S. Steel Wire Gauge except when the reference AASHTO, ASTM, or other specification for the wire specifies that it be ordered and measured in terms of wire size number or diameter.

The term ton will mean the short ton consisting of 2,000 pounds avoirdupois. The term megagram will mean 1,000,000 g or 1,000 kg. All materials which are measured or proportioned by weight (mass) shall be weighed on accurate approved scales which are in accordance with all requirements and specifications adopted by the Indiana State Board of Health, Division of Weights and Measures. The weighing shall be accomplished by competent qualified personnel at designated locations. Materials specified according to metric unit weights may be weighed on a scale that uses English system units and then converted to the metric equivalent using the conversion factors shown elsewhere in the specifications.

(b) Scales and Measurement by Weight (Mass)

All materials for which measurements are obtained by weight (mass) shall be weighed on approved scales which, except as hereinafter provided for out-of-state scales, shall be tested and sealed by the Indiana State Board of Health, Division of Weight and Measures. This inspection shall have been made within a period of not more than one year prior to the date of use for weighing material. A scale which has been tested and approved within this one year period and which has been repaired or dismantled or moved to another location, shall again be tested and approved before it is eligible for weighing. All interested parties, such as the Department, the Contractor, or the owner of the scales, may request an inspection of the scales in question. The latest inspection shall take precedence over all previous inspections. Automatic printer

systems may be used with HMA plant scale systems under certain conditions in accordance with 409.02(a). If automatic printer systems are used, the same inspection, testing, and sealing requirement specified herein for scales shall apply to HMA plant batch scales and printer systems.

90 A motor-truck scale shall have a suitable undercarriage of such construction that shall safely carry and weigh an amount equal to 80% of the rated capacity of the scale on either end of the scale platform. When so loaded, the stresses in the lever system shall not exceed the stresses allowable under AREA specifications. The load carried per 1 in. of knife-edged bearing shall not exceed 5,000 lb.

The scale platform shall be of such length and width as to conveniently accommodate all trucks containing materials which need to be weighed. The entire truck load shall rest on the scale platform and shall be weighed as one draft.

100 If material is weighed on truck scales, weigh tickets showing the net weight of each load of material delivered shall be supplied for use in computing quantities. The tickets shall be prepared at the weighing site under the supervision of the State weighman, and shall contain the ticket serial number, date, contract number, source of supply, material designation such as size or type, DMF or JMF number for HMA, truck number, time weighed, gross weight direct reading if scale is of the direct reading type, tare, net weight, and moisture content if applicable. Two spaces shall be provided on each ticket for signatures of representatives of the Engineer. One space shall be designated for the state weighman and the second space for the technician or inspector.

110 A duplicate ticket may be furnished by the Contractor for its records. The original, and duplicate if furnished, tickets will be signed at the weighing site and at the point of incorporation into the work. No additional payment will be made for furnishing, maintaining, and operating scales.

120 The weight of materials weighed outside the State and intended for use on the contract may be determined on scales tested and approved by the proper governmental unit having authority where the scales are located. In such case, the Department shall be furnished with a certified copy of such inspection and approval which, to be acceptable, shall have been made within one year to the time of such weighing. Out-of-state truck scales used shall be in accordance with all pertinent provisions as they apply to truck scales accepted within the State of Indiana. They shall be subject to approval and inspection by the Department and to the requirements applicable to such scales located within the State.

If materials are shipped by rail, the car weight may be accepted provided payment is made for only the actual weight of the materials. Car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as directed. Each truck shall bear a plainly legible identification mark.

130 **(c) Measurement by Volume**

Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of the size or acceptable type provided the body is of such shape that the actual contents may be determined readily and accurately. All vehicles shall be loaded to at least their water level capacity. All loads shall be leveled when directed, after the vehicles arrive at the point of delivery.

140 When requested and approved in writing, material specified to be measured by the cubic yard may be weighed. Such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

In computing volumes of excavation, the average end area method or other acceptable methods will be used.

If excavation is measured by cross sections, the following will apply:

- 150
1. Unless otherwise provided, where sodded areas are involved, the cross sections will be considered as located at the surface of the sod.
 2. If the cost of excavation is specifically included in the payment for a pay item of work, the final sections will be taken at the finished surface of the work.
 3. If the cost of excavation is not specifically included in the payment for a pay item of work, the final sections will be taken at the limits of the authorized excavation.

160

Unauthorized wastage of material will be deducted. Only such quantities as are actually incorporated into the completed work will be included in the final estimate.

(d) Measurement of Asphalt Materials

If an asphalt material is to be paid for directly, it will, except as hereinafter provided, be weighed and paid for by the ton. If the Engineer decides that weighing is not feasible, the asphalt material may be measured by volume and converted to tons. The conversion will be based on the unit weight as determined in the laboratory.

170 If asphalt material is to be measured by volume, it will be measured by the gallon in tank cars, distributor tanks, tanks, or drums. Certified calibration of tank cars, distributor tanks, tanks, and certified quantities in drums in which asphalt materials are delivered or stored shall be furnished.

If asphalt material is furnished in drums, the amount in each drum shall be stenciled plainly on the drumhead by the producer. The amount so indicated will be

accepted as the quantity furnished. However, the amount in each drum may be checked in accordance with the requirements set out herein.

180 Tank car deliveries will be measured by volume and converted to tons.

Volumes will be measured at 60°F or will be corrected to the volume at 60°F in accordance with ASTM D1250 for asphalts or ASTM D633 for tars.

Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when asphalt material has been lost from the car or the distributor, is wasted, or is otherwise not incorporated into the work.

190 **(e) Measurement of PCC**

For design and production, PCC will be measured by the cubic yard. The relative yield will be determined in accordance with 505.01. Payment for PCC will be in the unit designated for the specified use.

(f) Measurement of Aggregates

200 Unless otherwise provided, all aggregates for which measurements are obtained by the cubic yard will be measured at the truck loading point in truck beds that have been measured, stenciled, and approved. They may be weighed and converted to cubic yards by a conversion factor computed at sufficient intervals to ensure correct measurement.

210 Free water in all aggregates for which payment is made as a separate pay item on a weight basis shall be drained prior to weighing and selection of samples. Samples for determination of moisture content shall be taken immediately prior to the time the material is to be weighed. The number of moisture tests will be governed by moisture conditions. Moisture contents shall be determined on the basis of oven dry weight by drying samples to constant weight at 230°F, ±9°F. However, if ovens are not available for drying samples, other methods which give equivalent results may be used. Moisture content shall be computed to the nearest 0.5% in accordance with the formula as follows:

$$\text{Percent of Moisture (M)} = \frac{\text{Wet weight of sample} - \text{Dry weight of sample}}{\text{Dry weight of sample}} \times 100$$

The percent of moisture shall be noted on each weight ticket.

220 The wet weight will be used for the basis of payment, if the % of moisture is determined to be less than 6% for B borrow; 9% of optimum moisture content, as determined in accordance with AASHTO T 99, whichever is greater, for size No. 53 or No. 73 aggregates or modifications thereof when specified; or 4% for aggregates of all other specified sizes including sand.

If the percent of moisture exceeds the limitations set out above, the weight to be paid for will be the gross weight of aggregate minus the weight of the excess moisture computed as follows:

$$\text{Weight to be paid for} = G \times \frac{(100 + m)}{(100 + M)}$$

in which:

- 230 G = Gross weight of material,
 M = Percent of moisture in the aggregate to the nearest
 0.5% based on oven dry weight,
 m = Percent of moisture allowed in the wet aggregate to
 be paid for based on oven dry weight.

(g) Measurement of Timber or Lumber

Timber or lumber will be measured by the thousand feet board measure or MFBM actually incorporated into the work. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

(h) Rental of Equipment

- 240 Rental of equipment will be measured in hours of actual working time and necessary traveling time of the equipment within the project limits. If special equipment has been ordered in connection with force account work, travel time and transportation costs to the project site will be recorded. If equipment has been ordered and held on the project site on a standby basis, full time rates for such equipment will be paid.

(i) Manufactured Materials

- 250 If standard manufactured materials are specified such as fence, wire, plates, rolled shapes, pipe, or conduit, and such materials are identified by gauge, unit weight, or section dimensions, such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted. Nearly equivalent metric dimensioned manufactured items will be accepted in lieu of English dimensioned items, provided they are within the specified tolerances, when English sizes are specified. Nearly equivalent English dimensioned manufactured items will be accepted in lieu of metric dimensioned items, provided they are within the specified tolerances, when metric sizes are specified.

109.02 Scope of Payment

- 260 Compensation provided for in the contract shall be received and accepted as full payment for furnishing all materials and for performing all work specified in the contract in a complete and acceptable manner. This shall also be payment in full for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the prosecution thereof, in accordance with 107.23.

If the basis of payment clause in the specifications relating to a unit price in the Schedule of Pay Items requires that said unit price cover and be considered

270 compensation for certain work or material essential to the pay item, this same work or material will not also be measured or paid for under another pay item which may appear elsewhere in the specifications.

The term lump sum when used as a unit of payment will mean complete payment for the pay items of work described in the contract.

The payment of a current estimate before final acceptance of the work shall not affect the obligation of the Contractor to repair or renew any defective parts of the construction. The responsibility for all damages due to such defects will be determined in accordance with 107.19.

280 If it is agreed in writing that the quantities of certain items or portions of items of work, as set forth in the contract, are in substantial agreement with actual quantities of work performed, compensation therefore will be based on the quantities set forth in the contract without measurement thereof upon completion of the work. Compensation based on contract quantities as agreed shall be accepted as full payment for such items or portions of items.

290 If the Contractor has previously agreed in writing to accept photogrammetric methods of measurement for common excavation and borrow, the Department may utilize such methods of measurement as the basis of payment. Computation of volumes shall be in accordance with 203.

109.03 Compensation for Altered Quantities

300 If the accepted quantities of work vary from the quantities shown in the Schedule of Pay Items, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the accepted quantities of work done. No allowance, except as provided in 104.02, will be made for increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefore, or from any other cause.

If an increase or decrease in a contract item is in accordance with 104.02, the contract unit price will be the rate of payment unless an adjusted price is agreed to by the parties to the contract. The contract unit price for a minor item may be adjusted if agreed to by parties for only that portion of the item which exceeds 6% of the total bid amount of the contract. A loss or gain of overhead costs will not be a consideration for adjusting the unit prices.

310 If such alteration directly causes the loss of any work or materials already furnished under the terms of the original contract, the actual cost of such work or salvaging such materials will be reimbursed. All such materials may, at the option of

the Department, be purchased at the actual cost including freight to the Contractor, plus 12%.

109.04 Cost Reduction Incentive, CRI

320 The Contractor may submit a written proposal for modifying the Contract Documents for the purpose of reducing construction costs or contract time. The proposal shall produce a savings without impairing essential functions, characteristics, and timing of the project including, but not limited to, safety, service life, economy of operations, the traveling public, ease of maintenance, desired appearance, design standards and construction schedules.

(a) CRI Initial Requirements

The Contractor shall initially submit five copies of a brief proposal to the Department to illustrate the concept or idea. At a minimum, the Contractor shall submit the following:

- 330 1. A statement that the proposal is submitted as a conceptual CRI.
2. A brief proposal with graphics, if appropriate, to illustrate and describe the concept.
3. A brief description of the existing work and the proposed changes for performing the work including a discussion of the comparative advantages and disadvantages for each and how the proposal meets the original intent of the design.
- 340 4. An approximate cost estimate for performing the work under the existing contract and under the proposed change.
5. An approximate cost estimate of design and engineering fees associated with the proposed change.
6. A description of any effects the proposed change would have on Department costs other than those in the contract such as future construction, design, right-of-way, utilities, maintenance, and operations costs.
- 350 7. The amount of time that will be needed to develop a formal CRI proposal.
8. A statement of the date by which the Department must execute an agreement adopting the proposal to obtain the maximum cost reduction during the remainder of the contract time, the date the work must begin in order to not delay the contract, and the reasoning for this time schedule.
9. An approximate estimate of the effect the proposal will have on

- 360 the time for completion of the contract, including development of the formal proposal, review by the Department and implementation.
10. The name of the redesign professional engineer, if any.
 11. Reference to the applicable Indiana Design Manual provisions.
 12. A statement regarding impacted permit requirements.
- 370 13. Identification of any material not in the current contract that the contractor proposes to use and corresponding applicable specifications.

The Department will notify the Contractor in writing within five business days after receipt of the proposal that the proposal has been rejected, accepted, or that a meeting needs to be arranged to discuss the proposed conceptual CRI. If the Department fails to respond within five business days, the proposal will be deemed rejected. If a meeting is requested, the Contractor shall arrange a meeting involving any professional engineer that will be used in development of the proposal; the engineer who designed the original plans or review engineer designated by the Department; contractor personnel; and Department personnel as determined by the Engineer. This meeting shall be held within 10 business days of receipt of the written notification, unless the Engineer approves additional time. At least two business days prior to the meeting, the Contractor shall provide a copy of its conceptual CRI to all persons invited to the meeting. Within 10 business days or a mutually agreed upon time after this meeting, the Department will notify the Contractor in writing as to whether a complete CRI may be developed.

380

(b) CRI Formal Proposal Requirements

390 If a concept is accepted by the Department, a formal proposal shall be submitted with a statement identifying the proposal as a CRI and shall contain, at a minimum, information as follows:

1. A description of the difference between the planned work and the proposed change with a comparison of effects on safety, service life, economy of operations, the traveling public, ease of maintenance, desired appearance, design standards, and construction schedules.
- 400
2. Proposed changes in the contract documents. Documents showing design changes shall be signed and bear the seal of a Professional Engineer. Design changes shall be supported by design computations as necessary for a thorough and expeditious evaluation.

3. The pay items, unit prices, and quantities affected by the change.
- 410 4. Complete, detailed cost estimates for performance of the work both as planned and as proposed.
5. The calendar date required for approval of the proposal in order to produce the savings indicated.
6. Locations and situations, including test results, in which similar measures have been successfully used.
7. A statement regarding the effect the proposal will have on the contract completion time.
- 420 8. A signed contract between the Contractor and the Contractor's redesign engineer, who prepared and sealed the plans for the CRI proposal, shall be submitted to the Department. The contract shall provide for the following:
 - 430 a. The Contractor's redesign engineer shall be responsible for the professional quality, technical accuracy, and the coordination of all designs, drawings, specifications, load rating analysis, and other services furnished by the redesign engineer under this contract. The redesign engineer shall correct or revise any errors or omissions in its designs, drawings, specifications, and other services. The Contractor's redesign engineer shall indemnify, defend, and hold harmless the State and its agents, officials, and employees, from all claims and suits including court costs, attorney's fees, and other expenses caused by any acts, errors, or omissions of the Contractor's redesign engineer, its agents, or employees, in connection with the CRI proposal.
 - 440 b. Neither the Department's review, approval, nor acceptance of the plans for the CRI shall be construed to operate as a waiver of rights under the contract or cause of action arising out of the contract. The Contractor's redesign engineer shall be and shall remain liable to the Department for all damages caused by the Contractor's redesign engineer.
 - 450 c. The rights and remedies of the Department provided in the contract are in addition to all other rights and remedies provided by law.

- d. No terms between the Contractor and the redesign engineer shall adversely affect the Department's liability protection.
9. The Contractor's engineering costs to develop the proposal shall be submitted with full documentation.

460 Additional information shall be provided as required to properly evaluate the proposed change. Failure to do so may result in rejection of the cost reduction incentive proposal.

(c) Approval of Formal CRI Proposal

470 The Engineer will be the sole judge as to whether a formal CRI proposal qualifies for consideration, evaluation, and approval. A proposal which requires excessive time or cost for review, evaluation, or investigation, or which is not consistent with Department design policies, may be rejected. A proposal may also be rejected if not submitted within the time frame specified in the Contractor's conceptual proposal, unless the Engineer approves additional time. Proposed changes in pavement design including materials or pavement type, changes in materials required to be installed by a certified installer, or changes in right-of-way will not be approved. A proposal which uses empirical design (AASHTO LRFD Bridge Design Specifications, Section 9.7.2) of the concrete bridge deck will not be considered or approved. Only proposals which result in the Department's portion of the estimated net savings being \$10,000.00 or more will be considered. Except as provided in 109.04(d), the Department will not be liable for failure to accept or act upon a proposal submitted in accordance with the requirements herein or for delays to the work attributable to such proposal, unless an extension of time is provided as part of the agreed CRI proposal.

480 Original contract bid prices shall not be based on the anticipated approval of a CRI proposal. If the proposal is rejected, the contract shall be completed at the original contract prices. If a CRI proposal is not approved on or before the calendar date submitted by the Contractor in the CRI shown on the proposal, such proposal will be deemed rejected. In determining the estimated net savings, the contract prices bid may be disregarded if it is determined that such prices do not represent a fair measure of the value of the work to be performed or deleted.

490 The CRI proposal will not be approved if equivalent options are already available within the contract, or if the Department is already considering a change order to the contract which includes the proposal revisions.

When a CRI proposal is received which changes superstructure type, superstructure dimensions, or superstructure dead load, the Engineer will perform a load rating analysis on the proposed structure. The load rating analysis must yield an inventory rating of 1.0 or greater for the design live load in order to be considered for approval. If the inventory rating is less than 1.0, the proposed design shall be modified so that the load rating analysis yields an inventory rating of 1.0 or greater for the design live load before the CRI proposal is considered for approval.

If the CRI proposal is approved, it will be executed by means of a change order.
500 The change order will show the changes in the plans and specifications necessary to enable the proposal to be put into effect and the net estimated savings will be set forth on the change order.

Upon approval, the Department will have the right to use, duplicate, and disclose in whole or in part, all data necessary for the subsequent adoption of the proposal for future projects.

The provisions of this specification will apply only to a contract awarded to the lowest bidder in accordance with the Department's competitive bidding requirements.
510

(d) Payment for Design of Formal Proposal, if Rejected

Except as provided elsewhere herein, if the Department rejects the formal CRI proposal, the Contractor will be reimbursed for 50% of the Contractor's reasonable design costs incurred after the Department's acceptance of the CRI conceptual proposal.

The Contractor will also be reimbursed for 50% of the Contractor's reasonable design costs of an approved CRI proposal if the Department determines that the proposal is no longer feasible because of changes in field conditions or other
520 conditions beyond the control of the Contractor. If written approval was given to proceed with the work, procure materials, begin fabrication, and rejection occurs, the work and fabrication costs will be reimbursed in accordance with 109.05. The Contractor will be compensated for materials ordered which are unique to the project based on the Contractor's cost minus salvage value if the Contractor is unable to return these items to the vendor. All such material may, at the option of the Department, be purchased at its actual cost. There will be no reimbursement for costs incurred prior to the acceptance of the conceptual CRI proposal. The Contractor will not be reimbursed for design costs if a formal CRI proposal is rejected because it was not submitted within the time frame specified in the Contractor's conceptual proposal or additional
530 time approved by the Engineer, if the Contractor fails to submit additional information requested by the Department, or if the design criteria used in the proposal does not comply with the Department's design standards.

(e) Other Conditions

The Contractor shall continue to perform the work in accordance with the contract requirements until a change order incorporating the CRI proposal has been approved. However, no contract work that will be affected by a CRI proposal shall be performed until the CRI proposal has been approved or rejected.

540 Prior to approval, the Engineer may modify a proposal with the concurrence of the Contractor, to enhance it or make it acceptable. If any modification increases or decreases the net savings resulting from the proposal, the Contractor's 50% share will be determined upon the basis of the proposal as modified.

The Department reserves the right to include in the change order the conditions it deems appropriate for consideration, approval, and implementation of the CRI proposal. Acceptance of the change order by the Contractor shall constitute acceptance of such conditions. As a condition for considering a Contractor's CRI proposal, the Department also reserves the right to require the Contractor to share in the Department's costs of investigating the proposal. If this condition is imposed, the Contractor shall indicate acceptance in writing. Such acceptance shall constitute full authority for the Department to deduct amounts for the investigation from moneys due the Contractor under the contract.

The Engineer may reject, in accordance with 105.03 and 105.11, all or any portion of work performed under an approved CRI proposal.

(f) Time Savings Proposals

The Contractor may submit a CRI proposal that reduces contract time by changing phasing of the work, the traffic control plan, or design elements.

The Department will consider proposals that result in time savings and at the same time may increase the cost of the project. The Department will be the sole judge as to whether the benefits of completing the project or a project phase before the scheduled completion date or milestone offsets an increase to the cost of the project.

The submittals for time savings will be reviewed using the CRI proposal process. The Contractor shall provide the Department sufficient information to enable the Department to evaluate the cost benefit of the savings.

(g) Adjustments to Contract Time

For approved formal CRI proposals the Department will adjust the applicable contract time as set out in the proposal. Any adjustment will be set forth in the change order for the CRI proposal. Depending on the Contractor's proposal, the adjustment will be an increase or decrease in the appropriate completion date.

(h) Method of Measurement

The work, as revised by the formal CRI proposal, will be measured as complete and in place and in accordance with the change order.

(i) Basis of Payment

The work, as revised by the formal CRI proposal, will be paid for as complete and in place and in accordance with the change order. In addition, the Contractor's Reasonable Design Cost and 50% of the total net savings of the CRI proposal will be paid for separately as follows:

1. The Contractor's Reasonable Design Cost for the CRI proposal will be paid for after approving the formal CRI proposal with the change order.

2. Upon completion of all items of work included in the change order, the total net savings will be calculated and the Contractor will be paid 50% of the total net savings.

The total net savings resulting from the CRI will be calculated as follows:

$$\text{TNS} = \text{OCW} - \text{RCW} - \text{CRDC} - \text{DC}$$

where:

TNS = total net savings

OCW = original cost of the work required by the original contract

RCW = revised cost of the work

CRDC = Contractor's reasonable design cost for the CRI proposal

DC = Department's cost for investigating, evaluating, and implementing the CRI proposal.

600

3. A cost savings of not less than \$5,000.00 shall be guaranteed to the Department.

The actual formal CRI proposal net savings will be checked upon completion of the contract and determination of final quantities to determine if any payment adjustment is required.

610

Only those work items directly affected by the plan change will be considered in making the determination of net cost savings. Subsequent plan changes affecting the modified work items but not related to the CRI proposal will be excluded from such determination. Upon completion of all work included in the CRI proposal, the final total net savings will be determined by comparing the cost of the work based on the original contract quantities with the cost of the actual CRI proposal work performed.

In determining the savings, the Department reserves the right to consider other factors in addition to the contract bid prices and proposed unit prices if, in the judgment of the Department, such prices do not represent a fair measure of the value of the work to be deleted from or added to the contract.

620

The net savings of a CRI proposal to reduce contract time will be determined by multiplying the number of days saved by the daily liquidated damages as set forth in Section 108.08 or as otherwise provided in the contract.

Redesign engineering, in accordance with this section, is defined as 50% of the contractor's reasonable design costs incurred after the Department's acceptance of the CRI proposal. Redesign Engineering will be paid when a conceptual CRI has been accepted by the Department, but the final proposal is rejected.

630

Payment will be made under:

Pay Item	Pay Unit Symbol
Contractor's Reasonable Design Cost for CRI Proposal No. _____	LS
Cost Reduction Incentive Proposal No. _____	LS
Redesign Engineering, CRI Proposal No. _____	LS

109.05 Payment for Extra Work

640 A Change Order Request form, available on the Department's website, shall be submitted for review for all extra work prior to the Engineer drafting a change order. The form shall describe any unique circumstances and shall include unit prices or lump sum prices utilizing standard Department pay items.

Extra work performed in accordance with 104.03 will be paid for by one of the following methods:

(a) Agreed Price

650 Extra work will be paid for at agreed upon unit prices or lump sum prices as documented on approved change orders. The Department will perform a cost analysis of the Contractor's unit price or lump sum price indicated on the Change Order Request form.

Based on the results of the cost analysis, the Engineer may direct the Change Order Request form to be amended to incorporate additional information, including:

1. A detailed explanation of unique circumstances of the extra work.
- 660 2. The effect of the circumstances on the requested price.
3. A breakdown of the estimated costs for the categories of labor, equipment, and materials in sufficient detail to enable the Engineer to determine the basis and amount of the requested price.

(b) Force Account

670 The Department may require the Contractor to perform extra work on a force account basis when a price cannot be agreed upon in accordance with 109.05(a). The Contractor shall, when directed, submit a written proposal for the extra work prior to the start of the work. When directed, the proposal shall include the planned labor, materials, equipment, and schedule for the work. Extra work performed by force account will be documented on an approved change order and will be compensated in the following manner:

1. Labor Costs

For all labor and foremen in direct charge of the specific operations, the

109.05

Contractor will receive the rate of wage, or scale, agreed upon in writing before beginning work for each hour that said labor and foremen are actually engaged in such work.

680

The Contractor will receive the actual costs paid to, or in behalf of, workmen by reasons of subsistence and travel allowances, worker's compensation insurance premiums, unemployment insurance contributions, social security taxes, health and welfare benefits, pension fund benefits, or other benefits when such amounts are required by collective bargaining agreement or other employment contract generally applicable to the classes of labor employed on the work. The Contractor shall furnish satisfactory evidence of the rate or rates paid for insurance premiums and tax.

690 An amount equal to 20% of the sum of the above items will also be paid to the Contractor.

2. Bond and Insurance

For bond premium and property damage and liability insurance premiums, the Contractor will receive the actual cost, to which cost 10% will be added. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond premium and insurance premiums.

3. Materials

700 For materials accepted and used, the Contractor will receive the actual cost of such materials delivered on the work, including transportation charges paid by the Contractor, exclusive of machinery rentals as hereinafter set forth, to which cost 12% will be added.

4. Equipment

710 For Contractor owned machinery or special equipment other than small tools as defined herein, the rates shall be not more than those listed in the current Rental Rate Blue Book as published by EquipmentWatch®. The rate used shall be the FHWA hourly rate which is the ownership cost rate plus the operating cost rate. Regardless of the time used, the ownership cost rate shall be the hourly rate obtained by dividing the monthly Blue Book rate by 176 with appropriate adjustments made for region and age. Actual transportation costs may be added to the FHWA rate. Small tools will be defined as tools costing less than \$500 each, or an aggregate total of \$1,000 or less.

For machinery or special equipment not owned by the Contractor, the rate shall be as shown on invoices. Actual fuel, lubricant and transportation costs may be added to the rental cost. The Engineer may designate the use of the fuel percentage of the Rental Rate Blue Book operating cost rate in lieu of actual fuel and lubricant costs. No payment will be made for repairs to rented equipment.

720 For equipment that is operational, on-site, and necessary for force account work, but is idle due to conditions beyond the control of the Contractor, a standby rate will apply. The standby rate will also apply during the period of transportation and on-site assembly and disassembly of the equipment for transportation purposes. The standby

rate will be the published ownership cost rate reduced by 50%. Standby time will not be paid for in excess of 8 hours per day minus the number of hours paid for at the FHWA rate per day; or 40 hours per week minus the number of hours paid for at the FHWA rate per week. If rented equipment necessary for force account work is idle, the Department will pay the Contractor for the actual invoice rates for the duration of the idle period.

730

The Contractor shall provide a list of all information needed to verify the Blue Book rental rate for each piece of equipment. The information shall include the equipment type, manufacturer name, model number, year, any attachments used, and any other information necessary to determine the proper rate.

The Contractor will receive payment for the total costs agreed upon to which sum 12% will be added.

5. Miscellaneous

740 No additional allowance will be made for general superintendence or other costs for which no specific allowance is herein provided.

6. Subcontracting

For administration costs in connection with approved subcontract work, the Contractor shall receive an amount equal to 7% of the total cost of such work computed as set forth above.

7. Compensation

750 The Contractor and the Engineer shall compare records of the cost of work done as ordered on a force account basis at the end of each day. These records shall be made in duplicate and signed by both. Each shall retain one copy.

8. Statements

No payment will be made for work performed on a force account basis until the Contractor has furnished triplicate itemized statements of the cost of such force account work detailed as follows:

760

- a. name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman;
- b. designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment;
- c. quantities of materials, prices, and extensions;
- d. transportation of materials;
- e. cost of property damage, liability and worker's compensation insurance premiums, unemployment insurance contributions, and social security tax.

770

Statements shall be accompanied and supported by receipted invoices for all materials used and for transportation charges. However, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of the invoices the Contractor shall furnish an affidavit certifying that such materials were taken from its stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

780 If the Contractor fails or refuses to prosecute extra or force account work as directed, the Department may withhold payment of all current estimates until the Contractor's failure or refusal is eliminated.

109.05.1 Quality Adjustments

Quality adjustments are those adjustments in the payment for work done or materials furnished and incorporated into the work which either exceed or fall below the standards established by the contract.

790 A change order will be prepared to reflect these adjustments. The unit price for these adjustments will be \$1.00 and the quantities will be in units of dollars.

Payment will be made under:

Pay Item	Pay Unit Symbol
Quality Adjustments, _____ type	DOL

800 The dollars shown shall be the amount of the quality adjustments for the following types and may consist of plus or minus adjustments.

(a) HMA

Quality adjustments with respect to mixture, density, and smoothness for mixture produced will be computed in accordance with 401.19.

(b) PCCP

Quality adjustments will be calculated in accordance with 501.28 or 502.21(c) as appropriate.

810 **(c) Temporary Traffic Control Devices and Markings, TTCD**

Quality adjustments will be assessed when the device is deemed to be in non-compliance in accordance with 801.03. Adjustments will be determined in accordance with 105.14.

Adjustments for non-compliance of construction warning lights will be determined in accordance with 801.14.

(d) Failed Materials, FM

820 Quality adjustments for materials which are deemed below the standards established, but which are allowed to remain in place by the Department's Failed Materials Committee in accordance with 105.03, will be as determined by that committee.

(e) Pavement Traffic Markings, PTM

Quality adjustments will be calculated in accordance with 808.07.

(f) Stormwater Management

Quality adjustments will be calculated in accordance with 205.08.

830 **109.05.2 Delay Costs**

When the Engineer determines that an excusable, compensable delay has occurred as defined in 108.08(b), the Department will pay for the costs incurred by the Contractor as a result of the delay. The Department will not pay for unrecoverable costs as defined in 104.02(d) and will not make duplicate payment for compensation made in accordance with 109.05.

840 The Department will not make payment for delays that occur during the period from December 1 through March 31 unless the Contractor's current accepted progress schedule, as required by 108.04, indicates work on the controlling operation or critical path during this period.

The Contractor shall provide satisfactory documentation to support payment for delay costs. The Department will not make any payment for delay costs until the documentation is submitted.

Payments made under this specification shall constitute full compensation for all delay costs and associated costs, including overhead.

(a) Allowable Delay Costs

850

1. Labor

Payment will be made for all necessary salaried and non-salaried personnel that must remain on the project, as approved by the Engineer, during the delay period and cannot be assigned to unaffected work. Necessary personnel will include field superintendents, assistants, watchmen, clerical and other field support staff, and those persons required for maintenance within the project limits, including maintenance of traffic control devices, maintenance of erosion and sediment control measures and similar activities as approved by the Engineer. Payment for labor costs will be calculated in accordance with 109.05(b)1.

860

2. Insurance

Payment will be made for the increased cost of insurance resulting directly from the delay and will be calculated in accordance with 109.05(b)2.

3. Equipment

Payment will be made for idle equipment that must remain on the project, as approved by the Engineer, during the delay period and cannot be used for active work. Payment for idle equipment will be calculated in accordance with 109.05(b)4.

870 If the Engineer determines that idle equipment should not remain on the project, the Department will pay for the cost to demobilize the equipment during the delay and remobilize it at the end of the delay.

4. Field Office Costs

Payment will be made for the cost to maintain a Contractor's field office, if determined necessary by the Engineer, during the delay period.

880 Field office costs include, but are not limited to, the Contractor's field office facilities, tool trailers, office equipment rental, temporary toilets, incidental supplies, and utility expenses. Payment will be made only for the actual costs incurred during the delay period as documented on paid invoices.

5. Escalation Costs

890 Payment for escalation costs due to an excusable, compensable delay will be limited to the escalated cost of labor, materials, and equipment on that portion of the work which is delayed beyond an original intermediate completion date or the contract completion date and is caused to be performed during a period when the costs were higher than when the work was planned to be performed as shown on the accepted schedule prior to the delay. The Contractor shall submit satisfactory documentation of escalation costs in a format approved by the Department.

a. Labor Escalation

Payment for escalated labor costs will be calculated as the difference in labor cost between the time the work was performed and the time the work was planned. Labor costs will be calculated in accordance with 109.05(b)1 except that no markup will be paid for labor escalation.

b. Materials Escalation or Storage

900 Payment for escalated material costs will be calculated as the difference in the material cost between the time the work was performed and the time the work was planned. No material escalation cost will be paid for any item covered by a separate escalation or indexing clause under the contract.

The Department will pay for storage of materials, as approved by the Engineer, due to the delay. Only the actual cost of storing the materials will be paid. No markup will be paid for materials storage.

c. Equipment Escalation

Payment for equipment escalation costs will be calculated as the difference

910 between the Rental Rate Blue Book FHWA hourly rate at the time the work was performed and the Rental Rate Blue Book FHWA hourly rate at the time the work was planned. No markup will be paid for equipment escalation costs.

(b) Blank

109.05.3 PG Asphalt Binder Material Cost Adjustments

920 The Contractor shall elect at the time the bid proposal is submitted, in a manner determined by the Department, whether or not to enact PG asphalt binder material cost adjustments. If the Contractor elects not to enact such adjustments, there will be no adjusted payment made to the Contractor for changes in the cost of PG asphalt binder materials used on the project and the provisions of this specification will not be applied to the contract. PG asphalt binder material cost adjustments will not be added to the contract at any time after the Contractor has elected not to enact such adjustments with submittal of the bid proposal. PG asphalt binder material cost adjustments will not be applied to alternate bid pavement items, but may be applied to the common items on contracts containing alternate bid pavement items.

930 When the Contractor elects to enact PG asphalt binder material cost adjustments at the time the bid proposal is submitted, the Department will adjust payment to the Contractor due to an increase or decrease in the cost of PG asphalt binder material used on the project to produce HMA mixtures that are paid in accordance with 304, 401, 402, 410, 414, 610, or 718. Payment will be adjusted when an increase or decrease in the PG asphalt binder index for the contract is greater than or equal to 10.01%. Payment will only be adjusted when the total original or revised quantity of at least one HMA pay item exceeds 2,000 tons.

940 For contracts without any original HMA pay item quantity equal to or greater than 2,000 tons, adjusted payment will not be made until the revised quantity of at least one HMA pay item meets the quantity criteria.

The initial 2,000 tons of HMA will not be eligible for a payment adjustment.

950 The Department will determine a PG asphalt binder index from one or more commercial services that provide regional indices. The PG asphalt binder index will be maintained by the Department's Division of Materials and Tests and posted on the Department's website. The posting will include an explanation of how the index is determined. A monthly payment adjustment will be calculated for each HMA pay item placed on the contract during that month. The total PG asphalt binder adjustment applied to the contract each month will be the sum of the calculations for each HMA pay item. The payment adjustment for each HMA pay item will be calculated as follows:

For a price increase:

$$\text{MPA} = (Q \times \text{Pb}) / 100 \times \text{LI} \times [(\text{BI} - \text{LI}) / \text{LI} - 0.10]$$

109.06

For a price decrease:

960
$$MPA = (Q \times Pb) / 100 \times LI \times [(BI - LI) / LI + 0.10]$$

where:

MPA = Mixture Payment Adjustment, in dollars, calculated to the nearest 0.01 dollar for each HMA pay item.

Q = Quantity of a HMA pay item placed, in tons, entered to the actual 0.01 unit placed. The quantity will be calculated prior to calculation of any other quantity adjustment.

970 Pb = Percent of virgin asphalt binder from the DMF, in the adjustment period, or JMF for the HMA mixture, entered to the nearest 0.1.

BI = PG asphalt binder index for the month the HMA pay item is placed, reported to the nearest whole dollar.

980 LI = PG asphalt binder index for the contract. The LI for all original contract HMA pay items equals the BI for the month immediately prior to the month of letting for the contract. The LI for any HMA extra work pay item will be the BI for the month the unit price for the pay item is submitted by the Contractor.

The calculation of (BI-LI)/LI will be rounded to the nearest 0.001. Payment will only be adjusted when the absolute value of (BI-LI)/LI is equal to or greater than 0.101.

If HMA pay items are placed beyond the specified contract completion date for the contract, the Department will calculate pay adjustments on the BI for the month of the specified completion date or the month of placement, whichever result is less.

990 The unit price of PG asphalt binder payment adjustment will be \$1.00 and the pay quantities will be in units of dollars.

Payment will be made under:

Pay Item	Pay Unit Symbol
Payment Adjustment, PG Asphalt Binder	DOL

109.06 Eliminated Pay Items

1000 If pay items contained in the Schedule of Pay Items are found unnecessary for the proper completion of the work, they may be eliminated from the contract as a change order. Such action shall not invalidate the contract. When notified of the elimination of pay items, the Contractor will be reimbursed for actual work done and all costs

incurred, including mobilization of materials prior to said notification. This material may, at the option of the Department, be purchased at the actual cost including freight to the Contractor, plus 12%.

109.07 Partial Payments

1010 The contract may contain more than one project. Partial payments may be made once each month as the work progresses or twice each month if it is determined that the amount of work performed is sufficient to warrant such payment. These payments will be based on estimates, prepared by the Engineer, of the value of the work performed and materials complete in place in accordance with the contract. No partial payment will be made or estimates will not be submitted when the total value of the work done since the last estimate amounts to less than \$500.

1020 Except as set out in 105 IAC 11-3-8 of the Rules For Prequalification of Contractors and Bidding, the balance, less all previous payments and less amounts claimed which are required to be held by the Department in accordance with Indiana Code 8-23-9-26 through 8-23-9-39, will be certified for payment.

Within 10 business days of receipt of payment for any such estimate, the Contractor shall make payment to all subcontractors, including lessors and material suppliers, for the value of their work performed and materials complete in place in accordance with the contract. Failure to comply with this clause shall constitute a material breach of the contract and may result in sanctions under the contract.

1030 Any delay or postponement of payment among the parties may take place only for good cause, with the Department’s written approval. The explanation from the Contractor shall be made in writing to the Department.

Upon receipt of a claim under Indiana Code 8-23-9-26, the Department will retain out of the amount due the Contractor the amount of the claim. The amount to be retained will be withheld from partial payment estimates until the total amount of the claim has been retained.

1040 In order to retain an amount when required by Indiana Code 8-23-9-26, the Engineer will apply a negative quantity to the contract liens pay item for the actual dollar amount of the claim. Upon resolution of the claim, the Engineer will post a positive quantity to the contract liens pay item equal to the amount originally retained. The final quantity of the contract liens pay item will be zero prior to final payment.

The contract unit price for contract liens will be \$1.00.

Payment will be made under:

Pay Item	Pay Unit Symbol
Contract Liens	DOL

1050

109.08

No allowance will be made for materials received which have not been incorporated into the work except in accordance with 111.

109.08 Final Payment

When the work has been completed in accordance with the terms of the contract, a final estimate will be prepared for the work done and a copy will be furnished to the Contractor. Final payment will not be made to the Contractor until allowed by Indiana Code 8-23-9-26 through 8-23-9-39.

1060 All prior partial estimates and payments will be subject to correction in the final estimate and payment.

Except as otherwise provided herein, final payment will be made within 180 days after acceptance of the project. Acceptance shall be considered as the date the Contractor is relieved of further maintenance as provided in 107.19 and as set out in the final acceptance letter. However, final payment shall not be made on an amount which is in dispute or the subject of a pending claim. However, final payment may be made on that portion of the contract or those amounts which are not in dispute or subject of a pending claim. Such partial payment shall not constitute a bar, admission, or estoppel or have any other effect as to those payments in dispute or the subject of a pending claim. For the purpose of this section, a dispute exists when the Contractor makes a claim for increase or decrease to any part of the contract or seeks additional compensation for any reason.

1070

SECTION 110 – MOBILIZATION AND DEMOBILIZATION

110.01 Description

This work shall consist of all work necessary for the movement of personnel and equipment to and from the project site, except for seeding, and for the establishment and removal of all field offices, buildings, and other facilities necessary to the performance of the work.

110.02 Limitations

10 For the purpose of payment, the mobilization portion of this work will be limited to 5% of the original total contract price. The remainder of the work will be considered demobilization. The first progress estimate will include a percentage payment of the pay item for mobilization and demobilization that is equal to the lesser of 5% of the original total contract price or the contract lump sum price for the pay item mobilization and demobilization.

The balance of the lump sum price will be paid when the contract has been completed and accepted.

20 **110.03 Method of Measurement**

No measurement will be made.

110.04 Basis of Payment

This work will be paid for at the contract lump sum price for mobilization and demobilization.

Payment will be made under:

Pay Item	Pay Unit Symbol
30 Mobilization and Demobilization.....	LS

The cost of all materials, equipment, tools, labor, transportation, operations, and incidentals required for mobilization and demobilization shall be included in the cost of this work.

If no pay item for mobilization and demobilization is shown in the Schedule of Pay Items, the cost of the work described above shall be included in the total cost of the contract, with no direct payment for the work.

40

SECTION 111 – STOCKPILED MATERIALS

111.01 Description

This work shall consist of the partial payment for certain stockpiled materials.

111.02 General Requirements

After certified copies of costs are presented, partial payments may be allowed for tested and accepted non-perishable materials purchased or produced expressly to be incorporated into the work and delivered in the vicinity of the project, or stored in approved storage facilities. Such materials shall be limited to structural steel, concrete structural members, reinforcing bars, pavement contraction joints, granular base and subbase materials, aggregates for HMA and concrete pavements, and structural supports for signals, signs, and luminaires.

In addition to the aforementioned, the Department will consider the stockpiling of other products, such as guardrail and culvert pipe, if it has been determined that a critical shortage of material would cause delay to the project.

111.03 Structural Steel and Concrete Structural Members

20 Partial payment for either of these pay items will be considered only when the total quantity for an entire structure, or designated unit of a structure as specified on the plans, has been completely fabricated.

(a) Delivered to the Job Site

Partial payment made under the requirements of this paragraph will be the delivered cost of the structural steel and concrete structural members, as verified by invoices, including freight, furnished by the Contractor. However, such partial payment will not exceed 75% of the contract unit price as set out in the Schedule of

111.04

30 Pay Items for structural steel or concrete structural members. Prior to authorizing partial payment, verification will be obtained that all required inspection has been made and the members are acceptable.

(b) Acceptably Stored at the Fabricator's or Manufacturer's Storage Facilities

40 Partial payment made under the requirements of this paragraph will be the delivered cost of structural steel and concrete structural members, minus freight charges, as verified from invoices furnished by the Contractor. However, such partial payment will not exceed 70% of the contract unit price as set out in the Schedule of Pay Items for structural steel or concrete structural members. Under this requirement, all invoices shall show the location of where the material is being stored. Prior to authorizing partial payment, verification will be obtained that all required inspection has been made, that the members are acceptable, and that they are acceptably stored.

111.04 Dowel Bar Assemblies

50 Partial payment made under the requirements herein will be the delivered cost of the dowel bar assemblies stored within the project limits or at a storage facility adjacent to the project site. Basis of payment for the dowel bar assemblies shall be the paid invoices furnished by the Contractor. Prior to authorizing partial payment, verification will be obtained that the dowel bars have been tested and are acceptable.

111.05 Granular Base, Subbase Materials, and Aggregates for HMA and Concrete Pavements

60 Partial payment made under the requirement of this paragraph will be made upon presentation of paid invoices or certified copies of the cost for the production of such materials. The partial payment will not exceed 30% of the unit price bid for the base or subbase material item as set out in the Schedule of Pay Items. The invoice or certified copies of the cost shall include an estimated quantity of the materials stored for partial payment. The estimated quantity of materials will be verified before payment.

60 The approved storage site shall be within the project limits, at the Contractor's adjacent storage facility, or at a production site where the designated materials are either assigned to, or owned by the Contractor. Materials stored under this requirement shall be kept separate from other production and shall not be used except on the assigned contract, unless otherwise approved in writing.

70 Testing shall be provided as directed, during production. Prior to authorizing partial payment, verification shall be provided that the materials have been tested and are acceptable.

111.06 Bridge Expansion Joints

(a) Type SS

Partial payment will be the delivered cost of the expansion joint SS, as verified by invoices, except it will not exceed 75% of the contract unit price for expansion joint

SS. Prior to authorizing partial payment, verification shall be provided that all required inspections have been made and the joint is acceptable.

(b) Type M

80 Partial payment will be the delivered cost of the expansion joint M, as verified by invoices, except it will not exceed 75% of the contract unit price for expansion joint M. Prior to authorizing partial payment, verification shall be provided that all required inspections have been made and the joint is acceptable.

111.07 Structural Supports for Signals, Signs, and Luminaires

90 Partial payment will be the delivered cost of the materials, as verified by the invoices, except it will not exceed 50% of the contract unit price for the structural support which is stored within the project limits or at an approved storage facility adjacent to the project site. Prior to authorizing partial payment, verification shall be provided that the material has been tested and is acceptable.

111.08 Precast Concrete Median Barrier

Partial payment for precast concrete median barrier as stockpiled material will be the delivered cost of the materials, including freight, as verified by invoices furnished by the Contractor. Such partial payment will not exceed 50% of the contract unit price for the median barrier. The concrete barrier shall be stored within the project limits or at an approved storage facility adjacent to the project in order for stockpiled payment to be favorably considered.

100 **111.09 Concrete Face Panels and Ground Reinforcement for MSE Walls**

Partial payment for concrete face panels and ground reinforcement for MSE walls as stockpiled material will be the delivered cost of the concrete face panels and ground reinforcement, including freight, as verified by invoices furnished by the Contractor. Partial payment will not exceed 75% of the contract unit price for concrete face panels.

Concrete face panels and ground reinforcement shall be stored within the project limits or at an approved storage location. Prior to authorizing partial payment, verification shall be provided that the concrete face panels are in accordance with 901.10 and the ground reinforcement is in accordance with 910.07(b).

110

111.10 Additional Requirements

Partial payment will not be allowed on an estimate for materials of less than \$10,000 in value.

The Department may consider partial payment for stockpiled materials having a value of over \$25,000. Partial payment will be the delivered cost verified by invoices, except it will not exceed 50% of the contract unit price.

120 All materials when so paid for under this requirement will become the property of the Department in the event of default on the part of the Contractor. The Department may use, or cause to be used, such materials in the construction of the work provided

SECTION 112 – BLANK

SECTION 113 – PARTNERING OVERHEAD

113.01 Description

All major players for both the Contractor and the Department will be expected to attend a partnering workshop to develop a statement of goals and monthly follow-up meetings. Players need to attend the follow-up meetings only when they are active in the project. This workshop shall be held at a neutral location and may include a working lunch if the cost is less than \$10.00 per person. The workshop should take place before the preconstruction conference, but shall not take the place of the preconstruction conference.

113.02 Requirements

The requirements for the workshop shall be as follows:

(a) Meeting Room

The size of the room and the number of persons in attendance may vary.

	<u>Attendees</u>	<u>Approximate Number</u>
20	City or County Officials, if applicable	3
	Department Personnel	12
	Designers or Design Consultant	2
	Prime Contractor’s and Subcontractor’s Personnel	13
	Utilities, if applicable	6
	Total Approximate Number in Attendance	36

(b) Meeting Length

The workshop is expected to last a minimum of 5 h. The follow-up meetings are expected to last approximately 1 to 2 h.

(c) Facilitator

A facilitator shall be provided. Such facilitator shall have expertise in conducting workshops of this nature. The Contractor shall select the facilitator. The facilitator will be subject to approval by the Engineer prior to being contracted for the work. The facilitator shall conduct the workshop, the first follow-up meeting, every third follow-up meeting, and a close-out meeting. The other monthly follow-up meetings will be conducted by the Engineer and Contractor. At the close-out meeting, a statement of successes and failures shall be developed. The facilitator shall compile and publish a summary of these successes and failures for distribution to all players.

113.03 Method of Measurement

Partnering overhead will not be measured for payment.

113.04

113.04 Basis of Payment

Partnering overhead will be paid for at the contract lump sum price for partnering overhead.

50 Payment will be made under the following:

Pay Item	Pay Unit Symbol
Partnering Overhead.....	LS

The cost of the room, facilitator, mailings, video and audio equipment required, and all other incidentals shall be included in the cost of partnering overhead.

DIVISION 200 – EARTHWORK

SECTION 201 – CLEARING AND GRUBBING

201.01 Description

This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the construction limits shown on the plans, except such objects that are designated to remain or are to be removed in accordance with other sections of these specifications. If no construction limits are shown, the right-of-way and easement areas will be the construction limits. This work shall include the preservation from injury or defacement of all vegetation and objects designated to remain. Disposal of material shall be in accordance with 203.08.

CONSTRUCTION REQUIREMENTS

201.02 General

Right-of-way lines and construction limits will be established. Trees, shrubs, plants, seeded or sodded shoulders, slopes or other items to remain will be designated. All such designated items and vegetation shall be preserved. All areas outside the construction limits shall remain in their original condition. All damage to natural terrain, vegetation, objects designated to remain, or areas outside the construction limits which have subsequently eroded or been damaged, shall be repaired or replaced in accordance with 621.11. Tree wound dressing required for cut or scarred surfaces of trees or shrubs selected for retention shall be in accordance with 914.09(c).

201.03 Clearing and Grubbing

Surface objects, trees, stumps, roots, and other protruding obstructions not designated to remain shall be cleared and grubbed, including mowing as required. Undisturbed sound stumps, roots, and non-perishable solid objects, which are a minimum of 3 ft below the final subgrade or slope of embankments, may be left, provided they are as nearly flush as possible. However, they shall not extend more than 4 in. above the ground line or low water level. Sound stumps may be cut off at ground level outside the construction limits of cut and embankment areas if approved.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted in accordance with 203.23.

Burning of perishable material shall be done in accordance with applicable laws, ordinances, rules, and regulations. All necessary permit approvals shall be obtained prior to burning.

Unless burned in accordance with the requirements herein, perishable materials and debris shall be removed from the right-of-way and disposed of in accordance with 203.08. If allowed, sod may be disposed of within the right-of-way.

All merchantable timber in the clearing area, which has not been removed from the right-of-way prior to the beginning of construction, shall become the property of the Contractor, unless otherwise provided. The value of the timber shall be taken into account when the bid is prepared.

- 50 Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 20 ft above the roadbed. All trimming shall be done by skilled workers and in accordance with good tree surgery practices.

201.04 Scalping

- Areas where excavations are to be made, or embankments are to be placed, shall be scalped to a maximum of 4 in. Scalping shall include the removal of material such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter from the surface of the ground.
- 60

201.05 Hedge Removal

Hedges and shrubs shall be pulled or grubbed in such a manner as to ensure complete and permanent removal.

201.06 Method of Measurement

When specified as a pay item, measurement of this work will be made by one or more of the following methods.

- 70 **(a) Area Basis**

The work to be measured will be the number of acres and fractions thereof acceptably cleared and grubbed within the limits shown on the plans or staked for clearing and grubbing. Areas not shown on the plans or not staked for clearing and grubbing will not be measured for payment.

(b) Lump Sum Basis

If clearing and grubbing is specified as a lump sum pay item, no measurement of area will be made.

- 80 **(c) Individual Unit Basis**

1. The diameter of trees will be measured at a height of 24 in. above the ground. Trees of less than 4 in. in diameter will be classified as brush.
2. Stumps will be measured by determining the average diameter at the cutoff location.
3. Scalping will be measured by the acre.

90

4. If the Schedule of Pay Items shows measurement to be on an individual unit basis, the units will be designated and measured in accordance with the schedule of sizes as follows:

Measured Diameter at Height of 24 in.	Pay Diameter
4 to 8 in.	6 in.
Over 8 to 12 in.	10 in.
Over 12 to 24 in.	18 in.
Over 24 to 36 in.	30 in.
Over 36 to 60 in.	48 in.
Over 60 in.	60 in.

201.07 Basis of Payment

The accepted quantities of clearing and grubbing will be paid for as specified and described below.

100 Payment will be made under:

Pay Item	Pay Unit Symbol
Clearing and Grubbing	ACRE
.....	LS
Clearing Right-of-Way	LS
Scalping	ACRE
_____, _____, Remove.....	EACH
name size	

110

(a) Area Basis

The determined quantities will be paid for at the contract unit price per acre respectively for each of the pay items shown in the Schedule of Pay Items.

(b) Lump Sum Basis

If the Schedule of Pay Items shows a lump sum pay item, the lump sum price will be paid for all work shown within the construction limits. All clearing the Contractor is directed to perform outside the construction limits, including clearing for utility relocation which is for the benefit of the Department, and not simply for the Contractor's convenience, will be paid for in accordance with 104.03 or 109.03 unless such clearing is shown on the plans, in the Contract Information book, or is for the construction of fence or right-of-way markers.

120

(c) Individual Unit Basis

If individual unit quantities are shown in the Schedule of Pay Items, the accepted quantities will be paid for at the contract unit prices for the respective pay items.

202.01

130 Payment for tree removal sizes as designated in requirement 4 of 201.06(c), which are larger than those sizes shown as pay items, will be made on the basis of the largest size shown in the Schedule of Pay Items except as set out below.

(d) Clearing Right-of-Way

140 If the Schedule of Pay Items contains a lump sum pay item for clearing right-of-way, such pay item shall include the cost of all work described in this section and all of the work performed in accordance with 202 within the construction limits except for such work set out specifically as pay items or as otherwise provided for herein. All clearing the Contractor is directed to perform outside the construction limits, including clearing for utility relocation which is for the benefit of the Department, and not simply for the Contractor's convenience, will be paid for in accordance with 104.03 or 109.03 unless such clearing is shown on the plans, in the Contract Information book, or is for the construction of fence or right-of-way markers.

Except as specified in 621, the cost of repair or replacement of terrain, vegetation, objects designated to remain, or areas outside the construction limits which have been damaged by the Contractor or have subsequently eroded, shall be included in the cost of clearing right-of-way.

(e) Exclusions

150 If the Schedule of Pay Items does not contain an estimated quantity or a lump sum pay item for work described herein except as set out above, such work will not be paid for directly. The cost thereof shall be included in the cost of other pay items.

SECTION 202 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.01 Description

10 This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, structures, old pavement, abandoned pipe lines, abandoned tanks, and any other obstructions which are not designated or allowed to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall include the salvaging of designated materials and backfilling the resulting trenches, basements, holes, and pits.

CONSTRUCTION REQUIREMENTS

202.02 General Requirements

20 All buildings and foundations in accordance with 202.06, structures, fences, tanks, and other obstructions, any portions of which are on the right-of-way shall be razed, removed, and disposed of, except utilities and those features for which other provisions have been made for removal. Salvageable material designated by the Department shall be removed without unnecessary damage in sections or pieces which may be transported readily and shall be stored at specified places within the project limits or as otherwise designated.

Materials not designated by the Department as salvageable and removed from the construction site shall become the property of the Contractor and shall be disposed of in accordance with 203.08 Regulated materials shall be disposed of in accordance with 104.06. Bridge painting debris shall be disposed of in accordance with 619.

30 Unsuitable material shall be removed from cisterns, septic tanks, other tanks, basements, and cavities. The disposal of this material shall be in accordance with all applicable and current local, State and Federal regulations. Cisterns, septic tanks, other
 40 tanks, basements, and cavities shall be backfilled in an approved manner. Those which cannot be backfilled satisfactorily shall be removed. If the backfill is within the limits of construction, it shall be completed in accordance with 203.23, unless otherwise directed. All abandoned wells shall be backfilled in accordance with the Indiana Code. A copy of the driller's license shall be furnished prior to commencement of work.

In accordance with 326 IAC 14-10, the Contractor shall complete and submit a demolition/renovation notification to IDEM when demolition or renovation of buildings, houses, canopies, and bridges are part of the contract. This notification shall be submitted regardless of whether asbestos containing material is present. Fees for
 40 this demolition/renovation notification shall be paid to IDEM by the Contractor.

Copies of the demolition/renovation notification form can be obtained from the IDEM's website. Questions concerning the completion of the demolition/renovation notification should be addressed to IDEM's Office of Air Quality.

Initial notification to IDEM shall be by certified mail, return receipt requested, or by hand delivery. Verification of this notification shall be provided to the Engineer. The Contractor shall provide such notification 10 work days prior to the date on which
 50 demolition or renovation operations are anticipated to begin. If the Contractor postpones the beginning date of demolition or renovation operations, IDEM shall be provided written notice of the new start date, postmarked at least five work days or delivered at least two work days before these operations begin. Verification of this notification shall also be provided to the Engineer.

Unless otherwise specified, materials removed from the construction site shall become the property of the Contractor and proper allowance for their value shall be taken into account in the bid price of the item involved. Where a house or building has been removed previously and the existing utilities and drains or sewer connections have not been terminated and sealed, this work shall be performed in accordance with
 60 104.03, or as otherwise provided for in the contract.

Unless inspection has previously been conducted by the Department, and the findings are shown in the Proposal book, all facilities to be demolished shall be inspected for the presence of regulated materials as defined in 104.06. Facilities are defined as all institutional, commercial, residential or industrial structures, installations, buildings, and all bridges. Inspection and testing for asbestos shall be in

202.03

accordance with 202.07. If inspected by the Department, a copy of the findings will be included in the Contract Information book.

- 70 At the direction of the Engineer and in accordance with 104.06(b), appropriate tests shall be made by the Contractor of all potentially regulated materials found. The Contractor shall comply with all applicable environmental regulations.

All identified regulated materials shall be reported and removed in accordance with the procedures specified in 104.06 prior to commencing the demolition of the facility. Asbestos removal shall be in accordance with the OSHA Asbestos Standard for Construction Industry, the EPA Asbestos Facts: Demolition and Renovation Regulations, and 202.07.

- 80 Except for tank content waste, in accordance with 202.08, the Engineer will classify regulated materials as one of the following Department categories for the purpose of disposal requirements and payment.

(a) Type Y Waste

All waste material that may be disposed of in a RCRA approved landfill.

(b) Type Z Waste

All waste material that is prohibited from being disposed of in a RCRA approved landfill.

90

202.03 Removal of Bridges, Culverts, and Other Drainage Structures

Bridges, culverts, and other drainage structures in use by traffic shall not be removed in whole or in part until satisfactory arrangements have been made to accommodate traffic. Any excavation adjacent to the structure or to its approaches shall be shored adequately to avoid damage to them or to traffic.

- 100 When a reinforced concrete arch bridge is to be removed, either in whole or in part, the work shall include the removal of miscellaneous items within the limits of the structure. The items shall be removed prior to or in conjunction with the removal of the structure. These miscellaneous items shall include but shall not be limited to concrete and asphalt pavements, concrete and asphalt sidewalks, and fill within the arches regardless of content.

For all painted or coated structural steel including beams, girders, diaphragms, cross frames, plates, and all other structural steel items that become the property of the Contractor through either a complete bridge removal in accordance with 202.03(a) or the removal of portions of a bridge in accordance with 202.03(b), the Contractor shall either:

- 110
1. take the steel to a recycling facility for proper disposal, or
 2. take ownership of the steel.

For structures shown in the contract documents as being built before 1995, the Contractor shall assume that the existing coating contains hazardous materials and that mill scale exists on the steel.

120 If the Contractor elects to take the steel to a recycling facility, a receipt from the facility shall be provided. The receipt from the recycling facility shall show the name of the facility that accepted the material, address, city, state, zip code, contract number, bridge number, date material was received from the Contractor, weight of the material accepted by the recycling facility, and detailed description of the items given to the recycling facility.

If the Contractor elects to take ownership of the steel, the steel shall be cleaned in accordance with 619.14 prior to its removal from the project.

(a) Complete

130 Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down 1 ft below the natural ground surface. Where such portions of existing structures lie wholly or in part within the limits of a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Portions of pre-existing structures that are not visible and not shown on the plans shall be removed as directed. Payment for such removal will be paid as class X excavation in accordance with 206.11.

140 Unless otherwise specified, structural steel and materials not designated by the Department to be salvaged shall become the property of the Contractor. It shall be removed from the site before completion of the work and proper allowance for its value shall be taken into account in the bid price of the item involved. If the structure is to remain the property of the Department, steel or wood bridges shall be carefully dismantled without unnecessary damage, steel members shall be match marked, and all salvaged material shall be stored in accordance with 202.02.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.

(b) Portions

150 Portions of the existing structure shall be removed as shown on the plans. Reinforcing bars shall be cut off or allowed to extend into the proposed work as required or as otherwise directed. Explosives shall not be used in the removal of concrete. Where new concrete joins existing concrete masonry, the surface shall be cleaned satisfactorily before new concrete is placed. Adequate safeguards shall be provided to prevent materials from falling below the structure when over or adjacent to traffic; when over bodies of water; as needed to protect life or property; and as needed to comply with laws, regulations, or other contract requirements. A plan shall be submitted for approval showing the proposed method of protection.

160 Pneumatic hammers, up to a maximum of 45 lb may be used for all removal areas to be patched in the deck and all areas within 24 in. of full depth removal lines. Pneumatic hammers up to 69 lb maximum weight may be used for removal of all parapet walls having a construction joint separating the wall from the coping and all partial curb removals. Pneumatic hammers up to 90 lb maximum weight may be used for all other removals outside these limits. Concrete splitters may be used for partial concrete removal subject to satisfactory performance. Deck areas that are to be removed full depth shall be completely separated from adjacent concrete by sawing before hammers heavier than 45 lb may be used.

170 Concrete superstructures or deck removal may be accomplished by pneumatic hammers larger than 90 lb, except directly over structural members that are to remain in place. Partial concrete removal of columns, piers, and abutments may be accomplished with pneumatic hammers larger than 90 lb, provided that the reinforcing bars in the portion to be removed are completely separated from the concrete that is to remain in place. Alternate methods of removal may be considered if requested in writing.

180 Hydrodemolition may be allowed for removal of portions of bridge structures as an alternate method to pneumatic hammers. Hydrodemolition for such removals may be accomplished either by use of a machine or a handheld device. Hydrodemolition shall otherwise be in accordance with 722.

Any portion of the structure that is removed, but which was not included within the limits of the concrete to be removed as shown on the plans or as directed, shall be replaced with no additional payment. If at any time during the removal process the tools or methods being used appear to cause any damage to concrete that is to remain, the work shall cease immediately and shall not resume until the Engineer is assured the tools or methods used will not cause further damage.

190 **(c) Disposal of Concrete**

All concrete from complete or partial removals, which is determined to be acceptable for riprap, shall be used on the project as directed. Concrete which has paint or other coatings adhering to it or exposed reinforcing bars shall not be used for riprap. Disposal or placement as riprap will not be paid for directly, but the cost thereof shall be included in the cost of removal. Disposal of concrete from complete or partial removals shall be in accordance with 203.08.

202.04 Removal of Pipe and Tile Drains

200 When indicated in the contract documents or as directed, all pipe and tile drains shall be removed and reasonable precaution taken to avoid breaking or damaging them. The pipe or tile shall be stored neatly on the right-of-way, unless it is to be re-laid as a part of the contract. Otherwise, the conditions in accordance with 104.05 shall apply.

Pipes to be re-laid shall be removed and stored so that there is no loss or damage to the pipe. Replacement will be required of sections lost from storage or from damage through negligence or from improper methods in handling. Removal of pipe or drain tile, any necessary cleaning, removal of headwalls, storage of pipe, and disposal of removed headwall material and unsuitable pipe will not be paid for directly, the cost thereof to be included in the various pay items.

Sanitary or storm sewers no longer in use shall be removed from under the roadway and shoulders if so specified on the plans or in the proposal or if so directed. No payment will be made for this removal if the removal is shown on the plans and no pay item exists, or if this removal is necessary during the placing of other structures or during other excavation operations. The removal of pipes that are not shown in the contract documents and those that are not being replaced at the same location will be paid for in accordance with 109.05. Disposal of pipe and tile drain material shall be in accordance with 203.08.

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202.05 Removal of PCCP, Sidewalks, Curbs, RCBA, and Reinforced Concrete Moment Slabs

All unreinforced PCCP, sidewalks, curbs, gutters, and other unreinforced concrete elements designated for removal shall be:

- (a) broken into pieces and used for riprap on the project; or
- (b) broken into pieces, the maximum weight of which shall be 150 lb, and incorporated into the work as directed; or
- (c) otherwise disposed of in accordance with 202.02.

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RCBA, reinforced concrete moment slabs, and reinforced concrete elements designated for removal shall be disposed of in accordance with 202.02.

Pavement removal shall consist of the removal and satisfactory disposal of RCBA, reinforced concrete moment slabs, reinforced or unreinforced PCCP, PCC resurface with its base, or the total of any combination of HMA base, intermediate, and surface course overlaying PCCP, PCC resurface with its base, RCBA, or reinforced concrete moment slab base. Pavement removal shall include only the removal and disposal of existing public road, street, and alley pavement as required for the planned construction. Curb removal shall include curb that is separate from the pavement or removed separately. Integral curb that is removed with the adjacent pavement will be paid for as pavement removal.

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Prior to performing the work of pavement removal at locations shown on the plans or where directed, cement concrete pavement to be removed shall be cut with a power driven concrete saw along designated lines. Sawing shall be such that any portion of the pavement to remain in place will not be damaged. Any portion that is damaged or removed outside the designated lines shall be replaced with no additional payment.

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Sawing of pavement to be removed will not be paid for directly, but shall be included in the cost of pavement removal.

202.06 Removal of Houses and Buildings

260 This item consists of the satisfactory demolition, removal, backfilling, and disposal of all houses and buildings at locations shown on the plans or where directed. The houses and buildings shall be demolished and removed down to a point 1 ft below the original ground level or the subgrade elevation, whichever is lower. All accumulated debris in existing basements shall be removed and disposed of. Prior to starting demolition operations, or when directed, all existing utilities shall be terminated and all floor drains shall be sealed in a satisfactory manner. Temporary fence in accordance with 107.14 may be required where specified or directed. Basements or depressions left by demolition shall be backfilled with B borrow and compacted in accordance with 203.23. No additional payment will be made for temporary fence, the cost thereof to be included in the lump sum price for removal at the location. Temporary fence shall remain the property of the Contractor.

270 The removal of houses and buildings shall be arranged and prosecuted such that all Department maintained highways, and all local roads, streets, and alleys within the project limits shall remain open to normal traffic at all times unless otherwise directed.

Demolition and removal of any individual house or building shall not be started without written authorization. Compensation will be paid only for houses and buildings which are actually removed from the right-of-way as authorized. Removed materials shall be disposed of in accordance with 104.05 and 104.06.

280 In the event the houses and buildings listed for removal from a designated parcel are not in existence at the time of submission of the bid, the lump sum bid for that item shall be indicated at zero dollars and cents.

202.07 Inspection and Removal of Asbestos

The Contractor shall comply with all applicable environmental regulations including but not limited to those as follows:

- 290 (a) In accordance with 202.02 and 326 IAC 14-10, a demolition/renovation notification is to be submitted to IDEM 10 work days prior to the start of demolition or renovation operations. During the 10 day period, IDEM may make a determination of the existence of asbestos materials. Local governmental agencies may have additional regulations that shall be followed. The Contractor shall contact the IDEM Office of Air Quality to determine what local agencies have regulations.
- (b) 326 IAC 18-3, which requires the inspector conducting the required inspection to be certified by IDEM. An accredited asbestos project supervisor shall be required to be present at all asbestos removal projects in accordance with 326 IAC 14-10 and 18-1.

- 300 (c) Federal Asbestos National Emission Standard for Hazardous Air Pollutants.
- (d) Structurally Unsound and in Danger of Imminent Collapse Building Regulations, in accordance with 326 IAC 14-10-1(b).

202.08 Removal of Underground Storage Tanks Containing Petroleum Products or Other Hazardous Chemicals

310 Removal of underground storage tanks shall consist of the proper excavation; removal of the tank; removal and disposal of liquids, sludges, and other materials in the tanks; backfilling, and permanent closure of underground storage tanks located as shown on the plans or as identified by the Engineer.

This work shall be performed in accordance with the requirements as follows:

- (a) Technical Standards and Corrective Action Requirements for Owners and Operations of Underground Storage Tanks, UST, Code of Federal Regulations, Title 40, Part 280 (40 CFR 280), Subparts F and G;
- 320 (b) American Petroleum Institute Recommended Practice 1604, "Removal and Disposal of Used Underground Petroleum Storage Tanks";
- (c) American Petroleum Institute Publication 2015, "Cleaning Petroleum Storage Tanks";
- (d) RCRA and the Indiana Environmental Management Act;
- (e) UST Notification, Reporting and Closure Requirements as prepared by the IDEM Underground Storage Tank Branch;
- 330 (f) safety regulations issued by OSHA;
- (g) Indiana Fire Prevention Code, Flammable and Combustible Liquids, Article 79, 675 IAC 22;
- (h) all applicable Federal and State requirements for certification of underground storage tank removal contractors; and
- 340 (i) local fire codes.

An individual who has been certified for underground storage tank closure or removal, as appropriate, through the State Fire Marshall shall be present at all times for tank closure or removal. Evidence of such certification shall be given to the

Engineer prior to starting work.

The removal and disposal of all regulated materials in or around the tanks shall be in accordance with 104.06.

The Contractor shall have the responsibilities as follows:

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(a) obtain a review of available tank information from the Engineer;

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(b) provide notification of tank removal operations to appropriate authorities, unless the Department has already done so. Notification shall be provided as required to IDEM, the Office of the State Fire Marshall and the local fire department in accordance with (a) through (i) above. Notification shall be provided to IDEM at least 30 days prior to closure or removal of regulated tanks in the form of the completed Notification for Underground Storage Tanks Form, and at least 14 days prior to removal or closure to the State Fire Marshall and the local fire department. At least 14 days prior notice shall be given to the IDEM Underground Storage Tank Branch of intended closure or removal date. Such forms are available from IDEM;

(c) allow the Engineer to visually inspect tanks after removal;

(d) allow the Engineer to visually inspect the excavation zone for contaminated soils;

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(e) obtain, from the Engineer, the limits of excavation for each tank to be removed;

(f) allow the Engineer to verify all documentation for remediation;

(g) sample and classify the tank contents, if access is available, or confirm tank contents by sampling and testing;

380

(h) submit a site operation plan for the contaminated area for review and obtain approval from the Engineer before beginning removal operations;

(i) provide and maintain pedestrian safety fencing;

(j) remove all liquids and sludges from tanks;

(k) clean tanks and connected piping, including feed lines and drain lines, of contents;

- 390 (l) remove tanks from the ground;
- (m) dispose of all tank content wastes in accordance with the directions provided by the Engineer in 104.06;
- (n) render tanks useless or dismantle tanks and transport to scrap dealer or landfill;
- (o) implement the site operation plan for the contaminated area as directed in accordance with 104.06;
- 400 (p) backfill excavations in an approved manner. Backfill shall be B borrow in accordance with 211;
- (q) maintain accurate records of all operations. Submit reports, including a completed Notification for UST and an UST System Closure Site Assessment Report, to IDEM's UST Branch within 30 days after closure. Two copies of these forms shall be provided to the Engineer with verification that the documents were submitted to IDEM;
- 410 (r) obtain disposal approvals for the hauling and disposal of all tank content waste materials from the site; and
- (s) if the soil or groundwater surrounding the tank shows evidence of contamination, the hole shall be covered to prevent contamination of rainwater until remediation is complete.

The Engineer will classify the tank contents as one of the following liquid wastes for purposes of disposal requirements and payment.

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(a) Type A Waste

Type A waste will consist of direct discharge wastewater which may be discharged to a sanitary sewer system with or without treatment, upon receipt of required permits.

(b) Type B Waste

Type B waste will consist of low flash wastewater which shall be treated off-site at a treatment facility prior to disposal.

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(c) Type C Waste

Type C waste will consist of petroleum or other chemical liquid and sludge wastes which are regulated materials under current EPA, U.S. Department of Transportation, or IDEM regulations. Such waste shall be disposed of at a RCRA approved facility.

202.09 Remediation of Contaminated Soil and Groundwater

This work shall consist of remediation. All work shall be performed in accordance with all applicable Federal, State, and local requirements, and 104.06.

440 Prior to commencing work, the Contractor shall provide evidence, satisfactory to the Engineer, that the firm and personnel which are performing the remediation are properly trained or certified as required. The Contractor shall have the equipment for the proper remediation of regulated materials. The Contractor shall be familiar with the required procedures and practices governing such work.

The Contractor shall have the responsibilities as follows:

- (a) notify the appropriate authorities regarding remedial operations and provide verification to the Engineer;
- 450 (b) take samples and conduct tests as approved by the Department to determine extent of the contamination;
- (c) develop a remediation plan and obtain approval for the plan from the Department and the proper authorities;
- (d) remediate the site upon plan approval;
- (e) verify that remediation has been completed by conducting the appropriate sampling or testing;
- 460 (f) backfill excavations and restore ground lines as directed, in accordance with 211;
- (g) maintain accurate and complete records of all operations; and
- (h) submit reports to the Engineer and the proper authorities as requested for proper cleanup documentation.

202.10 Remediation of Other Regulated Materials

470 This work shall consist of the remediation of regulated materials not otherwise described herein. This work shall include all necessary excavation, backfilling of resultant excavations, and other handling or storage required.

All work shall otherwise be performed in accordance with all applicable Federal, State, and local requirements, 104.06, and 202.09.

202.11 Transportation and Disposal of Regulated Materials

480 This work shall consist of determining locations for disposal, treatment, or recycling of regulated materials removed from the project site. This work shall also consist of loading regulated materials into a vehicle or transport container and the

movement of such material from the project site to a state or EPA permitted disposal site, storage treatment, or recycling facility by appropriately trained and licensed personnel.

The Contractor shall have the responsibilities as follows:

- 490 (a) determine the location for disposal, treatment, or recycling of regulated materials removed from the project site; obtain written approval of the site; arrange with the approved site for the acceptance of the materials; and obtain the Engineer's written approval for the use of the site prior to transporting the materials;
- (b) ensure that all packing containers or tank vehicles are in accordance with the applicable Federal, State, and local requirements;
- (c) prepare a shipping paper or manifest, as required by Federal and State requirements, for signature of the Engineer or designated Contractor representative;
- 500 (d) ensure that the shipping paper or manifest is carried in the vehicle;
- (e) ensure that all required placards are properly displayed on the vehicle;
- (f) ensure prompt movement of the vehicle to the disposal site; and
- (g) return one copy of the signed shipping or manifest documents to the Engineer.

510 **202.12 Blank**

202.13 Method of Measurement

If the contract stipulates that payment will be made for removal of obstructions or of houses and buildings, or for clearing right-of-way on a lump sum basis, the pay items for such removals will include all structures and obstructions encountered within the right-of-way in accordance with the requirements herein. No measurement will be made. If it is specified that payment will be made for the removal of specific obstructions on a unit basis, measurement will be made by the unit specified in the Schedule of Pay Items. Material used to backfill excavated areas as directed will be
520 measured by the cubic yard.

If the contract stipulates that payment will be made for removal, transportation, or disposal of regulated materials on a unit basis, measurement will be made by the unit stipulated in the Schedule of Pay Items. However, removal of regulated asbestos, if found, will be measured by the square foot.

202.14

Underground storage tank removal will be measured per each within the size groupings of under 3,000 gal., from 3,000 through 6,000 gal., over 6,000 through 10,000 gal., or over 10,000 gal. Testing for regulated materials will be measured per
530 each for the type and number of tests required.

The length of pipe removed will be measured by the linear foot, computed by multiplying the number of commercial lengths removed by the nominal laying length, or by measuring in place prior to removal, if practicable.

Removal of present structure or portions thereof will not be measured for payment.

For steel that the Contractor elects to take to a recycling facility, handling, hauling,
540 and all other activities involved with removing and properly disposing of existing steel at a recycling facility will not be measured for payment.

For steel that will become the property of the Contractor, required cleaning of existing steel, removal of mill scale, testing, disposal of the waste stream, containment, and all other items involved with removing and properly disposing of the existing coating will not be measured for payment.

Pavement removal will be measured by the square yard of the area removed.

550 **202.14 Basis of Payment**

The accepted quantities of removal of structures and obstruction within the construction limits will be paid for at a contract lump sum price. All structures or obstructions the Contractor is directed to remove outside the construction limits, including clearing for utility relocation which is for the benefit of the Department, and not simply for the Contractor's convenience, will be paid for in accordance with 104.03 or 109.03 unless such clearing is shown on the plans or in the Contract Information book. Such price shall be full compensation for removing and disposing of obstructions in accordance with requirements herein. Regulated materials shall be subject to 104.06. If no contract price is listed in the Schedule of Pay Items for a pay
560 item set out in this specification, no direct payment will be made for work necessary to comply with the requirements for such pay item, except as set out herein. The cost thereof shall be included in the cost of other pay items. If unknown regulated materials are discovered during the life of the contract, payment for all work relating to removal, testing, transportation, or disposal of such materials will be in accordance with 104.03.

Specific obstructions, including pipe stipulated for removal and disposal, which are shown as pay items, will be paid for at the contract unit price per the unit specified in the Schedule of Pay Items.

570 Removal of houses and buildings will be paid for at the contract lump sum price for houses and buildings, of the parcel number shown in the Schedule of Pay Items, remove.

Testing for regulated materials will be paid for at the contract unit price per each for the type and number of tests required. Testing shall include collecting of samples and all necessary laboratory procedures.

580 Payment for removal of contaminated soils will be based on the actual cubic yards removed, or by the number of 55 gal. drums filled with the contaminated soil.

B borrow required for backfilling basements or depressions left by demolition will not be paid for separately but will be included in the cost of the removal item. B borrow required for backfilling of removed contaminated soils or tank will be paid for in accordance with 211.10.

590 Underground storage tank removal will be paid for at the contract unit price per each tank within the size groupings of under 3,000 gal., from 3,000 through 6,000 gal., over 6,000 through 10,000 gal., or over 10,000 gal. Underground storage tank liquid waste disposal will be paid for based on the type of waste and the actual number of gal. of liquid and sludge removed.

Transportation, disposal, and removal of regulated materials will be paid for based on the type of regulated material and the pay unit shown in the Schedule of Pay Items. If such pay unit is specified as drum, the term drum will mean the contents of a 55 gal. drum.

600 Clearing right-of-way within the construction limits will be paid for in accordance with 201.07 and shall include the cost of all work described herein except for that which is set out specifically as pay items, or work which is described in 104.06, 202.08, 202.09, 202.10, or 202.11. All clearing the Contractor is directed to perform outside the construction limits, including clearing for utility relocation which is for the benefit of the Department, and not simply for the Contractor's convenience, will be paid for in accordance with 104.03 or 109.03 unless such clearing is shown on the plans, in the Contract Information book, or is for the construction of fence or right-of-way markers.

610 Removal of present structure will be paid for at the contract lump sum price for present structure, for the structure number specified, remove. Removal of present structure portions will be paid for at the contract lump sum price for present structure, for the structure number specified, remove portions.

When directed, portions of the present structure contiguous to the areas shown on the plans or non-contiguous portions of the same character as the planned removal shall be removed. Such additional portland cement concrete acceptably removed will be paid for as measured in its original position, at twice the contract unit price per cubic yard for class A concrete in superstructures, class A concrete in substructures, class C concrete in superstructures, or \$652.00 per cubic yard, whichever is lowest.

Pavement removal will be paid for at the contract unit price per square yard.

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If there is no pay item for pavement removal and such is encountered, payment will be made for each square yard removed. Such pavement removal shall apply only to portland cement concrete pavement or base. A unit price for this work will be established based on thickness, quantity, and removal process. Such unit price will be generated prior to the work being performed.

If portland cement concrete pavement has an asphalt overlay, its removal will be considered as incidental, for which no direct payment will be made.

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Before the Contractor can be paid for any item related to an UST removal in accordance with 202, a detailed explanation of how costs were calculated for those items shown in the Schedule of Pay Items that are related to the UST removal shall be submitted to the Engineer. Such documentation shall include, but is not limited to, a portion of the mobilization and demobilization, a portion of the field office, a portion of the B borrow for backfill of the UST excavation, a portion of the surface removal over the UST, including sawing, and soil borings and laboratory analysis under the testing for waste item. The explanation shall show the type of pavement removed. Contaminated soil removal shall be broken down into equipment cost, labor, and mobilization of equipment used. Transportation of the regulated materials shall be

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broken down into loading, hauling, and mileage costs.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Contaminated Soil, Remove.....	CYS
	Houses and Buildings, Parcel No. _____, Remove	LS
	Pavement Removal.....	SYS
	Present Structure, Str. No. _____, Remove Portion	LS
650	Present Structure, Str. No. _____, Remove	LS
	_____, Remove.....	EACH
	specific work	LFT
		SYS
	Regulated Asbestos Containing Materials, Remove.....	SFT
	Regulated Materials, Dispose, _____	GAL.
	type	CYS
		TON
		DRUM
		EACH
660	Regulated Materials, Remove, _____	GAL.
	type	CYS
		TON
		DRUM
		EACH

	Regulated Materials, Transport, _____	GAL.
	type	CYS
		TON
		DRUM
		EACH
670	Structures and Obstructions, Remove.....	LS
	Testing for Asbestos	EACH
	Testing for Wastes, _____	EACH
	type	
	Underground Storage Tank, Liquid Waste Disposal, _____	GAL.
	type	
	Underground Storage Tank, Remove and Dispose,	
	Under 3,000 Gallons Capacity.....	EACH
	Underground Storage Tank, Remove and Dispose,	
	3,000 through 6,000 Gallons Capacity	EACH
680	Underground Storage Tank, Remove and Dispose,	
	6,000 through 10,000 Gallons Capacity	EACH
	Underground Storage Tank, Remove and Dispose,	
	Over 10,000 Gallons Capacity.....	EACH

690 The cost of removal and disposal of buildings, foundations, debris and unsuitable material, guide posts, delineator posts, temporary road material, existing asphalt patches, the filling of abandoned wells; terminating utilities; sealing floor drains where necessary; breaking basement floors; furnishing and erecting all barricades, fences, and other safety measures necessary for adequate protection of the sites; and backfill of basements or depressions left by demolition shall be included in the cost of the pay items of this section. All fence posts and concrete footings shall be completely removed and the resulting holes backfilled accordingly.

If no contract price is listed in the Schedule of Pay Items for work set out herein, no direct payment will be made for compliance with the requirements for such work, except as set out herein. The cost thereof shall be included in the cost of other pay items.

700 If the houses and buildings listed for removal from a designated parcel are not in existence at the time of the letting, no payment will be made for removal work on such parcel.

710 The cost of removing the tanks and all pipe from the ground, removal and disposal of all miscellaneous parts associated with the tank such as concrete pads or holding devices, filing of all required notifications, preparation and implementation of a site operation plan, excavation of all materials necessary in order to remove the tank, compliance with closure requirements, all necessary pedestrian safety fencing, cleaning and draining of tanks and pipes, dismantling or transport, and all required record keeping or reports shall be included in the cost of underground storage tanks, remove and dispose. However, disposal of waste contents and removal of

contaminated soil will be paid for separately. No payment will be made for work not performed in accordance with the specifications or not required by the contract.

The cost of all on-site or off-site storage of the materials shall be included in the cost of transportation.

720 All disposal fees and recycling or treatment costs required for regulated materials found within the project limits shall be included in the cost of regulated materials, dispose. If regulated materials are treated on site and not disposed of at an approved location, payment will be in accordance with 104.03.

The cost of removal of all regulated asbestos-containing materials and all safety procedures shall be included in the cost of regulated asbestos containing materials, remove.

The cost of packaging regulated materials, excavation, restoring ground lines, and maintaining and filing required documents and reports shall be included in the cost of the pay items.

730 The cost of removal of regulated asbestos-containing materials shall include only the removal of material identified in the contract or by the Engineer as regulated asbestos-containing material. Regulated asbestos-containing materials include the following:

- (a) friable asbestos-containing material;
- (b) Category I non-friable asbestos-containing material that has become friable or will be subjected to sanding, grinding, cutting, abrading, or burning;
- 740 (c) transite-like material; and
- (d) other Category II non-friable asbestos-containing material that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of normal demolition operations.

750 Unless directed by the contract or the Engineer, the cost of asbestos removal shall not include the removal of Category I or II non-friable asbestos-containing material that is not friable or does not have a high probability of becoming friable but which becomes friable because the Contractor uses demolition methods that cause such materials to become regulated. Such cost shall be included in the cost of other pay items.

The cost of all labor, equipment, materials, and documentation required for complying with the applicable laws, regulations and procedures, including but not

limited to, licenses, permits, other legal fees, or disposal charges shall be included in the cost of the pay items. No payment will be made for work not performed in accordance with the specifications or is not required by the contract.

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The cost of removal of specific work shall include the removal and disposal of such obstructions, the necessary excavation required, salvage of materials removed, their custody, preservation, storage on the right-of-way, and disposal as provided herein. All damage to existing facilities caused by the Contractor's operations or equipment shall be satisfactorily replaced or repaired with no additional payment.

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If it is necessary to package the contaminated soil in a container, the cost of the container and all cost related to packaging shall be included in the cost of removal. The cost of all excavation pertaining to contaminated soil, removal of all soil within the limits established by the Engineer, restoring ground lines, maintaining required records and filing of reports shall be included in the cost of contaminated soil, remove. No payment will be made for work beyond the limits established by the Engineer, work not performed in accordance with the specifications, or work not required by the contract unless in accordance with 104.03.

The cost of all handling of the product, removal of the product from the tank, disposal, all required packaging, and transportation shall be included in the cost of underground storage tank, liquid waste disposal.

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All necessary cleanup of spills caused by the Contractor will not be paid for.

For steel that the Contractor elects to take to a recycling facility, the cost of handling, hauling, and all other costs involved with removing and properly disposing of existing steel at a recycling facility shall be included in the cost of present structure remove, or present structure remove, portions pay item. The Department will withhold a payment equal to 50% of the present structure remove, or present structure remove, portions pay item until the Contractor presents a receipt from the recycling facility indicating that the recycling facility is now in possession of the steel.

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For steel that will become the property of the Contractor, the cost of cleaning existing steel, removal of mill scale, testing, disposal of the waste stream, containment, and all other costs involved with removing and properly disposing of the existing coating shall be included in the cost of present structure remove, or present structure remove, portions pay item. The Department will withhold payment of 50% of the present structure remove, or present structure remove, portions pay item until the Contractor presents a receipt from the facility where the waste stream disposal occurred.

SECTION 203 – EXCAVATION AND EMBANKMENT

203.01 Description

This work shall consist of embankment construction and excavation, hauling, and disposal or compaction of all material not being removed under some other item which is encountered within the limits of the work and also from intersecting entrance approaches beyond the right-of-way limits necessary for the construction of the roadway in accordance with 105.03. All excavation will be classified as hereinafter described.

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203.02 Common Excavation

Common excavation shall consist of all excavation not included as rock excavation or excavation which is otherwise classified and paid for, including asphalt type pavement. Coal ash encountered within the project limits shall be used in embankments under the same conditions as borrow in accordance with 203.08.2. If coal ash is encountered within the project limits, appropriate measures as described in 203.23.1 shall be used to prevent movement of coal ash from the project.

203.03 Rock Excavation

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Rock excavation shall consist of igneous, metamorphic, and sedimentary rock or other sound mineral matter which cannot be readily excavated by the use of a crawler mounted hydraulic excavator of not less than 40,000 lb gross operating weight equipped with a general purpose excavator bucket of not less than 1 cu yd capacity, in satisfactory running condition and operated in accordance with the manufacturers recommended operating instructions. Rock excavation shall also include all boulders and other detached stones each having a volume of 1/2 cu yd or more.

203.04 Unclassified Excavation

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Unclassified excavation shall consist of the excavation and disposal of all materials of whatever character encountered in the work.

203.05 Peat Excavation

Peat excavation shall consist of the necessary excavation and satisfactory disposal of peat, muck, marl, or any other similar unsuitable material in peat deposits, together with any overlaying material, except pavement, which is not used in embankment construction, except as otherwise provided in 203.16.

203.06 Waterway Excavation

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Waterway excavation shall consist of the necessary excavation and satisfactory disposal of all material resulting from excavation for clearing waterways, making channel changes, or both when such are itemized in the Proposal book, but shall not include class Y excavation, or excavation made for a structure in accordance with 206. If not otherwise specified, waterways shall be cleared for the entire distance within the right-of-way lines.

203.07 Class Y Excavation

Class Y excavation shall consist of material encountered within the limits of waterway excavation which can be classified as rock in accordance with 203.03, or material which consists of conglomerate, concrete, masonry, or any similar material
 50 which is not part of an existing structure shown on the plans. Material as defined in 203.02 will not be considered as class Y excavation.

203.08 Borrow or Disposal

Borrow shall consist of approved material required for the construction of embankments or for other portions of the work and shall be obtained from accepted locations and sources outside the right-of-way. Borrow material shall be free of substances that will form deleterious deposits, or produce toxic concentrations or combinations that may be harmful to human, animal, plant or aquatic life, or otherwise impair the designated uses of a stream or area. Unless otherwise designated in the
 60 contract, arrangements shall be made for obtaining borrow. Borrow, as designated herein, shall not include material excavated beyond the right-of-way limits at intersecting public roads, private and commercial drive approaches and material furnished as B borrow.

Disposal of material, other than regulated material and bridge painting debris, from within the right-of-way shall only be allowed at accepted locations. Disposal of regulated material shall be in accordance with 104.06. Disposal of bridge painting debris shall be in accordance with 619.

70 Proposed borrow and disposal sites shall be accepted by the Engineer prior to the start of any borrow or disposal operations at the site. For each proposed site, an IC-203 Request for Acceptance of Borrow or Disposal Site form, available on the Department's website, shall be submitted to the Engineer a minimum of 14 days prior to the Contractor's planned start of operations at the site. All requests for acceptance of a borrow or disposal site shall be in accordance with 203.08(a).

Acceptance of any proposed borrow or disposal site by the Engineer shall not relieve the Contractor of the responsibility to utilize an appropriate site and to comply with all applicable local, State and Federal laws and regulations.
 80

The Contractor shall provide the Engineer a minimum of 14 days notice prior to opening borrow areas in order to obtain original cross sections, measurements, and borrow material samples prior to borrow area use.

No extension of completion time will be granted due to any delays by the Contractor in securing acceptance of borrow and disposal sites.

(a) Borrow and Disposal Site Requirements

Any proposed borrow or disposal site submitted for acceptance shall be presented
 90 as, and meet the requirements of one of the following site definitions.

1. Solid Waste Site

A Solid Waste Site shall be defined as a solid waste facility, in accordance with 329 IAC 10-2-176, with a current IDEM operating number.

A request for acceptance of a Solid Waste Site shall include the following:

- a. Name and contact information of the facility operator.
- b. Address of the facility.
- 100 c. The IDEM operating number.
- d. The expiration date of the IDEM operating permit.

2. Established Site

An Established Site shall be defined as an established location, other than as defined in 203.08(a)1, proposed for borrow or disposal activity that is disturbed or developed for public, municipal, governmental, commercial, industrial, construction or any other similar or related activity. The Established Site shall be operating under permits required by local, State and Federal laws for the activities proposed by the Contractor.

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A request for acceptance of an Established Site shall include the following:

- a. Name and contact information of the site owner.
- b. Address of the site.
- c. Copy of a right-of-entry obtained from the property owner. Rights-of-entry shall include rights for access by Department personnel to the site.
- 120 d. Aerial view site plan with the location of the borrow or disposal areas delineated.
- e. Location of all proposed stormwater management features for the delineated borrow or disposal area.
- f. List of the documented permits, permit numbers and permit expiration dates for all permits under which the site operates.
- 130 g. Documentation that a wetlands delineation and an archaeological field survey, with record check, have been performed by qualified professionals shall be provided when borrow or disposal activities are identified for areas of the proposed site that remain undeveloped or undisturbed.

Any required wetlands delineation and archaeological field surveys, with record check, shall be limited to those

undeveloped and undisturbed areas identified for borrow or disposal that are greater than 0.1 acres.

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3. General Site

A General Site shall be defined as a location, other than as defined in 203.08(a)1 and 203.08(a)2, that has not been disturbed or developed for public, municipal, governmental, commercial, industrial, construction, or other similar or related activity. A General Site shall include private, residential, agricultural fields and pastures, or any other similar or related locations. General Sites shall require additional documentation for acceptance.

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A request for acceptance of a General Site shall include the following:

160

- a. Name and contact information of the property owner.
- b. Address or location of the site.
- c. Copy of a right-of-entry obtained from the property owner. Rights-of-entry shall include rights for access by Department personnel to the site.
- d. Site location plan, site dimensions, adjacent property and right-of-way lines, all demarcated jurisdictional wetlands or isolated wetlands, all demarcated archeological sites, existing and proposed finished contours and proposed finished slope grades.
- e. Site operations plan detailing the operations proposed for the site, what equipment will be utilized, how the site will be accessed and any other information relevant to the operation of the site.

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f. Copy of the Rule 5 Notice of Intent, if required in accordance with 327 IAC 15-5.

g. Stormwater management plan for the site including the stormwater features to be incorporated and the sequencing of the measures with respect to the operations plan for the site.

180

h. Documentation signed by a wetlands professional verifying that the site has been inspected for the presence of both wetlands and isolated wetlands and, if any are present, specifying the area to be demarcated as jurisdictional or isolated wetlands.

i. Documentation of the archeological field survey, with

record check, signed by a qualified archeologist including the limits and border of any archeological site discovered.

- 190 j. Copies of all other permits obtained by the Contractor to perform operations at the site.
- k. Documentation, in the form of a signed and notarized certification from the property owner, that the proposed site is not currently an active remediation or corrective action site operating under an IDEM or EPA cleanup program, and that there are no environmental liens, easements, deed restrictions, or environmental restrictive covenants against the proposed site location. If environmental liens, easements, deed restrictions, or environmental restrictive covenants exist for the proposed site location, the Contractor shall provide copies of the restriction and written approval from the regulatory agencies having an interest in, or jurisdiction over the proposed site approving use of the site for the borrow or disposal operations.
- 200

When a General Site is identified for borrow or disposal, the Contractor shall obtain all permits required by local, State and Federal laws prior to the start of any operations at the site.

210 All proposed General Sites shall have an inspection of areas impacted by the borrow or disposal operations conducted by a qualified wetland professional approved by the Department to determine if wetlands are present on the site. A list of approved wetland professionals is maintained on the Department's website. The wetlands inspection shall be in accordance with the Federal Manual for Identifying and Delineating Jurisdictional Wetlands. The inspection shall also determine if isolated wetlands as defined by IDEM are present. The Contractor shall demarcate the boundary of all wetlands identified within the proposed borrow or disposal site in a method acceptable to the Engineer.

220 Proposed General Sites shall have a qualified archaeologist perform a field survey, with record check, to determine if any significant archeological sites exist within the proposed site. The Indiana Department of Natural Resources Division of Historic Preservation and Archeology maintains a roster of qualified archeological consultants. If any archeological sites are identified, the archaeologist shall establish the limits of the site along with a reasonable border. The Contractor shall demarcate the border of all identified archeological sites within the proposed borrow or disposal site in a method acceptable to the Engineer.

(b) Additional Requirements

230 Identified archeological sites shall not be disturbed unless the site is cleared by established procedures and written authorization to enter the site has been obtained

from the Department's Cultural Resources office. Archaeological artifacts encountered during operations shall be addressed in accordance with 107.10.

No excavation shall occur and no material shall be disposed of within the boundaries of the demarcated wetlands and archeological areas unless the operations are in compliance with all required permits and these specifications.

240 The Contractor shall install all temporary stormwater management control measures at accepted borrow and disposal locations designated as Established Sites and General Sites prior to the start of any earth disturbing activity. The Contractor shall develop and construct all mitigation measures necessary to fulfill the requirements of all permits obtained by the Contractor for operation of a borrow and disposal site.

No excavation shall occur or no material shall be disposed of within the boundaries of the demarcated wetlands and archeological areas unless the operations are in compliance with all required permits and these specifications.

250 No extension of completion time will be granted due to any delays by the Contractor in securing approval of borrow and disposal sites.

260 Unless written permission is granted, there shall be no excavation in a borrow area below the elevation of the adjacent properties within 150 ft of the nearest right-of-way line of an existing highway, county road, or city street; the nearest right-of-way line of a proposed highway, county road, or city street; or adjacent property lines. If the properties adjacent to the borrow area are privately owned, the setback limit of 150 ft may be lessened if written approval or permission is granted by the owner of the adjacent property, the excavation is in accordance with local zoning laws and requirements, and if lessening the limit is in the best interest of the State. Such minimum distance shall not be closer than 50 ft to an adjacent property line. All excavated slopes of a borrow area shall not be steeper than 3:1 down to 2 ft below the groundwater elevation. All excavated slopes 2 ft below the groundwater elevation shall not be steeper than 2:1.

270 Top soil from the borrow or disposal area shall be stockpiled for use in restoring the disturbed area. A minimum encasement of 6 in. shall be placed on the 3:1 or flatter slopes. Final restoration of borrow or waste disposal areas shall include grading, seeding, or other necessary treatments that will blend the area into the surrounding landscape. Restored areas within 150 ft of the nearest right-of-way line shall be well drained. Areas beyond 150 ft shall be drained unless the landowner desires other treatment of the borrow area. Construction of borrow or disposal areas shall be in accordance with existing laws, regulations, and ordinances. Under no conditions shall borrow sites detract from the appearance of the natural topographical features or increase the potential hazard to a vehicle that has inadvertently left the highway.

If granulated slag, dunes sand, or other granular material which is not suitable for

203.08.1

the growth of vegetation is used, such material shall not be placed within 1 ft of the required finished surfaces of shoulders and fill slopes. Additional material required to complete the embankment, such as sandy loam, sandy clay loam, clay loam, clay, or other materials suitable for the growth of vegetation and free from clods, debris, and stones, shall be furnished at the contract price for borrow.

Additional fill material may be secured from within the permanent or temporary right-of-way in lieu of borrow or B borrow either from vertical or horizontal extensions, or both, beyond the lines and elevations of roadway and drainage excavation as shown on the contract plans when authorized in writing. If additional material has been obtained without written approval, the material will be classified either as to source or use, to the best advantage of the Department.

290 **203.08.1 Linear Grading**

Linear grading shall consist of:

- (a) earth wedging at the outside edge of a shoulder once the pavement has been resurfaced, widened, or replaced;
- (b) earth wedging behind guardrail to obtain the required earth backup for the posts;
- (c) median earth filling required for paving and placement of concrete median barrier.

These types of earthwork will not require benching.

203.08.2 Coal Ash

Borrow may also consist of coal ash.

Coal ash is defined as either fly ash, bottom ash, or a mixture of both. Fly ash is further defined as coal ash with 70% or less passing the No. 200 (75 μ m) sieve. Bottom ash is further defined as coal ash with 20% or less passing the No. 200 (75 μ m) sieve and 10% or less retained on the No. 10 (2.0 mm) sieve.

Boron levels in coal ash shall be less than 5 ppm as determined using the Indiana Neutral Leachate Testing, INLT, methodology.

The Contractor shall provide a copy of an IDEM waste classification certification for Type III or Type IV material prior to use. The IDEM certification shall identify the size and geographical location of the coal ash stockpile.

A type A certification in accordance with 916 shall be provided for coal ash. The results of the following shall be shown on the certification.

1. Name of the laboratory performing the tests.

2. Location and owner of the stockpile.
3. Date the samples were obtained.
4. Date the samples were tested.
5. Stockpile sampling locations including depth and available historical testing results.

Property	Test Method
Gradation	AASHTO T 88
Atterberg limits	AASHTO T 89 and T 90
Standard Proctor	AASHTO T 99
Level of boron	INLT

330 All tests shall be performed by a laboratory from the Department's list of Qualified Geotechnical Consultants. Tests shall be submitted to the Engineer and to the Department's Geotechnical Engineering Division for approval at least five business days prior to use.

If coal ash is obtained from a commercial source, such as a power plant, the Contractor shall also provide a letter from the source allowing access by Department personnel for the purpose of inspecting the processes used to produce the coal ash stockpile and for sampling the stockpile for testing by the Department.

340 CONSTRUCTION REQUIREMENTS

203.09 General Requirements

The excavation and embankments for the roadway, intersections, and entrances shall be finished to reasonably smooth and uniform surfaces. Excavated materials shall not be wasted without permission. Excavation operations shall be conducted so that material outside the limits of slopes will not be disturbed. Prior to beginning excavation, grading, or embankment operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with 201.

350 The Contractor shall stabilize an area if disturbed ground is anticipated to be left bare and unworked for seven consecutive calendar days or if directed. The stormwater management control features shall be installed in accordance with 205 or as otherwise directed. The area of the exposed materials shall be limited by the Contractor's capacity to adequately maintain permanent and temporary stormwater management control features.

360 Soils containing organic material greater than 6% by dry weight, or soils with a maximum dry density of less than 90 pcf shall not be incorporated in the embankment. Organic content will be determined in accordance with AASHTO T 267, and maximum dry density will be determined in accordance with AASHTO T 99.

Frozen materials, stumps, roots, all or parts of trees, brush, weeds, sod, or other perishable materials shall not be incorporated in the embankment. Rocks greater than

3 in. in any dimension shall not be left within 18 in. of the finished subgrade. The original ground surface, or the surface of any lift in place shall not be frozen and shall be free of snow, ice, or mud.

370 All vegetation, all spongy, yielding, soft, and unstable materials, which are encountered, shall be removed as shown on the plans or as directed. Removed materials may only be used in embankment construction if they are constructed in accordance with 203.23.

After clearing of the embankment area and prior to embankment placement, all pronounced depressions left in the original ground shall be filled with suitable material and compacted in accordance with 203. Proofrolling of the natural ground surface shall be performed in accordance with 203.26 within all areas where new fill shall be placed.

380 If the original ground cannot be compacted to the required strength because of soft or unstable soils, the use of stabilizing materials consisting of coarse aggregate No. 5 encapsulated in geotextile, in accordance with 214.03(a), or soil drying with a chemical modifier in accordance with 217 shall be used as directed. The coarse aggregate materials used for stabilization shall be 1 to 2 ft thick and shall allow the encapsulated material in the embankment to drain.

When free water is encountered, backfilling shall be accomplished using B borrow, in accordance with 211.02, to an elevation at least 2 ft above the free water level. Compaction of the B borrow placed above the free water level shall be accomplished using heavy vibratory equipment.

390 The use of hydraulic methods to construct embankments will be allowed only when authorized in writing. Only B borrow shall be placed below the free water level. Backfill at structures shall be in accordance with 211.04.

The embankment shall be kept drained at all times by keeping the center higher than the sides and uniformly graded.

400 Each embankment lift shall extend transversely over the entire area and shall be kept smooth. When fill materials are deposited in large masses onto the embankment, the materials shall be spread out in uniform lifts. Rock or shale used for embankment construction shall be in accordance with 203.20.

When grading operations are performed in non-daylight hours, artificial lighting shall be provided and maintained, to enable the construction and inspection of the operations.

When the embankment soils are granular, silty loam, sandy loam, silts, or when the plasticity index of the material is less than 8, the embankment shall be encased with materials consisting of silty clay loam, clay loam, sandy clay loam, or silty clay of 12 in. minimum depth measured perpendicular to the face of the slope. The

410 plasticity index for these materials shall be equal to or greater than 8 and the organic
content shall not exceed 6%. The surface of any necessary encasement shall meet the
finished slope limits shown on the plans or as directed.

All slopes to be graded and not immediately stabilized with stormwater
management control measures shall be roughened, as described herein, until
stormwater management control measures are placed. The soil slopes shall be
roughened to create a series of ridges and depressions parallel to the contour by making
grooves at least 1 in. deep and not more than 15 in. apart. Slopes shall be stabilized in
accordance with 205. Roughening shall take place each day after work is performed
420 on the slopes, or as directed to re-establish the roughening.

Sufficient quantities of excavated materials suitable for the growth of vegetation
shall be preserved from within the planned excavation area and used on constructed
cut, fill, and shoulder slopes to help develop the growth of vegetation. Materials
suitable for vegetative growth shall be at least 6 in. deep or as indicated within the
contract documents and shall be measured perpendicular to the face of the slope.
Unless otherwise provided, no additional compensation will be allowed for this work
except payment will be made for the class of excavation involved for authorized
undercutting of back slopes. Encasement of rock embankment and cut slopes will not
430 be required unless otherwise directed.

Material suitable for the growth of vegetation shall be in accordance with 914.01
prior to placement. The material placed on backslopes of cut sections shall be placed
in accordance with 203.21.

If sufficient excavation materials suitable for the growth of vegetation and used
on constructed cut, fill, and shoulder slopes are not available, borrow or other material
suitable for vegetative growth shall be furnished. The sources of all borrow material
shall be in accordance with 203.08 and 914.01. Payment for borrow will be made in
accordance with 203.28. If the contract does not contain a pay item for borrow, a
440 change order will be executed for payment of borrow. Suitable portions of common
excavation may be preserved or borrow material may be furnished for encasement
provided all suitable excavation is used constructively.

203.10 Disposal of Excavated Material except Waterway and Peat Excavation

Excavation material shall be used for the construction of embankments, shoulders,
special fill, or other places as may be specified or directed, depending on the nature of
the material. Excavated material that is suitable for embankment construction, that is
450 not required for maintenance of traffic, shall be placed in the embankment before
placing any borrow material, unless otherwise authorized in writing.

If more material is excavated from within required cut slopelines than is needed
to construct embankments or special fills, the excess may be used to widen
embankments, flatten fill slopes, or be used otherwise as directed. All excess

203.11

excavated material that cannot be used constructively within the project limits shall be disposed of off the right-of-way in accordance with 203.08.

460 Excavation obtained from the right-of-way and planned to be used in fills may be wasted and replaced with borrow with no additional payment only after written permission is obtained. All required samples of the borrow or the excavation materials involved shall be furnished with no additional payment.

203.11 Disposal of Waterway Excavation

Unless otherwise provided, material resulting from waterway excavation shall be used, if suitable, in embankment, special fill, approach embankments, or any combination of these, as specified or directed.

470 Any portion of waterway excavation material which is unsuitable for the above uses, any portion which is suitable but is in excess of that required for such uses, or when locations for such uses are not available, the material shall be disposed of in accordance with 203.08.

203.12 Disposal of Peat

All material removed as peat excavation, removed or displaced by machine operation, or displaced by the advancing backfilling material shall be disposed of in accordance with 203.08.

203.13 Slides

480 Slides encountered during construction shall be removed as directed and their removal will be paid for as the class or classes of excavation encountered.

If the contract involves paving, the omission or delay of paving operations may be required at the location of a slide. If proper treatment of a slide has been obtained prior to completion of the remaining pavement, the gap may be required to be paved, and payment will be at the contract unit price for pavement.

490 If proper treatment of a slide has not been obtained prior to completion of the remaining pavement, the gap left at the slide location shall become an exception to the contract item for pavement.

203.14 Drainage

Ditches shall be interpreted to mean open ditches and channel changes parallel to and adjacent to the roadbed. Channel changes excavated under the classification of waterway excavation are not included in this definition.

Lines, grades, and cross sections of ditches shall be as shown on the plans, unless otherwise established to obtain proper drainage.

500 Ditches and gutters emptying from cuts onto embankment shall be constructed to avoid eroding the embankment.

Exploration of underground drainage and sinkholes may be required, and payment will be hereinafter provided. Should any underground drain be encountered, the location of which is not shown on the plans, notification shall be made at once. Drainage shall be explored as directed and, if deemed necessary, taken care of under applicable provisions of these specifications, or as otherwise directed.

510 If existing surface drains, tile drains, sewers, or other underground drains, or parts thereof, are not to be replaced or are not required by the terms of the contract or directed to be changed, whether such drainage facilities are shown on the plans or not, all such drainage facilities or parts thereof shall be protected, preserved, and satisfactorily continued in use without change. If in the prosecution of the work such existing drainage is changed or interrupted, or through negligence such drainage is interrupted or damaged, satisfactory permanent repairs shall be immediately provided or adequate temporary drainage facilities shall be maintained until permanent repairs are made. If temporary facilities are provided, before the work is accepted, such damage or interrupted drainage facilities shall be restored to the original condition or to an altered state which is at least equal to their original condition.

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If slopes or ditches which were graded for a grading contract become eroded or scoured during the paving contract work, the scoured or eroded areas shall be reshaped to the original cross section and reseeded or resodded as shown on the plans, all in accordance with 208 and 621.

When so provided by the plans or special provisions, or when ordered, all tile drains, sewers, or other underground drains encountered in the prosecution of the contract shall be repaired, replaced, extended, reconstructed, connected, or otherwise changed.

530

Unless otherwise provided in the contract, the cost of replacing, restoring, or connecting an underground drain which is substantially in its original location and incidental to roadway and drainage excavation, structures, or other drains will not be paid for directly, but the cost thereof shall be included in the cost of various pay items.

Unless otherwise provided, any necessary drainage change or restoration not shown on the plans and not due to negligence or operations of the Contractor will be paid for at the contract unit price or prices thereof. If there is no such contract unit price or prices, such work shall be done and payment made in accordance with 104.03.

540

203.15 Excavating Rock

If material is encountered during excavation which appears to belong in the classification of rock excavation in accordance with 203.03, notification shall be made in writing. Ample time shall be allowed to make such investigation and measurements that are necessary to determine the class and volume of the material in question.

Exploratory cores shall be taken from the top of the rock to approximately

subgrade elevation as directed. The cores shall be cut with standard diamond core bits and series X double tube core barrels to obtain 2 1/8 in. diameter samples. All cores
550 shall be suitably marked and identified to show the location of the core by station, offset from centerline, elevation of top of rock, depth below top of rock, and percent recovery within each core. All cores shall be retained. The cores shall be placed in suitable compartmented wooden boxes in the order in which removed from the boring, with dividers between core runs. The top and bottom of each run shall be appropriately marked. The cores shall be transported to a location as directed.

The top of rock elevations shall be determined prior to locating the top of soil cut slopes where finished rock slopes are planned to be 1:1 or steeper.

560 Final breakage of rock excavation shall be in accordance with, or closely to, the slope lines as shown on the plans unless different slope lines are fixed, and the Contractor so notified. The final slopes shall be left reasonably smooth and uniform, and all loose and overhanging rock removed. Unless otherwise specified, no rock shall finally project more than 1 ft beyond established slopes. If natural seams intersect an established slope, the excavation may be carried, with permission, along the face of such seams for the distance approved.

570 Rock shall be excavated to the required elevation for the full width of the roadbed as shown on the plans or as directed. Where rock is excavated below the required elevation, the area shall be backfilled to the subgrade elevation with crushed stone, spalls, subbase material, or other approved granular material, which shall be shaped and compacted to the required elevation and cross section.

580 Exploratory drilling, which shall consist of drilling holes for the purpose of determining the existence of cavities affecting underground drainage and possible sinkholes in cut sections, may be required at locations as directed. Unless otherwise directed, the holes shall be drilled on the centerline of the proposed pavement at approximately 100 ft intervals and shall extend for a depth of 7 ft below the proposed grade and have a minimum diameter of 1 1/2 in.

Where cavities are discovered on centerline, additional holes shall be drilled at 25 ft intervals along the edge of the proposed pavement, and unless otherwise directed, extend for a depth of 7 ft below the proposed grade. Where any cavity is discovered or exposed having a minimum cover of less than 5 ft, the cover shall be removed, and the treatment of such areas shall be in accordance with details in the plans or as otherwise directed.

590 The final surface of rock excavation under the roadbed area shall be left so that drainage between the rock surfaces and any material placed thereon will be substantially complete. Where seams of clay or other soft material 1 ft or less in thickness are encountered in rock excavation, the volume of such seams will be considered as rock excavation and paid for as such.

Unless otherwise specified or directed, rock shall be pre-split by drilling and the use of explosives in such a manner as results in minimum breakage outside neat lines of the typical cross section and slope stakes as established. Deposits of commercial building stone outside the right-of-way shall not be damaged. Holes for pre-splitting shall be drilled along the established slope stake lines. The holes shall be from 2 to 4 in. in diameter and, unless otherwise directed, be spaced approximately 3 ft apart.

600 Holes shall be drilled approximately 2 ft below the established grade of the cut, or the predetermined bench elevation, or as directed.

The maximum depth of any pre-split lift shall be 30 ft, unless otherwise directed. If more than one lift is required, the first line of drill holes shall be set in such a manner as to allow for a specified offset for each succeeding lift and an offset of 2 ft from the back of the paved side ditch line. The explosives used and the method of loading depends on the material to be blasted. These explosives may vary from a single strand of detonating cord, for blasting unconsolidated formations, to a solid column of dynamite for massive formations. However, the explosive shall be of a type to

610 accomplish the pre-splitting with a minimum of breakage outside the excavated area. After the charges are placed, the holes shall be filled with sand or other suitable granular material.

Except as indicated below, all pre-splitting charges shall be detonated simultaneously by the use of instantaneous electric blasting caps or by means of a detonating cord trunkline. The line holes shall be fired before the main excavation is blasted. Pre-splitting shall be kept well in advance of regular blasting operations. Primary blasting holes shall be drilled no less than 6 ft from the pre-split face, unless otherwise directed. If additional charges are required, holes shall be placed at 1/2 the

620 distance of a full depth hole to a depth such that the bottom of the hole clears the pre-split face approximately 2 ft. The pre-split face shall deviate no more than 6 in. from the front line of drill holes or more than 12 in. from the back line of drill holes, except where the character of the rock will unavoidably result in some irregularities.

The amount of explosives per shot for instantaneous firing or the amount of explosives per delay for delay firing shall not be great enough to damage nearby structures, rock formations, or other property. Where commercial building stone formations are located in the effective vicinity, adequate seismograph readings shall be obtained, with no additional payment, as evidence that blasting operations have not

630 altered existing commercial building stone formations outside the right-of-way limits of the project.

Permission may be granted to use machine methods to establish the finished slopes in those cuts where machine methods are used to remove roadway excavation, provided final machine finished slopes are equal or superior to that which would be obtained by pre-splitting methods.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution

640 of the work or in consequence of the non-execution thereof, such property shall be restored, with no additional payment, to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as directed, or such damage or injury shall be made good in an acceptable manner.

No direct payment will be made for pre-splitting, but the cost thereof shall be included in the pay item of rock excavation or unclassified excavation.

203.16 Peat Deposit Treatment

650 If construction is specified at a location where a peat deposit is to be treated, the deposit shall be treated ahead of paving operations to obtain maximum settlement. If settlement has not been obtained when paving operations are at the limits of any peat deposit treatment, a gap in the pavement shall be left as directed. Gaps not constructed as part of the project will become an exception to the contract.

Treatment shall be by the following methods:

(a) Treatment of Existing Fills

If the required alignment is on an existing fill over a peat deposit, treatment may be required by any one or any combination of the following methods:

660

1. removal of the existing fill with or without the removal of the underlying peat and of the material at the sides of the existing fill;
2. blasting the peat under the fill;
3. loading the existing fill with additional fill material, and, if directed, blasting the peat underneath;
- 670 4. leaving the existing fill in place and treating the material at the sides either by removing the peat at the sides and backfilling or by displacement or both;
5. excavating and constructing with lightweight fills.

Determination of the method or methods to be used will be made based on conclusions from test holes which may be required to be drilled at designated locations.

680

(b) Treatment by Removal

This method consists of completely removing the objectionable material either as peat excavation or by machine operation and backfilling to the full toe-width of the proposed embankment or to such other widths, if so directed depending on the condition and depth of the material to be removed.

If water is not present, the space previously occupied by the removed material shall be backfilled with common excavation, borrow, or both, and placed in accordance with 203.

690 If water is present, the backfill shall be with material in accordance with 211.02. Placement of this material shall follow as closely behind the removal of the peat as possible. It shall be carried across the area from one end to the other by end-dumping and finally left at the established grade. This grade shall be such that keeps end-dumping to a minimum, which nominally shall be approximately 2 ft above free water level. That portion between free water level and this established grade shall be thoroughly water soaked to secure maximum compaction.

700 If additional fill is needed to bring the embankment to its final required grade, it may be common excavation or borrow. Further placing of the granular material above the end-dumped material may be authorized. This additional fill shall be placed and compacted in accordance with 203 but shall not be placed for at least 14 days after the end-dumped material is placed and compacted. This period may be shortened or lengthened with written approval, depending on the settlement that has been obtained.

(c) Treatment by Displacement

710 When this method is used, the peat at each end of the deposit shall be removed completely by excavation to the full width shown on the plans, or to such other width as may be directed, until a point is reached where the depth of the peat being removed is greater than 10 ft, or to a greater or lesser depth, as directed.

720 If conditions allow, the upper portions of the remaining peat shall be excavated across the remainder of the deposit in the same manner as set out above for the ends. Removal of this upper portion shall begin at one end and proceed to the other end at a sufficient distance ahead of backfilling operations so displacement of the remaining peat will not be retarded. If excavation to the required depth is not maintained for the full width ahead of the backfill or surcharge, additional units shall be used or backfill operations stopped until the two operations are in balance. If conditions allow, draglines shall be operated from mats in front of the advancing excavation. If blasting is required to aid displacement, it shall be completed as extra work in accordance with 104.03.

730 Backfilling shall be in accordance with 203.16(b) for end-dumped material except, when required, a temporary surcharge shall be maintained at the head of the backfilling. The top of the surcharge shall be constructed and maintained to a width equal to the full shoulder width of the proposed embankment, or as approved or directed. The height of the surcharge shall be the same as the depth of the peat being treated, unless otherwise directed. The original ground shall be the reference elevation for measuring peat depths and surcharge heights. The top of the surcharge shall be approximately level and the length on top shall be at least two times the depth of the peat being treated. The surcharge shall be kept built up and pushed forward with a bulldozer or other approved equipment as the displacement progresses. Machine

203.17

methods shall be used to relieve pressure at the advancing toe and sides of the surcharge. Sufficient hauling units shall be used to maintain the surcharge at the required height, width, and length. The machine operation to augment displacement shall be coordinated with the rate of placing temporary surcharge.

After the granular backfill has been completed across the deposit, any remaining fill necessary to bring the embankment up to the required final grade shall be in accordance with 203.16(b) for that portion above the end-dumped material.

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203.17 Cased Test Holes

As displacement progresses, cased test holes shall be placed at locations as directed to determine the extent of peat displacement and for use in conjunction with final measurement. These holes shall extend to the bottom of the deposit. The boring shall be conducted in such a manner that accurate information may be obtained as to the nature of the materials through which the test holes are placed. If these test holes indicate that full displacement has not been obtained, the remaining peat shall be blasted or additional treatment shall be performed as required.

750

Unless otherwise specified in writing, cased test holes shall be placed by hydraulic boring. The external casing shall be a minimum of 2 in. in diameter and of such additional size as to perform the operation satisfactorily. A continuous supply of fresh water shall be jetted through an internal pipe so that the wash water and loosened material is carried to the surface between the jet rod and the external casing. Pumps and other miscellaneous tools and equipment shall be used as required to perform a satisfactory operation.

203.18 Embankment Construction

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Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or outside the right-of-way; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits, and other depressions within the roadway area. Only approved materials shall be used in the construction of embankment backfill. Rocks, broken concrete, or other solid materials shall not be placed in embankment areas where piling is to be placed or driven.

770

Recycled concrete pavement may be used in embankment construction. The recycled material shall meet the requirements of B borrow in accordance with 211.02 or rock embankment in accordance with 203.20.

The recycled concrete pavement may only be placed below the pavement underdrains and shall be constructed in accordance with 203.23. The recycled concrete pavement shall not be used within 2 ft of the water table. Proofrolling in accordance with 203.26 shall be performed to cover the whole grade for every 5 ft of fill. Any rut greater than 1/2 in. shall be corrected as directed.

780 A geotextile in accordance with 918.02 shall be placed prior to the placement of other material when the material is finer than recycled material. A minimum 18 in. encasement suitable for vegetation growth shall be constructed in accordance with 203.09.

203.19 Embankment Over and Around Structures

Fill shall not be placed against any new masonry abutment, wingwall, retaining wall, or culvert, or over any culvert, bridge, or arch until approved. Applicable provisions of 702.23 shall be met.

790 Filling around culverts, bents, and piers, and fill below the natural ground surface at abutments, wings, and retaining walls shall be deposited on both sides to approximately the same elevation at the same time. Piers or bents shall not be displaced and shall be checked for proper location as the work progresses. Corrective measures shall be made if necessary. Filling at arch structures shall be carried up in horizontal layers, symmetrically from haunch to crown, and simultaneously over and against all piers, abutments, and arch rings.

Wedging action of filling material against structures shall be prevented. If directed, back slopes of excavation shall be destroyed by stepping or serrating.

800 The embankments around the end bents shall be constructed to approximate subgrade elevation for a distance of no less than 75 ft. This work shall be done before piling in the end bents are driven, and before the end bent or abutment is constructed. Compaction shall be in accordance with 203.23. After the embankments are completed, the embankments shall be excavated to construct the end bents and berms. Before driving piles, pilot holes to receive the piling shall be predrilled through the embankment in accordance with 701.09(a). After the piles have been driven, the space between the pile and the predrilled hole shall be backfilled with granular material as directed. If the embankment in the area of the end bents is to consist of sand, gravel, or other permeable material in which a predrilled hole would not remain open, the piling shall be driven before the embankment is constructed. No direct payment will
810 be made for excavation of the embankment at the end bents or abutments, or for predrilling, backfilling holes, or excavating fill; those costs shall be included in the cost of other pay items.

203.20 Rock and Shale Embankment

Utilization of these materials in embankment construction shall be in accordance with the following.

(a) Rock Embankment

820 Where rock is used for embankment, no large stones shall be allowed to nest but shall be distributed over the area to avoid pockets. Voids shall be filled carefully with small stones. The final 2 ft of the embankment just below the subgrade elevation shall be composed of suitable material placed in layers not exceeding 8 in. loose measurement and compacted to the required density. Shale or shale-like materials shall

not be incorporated in the upper 2 ft of the embankment.

830 Where the depth of an embankment exceeds 5 ft and is to consist entirely of rock, the rock shall be deposited in lifts not to exceed the top size of the material being placed, but in no event exceeding 4 ft. The rock for any particular lift shall be deposited on and pushed over the end of the lift being constructed by means of bulldozers or other approved equipment. Depositing of rock over the end of any lift from hauling equipment will not be allowed. If the voids of the last lift are not closed sufficiently, they shall be choked with small broken stone or other suitable material and compacted as directed. A geotextile in accordance with 918.02(a), Type 2A shall be placed between the rock and the soil.

840 Where the depth of embankment is 5 ft or less, or where the material being placed does not consist entirely of rock, the material shall be placed in lifts not to exceed the top size of the rock being placed but not exceeding 2 ft. Each layer shall be choked thoroughly with broken stone or other suitable material and be compacted to the required density or as directed. A geotextile in accordance with 918.02(a), Type 2A shall be placed between the rock and the soil.

Where a rock fill is to be placed over a structure, the structure shall first be covered with 2 to 4 ft of earth or other approved material, and properly compacted before the rock is placed. This covering shall be placed in accordance with 203.19.

Shale shall not be incorporated as rock embankment unless written permission is obtained.

850 **(b) Shale, Shale and Soft Rock Mixtures, or Soft Rock**

860 When these materials are encountered and are to be used for embankment construction, the compaction shall be accomplished with an approved vibratory tamping-foot roller in conjunction with a static tamping-foot roller. The minimum weight for the static tamping-foot roller shall be 30 t. The minimum total compactive effort for the vibratory tamping-foot roller shall be 27.5 t. Total compactive effort is defined as that portion of the static weight acting upon the unsprung compaction drum added to the centrifugal force provided by that drum. If the manufacturer's charts do not list the static weight acting on the compaction drum, the roller shall be satisfactorily weighed, the weight shall be added to the centrifugal force, and the roller rated in accordance with the Construction Industry Manufacturers Association, CIMA. Each tamping foot on the static roller shall project from the drum a minimum of 6 in. Each tamping-foot on the vibratory tamping-foot roller shall project from the drum a minimum of 4 in. The surface area of the end of each foot on both tamping-foot rollers shall be no less than 5 1/2 sq in.

Shale, shale and soft rock mixtures, or soft rock shall be placed in 8 in. maximum loose lifts. Strength and moisture control for compacted soils shall be in accordance with 203.23 or the density shall be at least 95% of maximum dry density with moisture control in accordance with 203.23. Excavation and blasting procedures shall

870 accommodate the selective placement of these materials and avoid intermixing rock. Rock shall be placed in accordance with 203.20(a).

Water shall be applied to the shale in the cut to accelerate the slaking action and again prior to disking and compaction to facilitate the compaction. The water shall be distributed by an approved method which provides uniform application of the required quantity of water. The water shall be uniformly incorporated throughout the entire lift by a multiple gang disk with a minimum disk wheel diameter of 24 in.

880 Unless otherwise approved in writing, each embankment lift shall receive a minimum of three passes with the static roller and a minimum of two passes with the vibratory roller. The material shall be bladed before using the vibratory tamping-foot roller. A pass shall be in accordance with 402.15. The rollers shall not exceed 3 mph during these passes. The number of passes will be adjusted upward if necessary to meet the requirements of 203.23. No additional compensation will be allowed for additional passes as specified herein, the cost of which shall be included in the cost of the pay items.

890 Water required to facilitate the slaking and compaction of the shale or soft rock will be measured in accordance with 203.27(h) and paid for in accordance with 203.28. No payment will be allowed for any water required for compaction of material furnished as borrow.

(c) Shale and Thinly Layered Limestone

In Dearborn, Decatur, Fayette, Franklin, Jefferson, Ohio, Ripley, Rush, Switzerland, Union, and Wayne Counties specifically, or in other areas where relatively thin layered shale and rock are encountered, their use will be allowed in the construction of embankment, if the following provisions, in addition to those stated in 203.20(b), are observed.

- 900
1. The slopes shall be encased with a minimum of 10 ft of relatively impervious, non-shale, non-erodable material.
 2. The maximum size of limestone in the mixture shall be 6 in. in thickness and 1.5 ft in any other dimension.
 3. The minimum number of passes with static roller and the vibratory tamping-foot roller shall be six static and two vibratory.

910 If the material is found to be too intermixed with limestone fragments to enable field density tests as required in this section, this requirement may be waived by written permission. As an alternate to this requirement, proofrolling shall be performed after every four lifts, and the moisture content will be controlled on clayey soils in accordance with 203.23.

203.21 Embankment on Hillsides or Slopes

Before an embankment is placed on natural soil slopes or existing fill slopes of 4:1 or flatter, the existing ground surfaces shall be plowed or deeply scarified or, if the nature of the ground indicates greater precautions should be taken for integrating the proposed fill materials with the existing slopes, benches shall be cut into the existing slopes before fill placement is started. All such precautionary work shall be done as directed. No direct payment will be made for plowing or scarifying, the cost thereof shall be included in the various pay items of the contract. Before an embankment is placed on natural soil slopes or existing fill slopes steeper than 4:1, benches a minimum of 10 ft wide, unless otherwise specified, shall be cut into the slopes prior to the placement of embankment fill. If benches are cut, the excavation involved will be paid for at the contract unit price per cubic yard for the class or classes of excavation encountered.

930 **203.22 Embankment Over Existing Roadbeds**

If embankment for new pavement is to be placed over an area where a rigid pavement or any pavement having a concrete base is in place, or in other cases when required, the upper surface of which is 1 ft or less below the subgrade elevation of the proposed new pavement, the existing old pavement, including any concrete base, shall be removed. The method of removal, disposal, and basis of payment shall be in accordance with 202.05 and 202.14.

940 If embankment for new pavement is to be placed over an area where an existing rigid pavement is in place, the upper surface of which is more than 1 ft but less than 3 ft below the subgrade elevation of the proposed new pavement, or in other cases when required, the existing pavement shall be broken. Pavement shall be broken so the area of any individual unbroken slab does not exceed 1 sq yd.

950 If embankment for new pavement is to be placed over an area where an asphalt filled brick-type or an asphalt-type surface on a concrete base is in place, and such existing surface is more than 1 ft but less than 3 ft below the subgrade elevation of the proposed new pavement, or in other cases when required, the brick and cushion material, or the asphalt courses, shall be removed and the concrete base broken. Removal of the surfacing material, breaking the base, disposal of removed material, and basis of payment shall be in accordance with 202.05 and 202.14.

960 If embankment for new pavement is to be placed over an area where a flexible-type pavement is in place, the top of which is at the approximate elevation of, or is 1 ft or less below the required subgrade elevation of the proposed new pavement, the existing pavement shall be loosened to the depth directed, but no less than 1 ft. This loosened material shall be spread uniformly over the full width of the subgrade plus 1 ft on each side and compacted. No direct payment will be made for this loosening, spreading, and compacting, the cost thereof to be included in the various pay items of the contract.

If embankment for new pavement is to be placed over an existing macadam, the

surface of which is more than 1 ft but less than 3 ft below the subgrade elevation of the proposed new pavement, the existing macadam shall be loosened to a depth sufficient to prevent possible trapping of water above the existing surface. No direct payment will be made for this loosening, the cost thereof to be included in the various pay items of the contract.

970 Where the existing roadbed is too narrow, except as otherwise herein provided, new pavement shall not be placed partly on old and partly on new embankment. If the fill supporting an existing roadbed is 1 ft or more in depth, and is too narrow to carry the entire width of the proposed new pavement, the existing width of roadbed shall be taken down to include the new roadbed width and rebuilt from the lowest elevation of the disturbed old roadbed to the required new width. This rebuilding shall be in accordance with these specifications for constructing embankment and as directed. For the necessary tearing down of the existing embankment, payment will be made at the contract unit price per cubic yard for the class or classes of excavation encountered.

980 If an embankment is to be widened, due precautions shall be taken to ensure a firm foundation. After all sod and other perishable material has been removed, the existing shoulders shall be plowed down 2 ft out from the existing pavement. This material shall be used for widening. Benches, a minimum of 4 ft wide, shall be cut into the slope of the old embankment, unless otherwise directed. The materials from plowing down the shoulders and benching the slopes shall be deposited, spread, and compacted as set out herein for embankment, after which any remaining required embankment shall be finished with additional material, deposited and compacted in like manner. No direct payment will be made for benching, plowing, spreading, and compacting, the cost thereof to be included in the various pay items of the contract.

203.23 Embankment other than Rock, with Strength or Density Control

990 The compaction will be determined by dynamic cone penetrometer, DCP, testing in accordance with ITM 509 and the moisture content in accordance with ITM 506. Soil classification will be performed in accordance with the ITM 512 and the following DCP blow counts will be used for compaction control:

Textural Classification	Maximum Dry Density (pcf)	Optimum Moisture Content Range (%)	Acceptable Minimum DCP value for 6 in. for 95% compaction	Acceptable Minimum DCP value for 12 in. for 95% compaction	Acceptable Minimum DCP value for 6 or 12 in. for 100% compaction
CLAY SOILS					
Clay	< 105	19 - 24	6		*
Clay	105 - 110	16 - 18	7		*
Clay	111 - 114	14 - 15	8		*
SILTY SOILS					
Silty	115 - 116	13 - 14		9	*
Silty	117 - 120			11	*
SANDY SOILS					
Sandy	121 - 125	8 - 12		12	*
Sandy	> 125			15	*
GRANULAR SOILS - STRUCTURE BACKFILL and A-1, A-2, A-3 SOILS					
No. 30				6	9
No. 4				7	10
1/2 in.				11	14
1 in.				16	19
Note: * Test section required in accordance with ITM 513.					

Unless otherwise specified, all material directed to be compacted in accordance with 203.23 shall meet the acceptable minimum DCP value for 95% compaction. Subgrade shall meet the acceptable minimum DCP value for 100% compaction when required.

1000

As an alternate, all embankments shall be compacted to at least 95% of their maximum dry density and all subgrade shall be compacted to at least 100% of their maximum dry density. In situ density will be determined in accordance with AASHTO T 191 and the moisture content as specified.

For clay, silty, and sandy soils compacted to 100% of their maximum dry density, a test section is required in accordance with ITM 513 for DCP testing.

1010 Clay soils shall be constructed and tested with DCP in 6 in. lifts, whereas silty, sandy, and granular soils shall be constructed in 6 in. lifts and tested with DCP for 12 in.

The moisture compaction range for all soil types shall be as follows:

Soil Type	Moisture Compaction Range
Clay (< 105 lb/cu ft)	-2 to +2% of optimum moisture content
Clay (105 - 114 lb/cu ft)	-2 to +1% of optimum moisture content
Silty and Sandy (> 114 lb/cu ft)	-3% to optimum moisture content
Granular	5 to 8%

DCP testing will be performed in accordance with the Frequency Manual at random locations determined in accordance with ITM 802.

Moisture testing will be performed in accordance with the Frequency Manual.

1020

If the embankment material is too wet or too dry, either the material shall be aerated to remove excess moisture or watered and disked to increase the moisture content, until in either case the moisture content is within the specified range. Sufficient moisture tests will be made to ensure that this range is maintained throughout the embankment.

1030

The embankment material shall be placed in uniform level layers, left properly shaped as set out above, and compacted with approved compacting equipment. Compacting equipment shall include at least one 3-wheel roller or other approved compacting equipment capable of providing a smooth and even surface on the embankment as directed.

Each lift shall be disked or treated by some other mechanical means which shall ensure the breaking up of any existing lumps and clods.

The loose depth of each lift shall be such that the required compaction can be obtained, but in no case shall it exceed 8 in. Where a tamping roller is used, the loose depth of lift shall not exceed the length of the tamper feet. The surface area of the end of each foot of the tamping roller shall be no less than 5 1/2 sq in.

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203.23.1 Coal Ash Embankment

When used as borrow, coal ash shall be placed in the embankment, compacted, and encased upon delivery to the project unless stockpiled at an approved location and in an approved manner.

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The Contractor shall include appropriate measures to prevent the movement of coal ash from the embankment area. These measures include, but are not limited to controlling stormwater runoff and fugitive dust. The top of coal ash embankments shall be temporarily encased if embankment construction will be delayed for more than seven days or if weather conditions warrant encasement. Control measures shall be amended into the SWQCP in accordance with 205.

Coal ash shall not be mixed with other embankment materials within a given lift of the embankment.

Coal ash shall not be placed in any of the following locations:

1. Below existing ground.
- 1060 2. Within a 100 ft horizontal distance of a stream, river, lake, reservoir, wetland, karst feature or any protected environmental area.
3. Within a 150 ft horizontal distance of a well, spring, pond or other ground source of water.
4. MSE wall backfill.
5. As encasement material.
- 1070 6. Within the limits of subgrade treatment.
7. Directly in contact with any permanent metallic construction materials.

The loose depth of each lift of coal ash shall not exceed 8 in. Compaction of each lift shall begin at the outer edge and progress towards the center of the embankment using a maximum 10 t roller.

- 1080 The moisture content shall be controlled within -2 and +2 percentage points of the optimum moisture content determined in accordance with AASHTO T 99. Compaction will be determined by DCP testing in accordance with ITM 509. The DCP criteria for compaction acceptance will be as follows:

1. A minimum blow count of 7 for a 6 in. compacted lift for fly ash.
2. A minimum blow count of 16 for a 12 in. compacted depth of bottom ash consisting of two compacted 6 in. lifts.

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The Contractor shall coordinate with the Department's Geotechnical Engineering Division to determine the minimum blow count for a mixture of fly ash and bottom ash.

- 1100 Lateral underdrains shall be installed at the bottom of coal ash embankments. Lateral underdrains shall be trenched into the embankment after it has reached an elevation at least 2 ft above existing ground. The bottom of the trench shall be at the top of existing ground with adjustment made for slope of the drain. The trench shall be located within 2 ft of the toe of slope. The trench shall be backfilled with the coal ash material used for the embankment, mechanically compacted to meet the compaction requirements herein. Lateral underdrains shall be 6 in. diameter Type 4

pipe in accordance with 715.02(d) and shall be enclosed in geotextile for underdrains in accordance with 918.02. Lateral underdrains shall be spaced a maximum of 100 ft longitudinally along the centerline of the embankment, shall outlet into the roadside ditch on each side of the embankment, shall extend a minimum of 8 ft horizontally into the embankment, and shall be sloped at a minimum of 0.2%.

Underdrain outlet protectors in accordance with 718.06 shall be installed at the outlet end of each lateral underdrain.

1110

Coal ash shall be encased on all sides with cohesive soil. The cohesive soil shall be a silty loam, sandy clay, silty clay, sandy clay loam, clay, or a silty clay loam in accordance with 903.02. All cohesive soils shall have a minimum clay content of 10%.

Encasement shall be as follows:

Total Finished Embankment Height	Encasement (measured horizontally)
Less than 10 ft	2 ft
10 ft to 20 ft	3 ft
Greater than 20 ft	4 ft

Encasement material shall be placed and compacted concurrently with the coal ash lifts.

1120

The top of the coal ash embankment shall be encased with a minimum of 1 ft of cohesive soil beneath the bottom of subgrade.

203.24 Method of Making Strength, Stiffness and Density Tests

The strength of chemically modified or compacted soils will be determined by DCP in accordance with ITM 509.

The stiffness of chemically modified soils or aggregates will be determined by the LWD in accordance with ITM 508.

1130

The density of soils and aggregates, as a percent of compaction, will be based on the maximum dry densities unless otherwise specified or directed.

DCP field compaction tests will be performed in accordance with 203.23. LWD and density field compaction tests will be performed in accordance with this section. The required compaction shall be obtained before additional material is placed.

(a) Laboratory

The DCP criteria will be established on representative soils by performing ASTM D1140, AASHTO T 88, AASHTO T 89, AASHTO T 90, and AASHTO T 99 using Method A for soils and Method C for granular materials.

The optimum moisture content, maximum dry density, and gradation of aggregates will be determined by performing AASHTO T 99 Method C, AASHTO T 11, and AASHTO T 27 on representative samples of the aggregates.

(b) Field

1150 The soil strength of compacted soils or compacted chemically modified soils will be determined by DCP in accordance with ITM 509 and the stiffness of chemically modified soils or aggregates will be determined by LWD in accordance with ITM 508. The moisture content will be determined in accordance with ITM 506 or AASHTO T 255.

As an alternative, in situ field density may be determined in accordance with AASHTO T 191, except as listed below. The maximum dry density of the soil will be determined by ITM 512

1160 1. If AASHTO T 191 is used, the sand used for the test shall be silica sand in accordance with the gradation as follows:

- Passing the No. 20 (850 μm) sieve - 98 to 100%
- Passing the No. 40 (425 μm) sieve - 0 to 35%
- Passing the No. 70 (212 μm) sieve - 0 to 2%

Sand such as Wedron Silica Sand No. 4075 or Ottawa 2.8 Blasting Sand has been found to be acceptable.

1170 2. If particles larger than those that can pass through a No. 4 (4.75 mm) sieve for soil and a 3/4 in. (19 mm) sieve for granular material are encountered, corrections shall be made so that the density obtained is for the minus No. 4 (4.75 mm) or 3/4 in. (19 mm) only. After the densities are determined, the percent compaction will be computed by the following formula:

$$\text{Percent Compaction} = \frac{\text{In Place Density, pcf}}{\text{Maximum Density, pcf}} \times 100$$

1180 3. Other approved types of field density tests may be used for control purposes after density values corresponding to those obtained by either of the methods set out above have been established.

4. All references to soils in these methods of tests shall be interpreted to mean either or both soil and granular materials.

1190 Acceptance testing of chemically modified soils and coarse aggregates will be determined by LWD testing in accordance with ITM 508. The allowable deflection will be determined from a test section or will be specified. Test sections shall be constructed in accordance with ITM 514 in the presence of a representative of the Geotechnical Engineering Division for other materials not included in the Tables to determine the maximum allowable deflection. The compaction procedures shall be in accordance with 203.23, 215, 301, 302, and 303. Proofrolling of compacted aggregate shall be performed in accordance with 203.26.

The allowable average deflection and maximum deflection for chemically modified soils and aggregate over chemically modified and untreated soils shall be in accordance with the following:

1200 Table 1. Allowable Average Deflection and Maximum Deflection for Chemically Modified Soils and Aggregate over Chemically Modified Soils.

Material Type	Allowable Average Deflection (mm)	Maximum Deflection at a Single Test Location (mm)
Lime Modified Soil	≤ 0.30	0.35
Cement Modified Soil	≤ 0.27	0.31
Aggregate over Lime Modified Soil	≤ 0.30	0.35
Aggregate over Cement Modified Soil	≤ 0.27	0.31

Table 2. Aggregate over Untreated Soils:
Where Proofrolling Can Be Performed

Material Thickness	Allowable Average Deflection (mm)	Maximum Deflection at a Single Test Location (mm)
6 in. Thick Coarse Aggregate No. 53	≤ 0.51	0.57*
12 in. Thick Coarse Aggregate No. 53	≤ 0.34	0.40**
18 in. Thick Coarse Aggregate No. 53	≤ 0.31	0.35**
* When deflection exceeds this value, the area shall be recompacted or undercut as directed. The failed area will be delineated prior to excavation. Deflection will be measured based on the top 6 in. thick coarse aggregate No. 53 material placed for undercut.		
** The Contractor shall recompact the coarse aggregate No. 53 in accordance with 301.06.		

Table 3. Aggregate over Untreated Soils:
Where Proofrolling Cannot be Performed

Material Thickness	Allowable Average Deflection (mm)	Maximum Deflection at a Single Test Location (mm)
6 in. Thick Coarse Aggregate No. 53	≤ 0.60	0.65*
12 in. Thick Coarse Aggregate No. 53	≤ 0.47	0.52**
18 in. Thick Coarse Aggregate No. 53	≤ 0.44	0.49**
<p>* When deflection exceeds this value, the area shall be recompacted or undercut as directed. The failed area will be delineated prior to excavation. Deflection will be measured based on the top 6 in. thick coarse aggregate No. 53 material placed for undercut.</p> <p>** The Contractor shall recompact the coarse aggregate No. 53 in accordance with 301.06.</p> <p><u>Note:</u> The Engineer will perform the moisture test on in-situ soils prior to placement of coarse aggregate. If the result of the moisture test is > 13%, the Engineer will contact the Department's Geotechnical Engineering Division.</p>		

1210

Acceptance of the compaction of chemically modified soils or aggregate will be determined by averaging three LWD tests obtained at a random station determined in accordance with ITM 802, for each 1,400 cu yds of chemically modified soil or for each 800 t of compacted aggregate. Where the construction area is 8 ft wide or more, the location of the three tests will be at 2 ft from each edge of the construction area and at 1/2 of the width of the construction area. Where the construction area is less than 8 ft wide, the location of the three LWD tests will be spaced at 1/2 of the width of the construction area and spaced 5 ft apart in the longitudinal direction. The average deflection shall be equal to or less than the maximum deflection allowed in the tables above or determined by the test section.

1220

203.25 Embankment Without Stiffness Control

When aggregate is used for embankment construction and it is not possible to perform stiffness testing in accordance with ITM 508 or strength testing in accordance with ITM 509, such material shall be compacted with several passes of crawler-tread equipment or with approved vibratory equipment, or both. The equipment weight shall be at least 10 t. The materials shall be placed in lifts not to exceed 9 in. loose measurements, or as directed by the Engineer. Each lift shall be compacted with a minimum of five passes. The tread areas shall overlap enough on each trip so that the entire embankment is compacted uniformly. When the embankment reaches 24 in. below the proposed subgrade elevation, proofrolling shall be performed in accordance with 203.26. Proofrolling shall also be performed at every 5 ft of fill placed. Any defect shall be corrected as directed. Upon acceptance, a layer of geotextile in accordance with 918.02(a) Type 2B, shall be placed and the remaining embankment shall be constructed with No. 53 aggregate in accordance with 301.

1230

At locations inaccessible to the above compacting equipment, the required compaction shall be obtained with approved mechanical tamps or vibrators, in which

case the depth of lifts, loose measurement, shall not exceed 4 in.

1240

203.26 Proofrolling

When proofrolling is specified, the work shall be performed with an on-highway dump truck with a minimum tire pressure of 90 psi.

Proofrolling for original ground or embankment construction shall be performed using a dump truck weighing at least 15 t. Proofrolling for subgrade preparation shall be performed using a dump truck weighing at least 33 t. All proofrolled surfaces shall be covered completely with a single pass. Operating speed of the proofrolling truck shall not exceed 2 mph.

1250

Deflections or rutting in excess of 1/2 in. shall require remediation of the surface as directed. Deflection or rutting in excess of 3 in. shall require corrective remediation measures and the Department's Geotechnical Engineering Division will be contacted. Proofrolling shall be performed after remediation measures on embankment or subgrade prior to the placement of additional material. There shall be one or two complete coverages as directed. Roller marks, irregularities, or failures shall be corrected.

203.27 Method of Measurement

1260

(a) Contract Quantity

The quantities of excavation for which payment will be made will be those shown in the Schedule of Pay Items for the pay items, provided the project is constructed to the lines and grades shown on the plans.

Unless otherwise specified, the project limits will be considered as one balance. If earthwork balances are shown on the plans, they are for information only.

1270

When the plans have been altered or when disagreement exists as to the accuracy of the plan quantities in any balance, or the contract quantity, either party shall have the right to request and cause the quantities involved to be measured in accordance with measured quantities. When the quantities are measured for payment, the original plan cross sections plotted on the plans shall be used as original field cross sections. Additional original cross sections may be interpolated at points where necessary to determine the quantities more accurately. If the Contractor has acceptable engineered data that indicates an excavation quantity that is in error by more than 2%, then additional measurements will be performed on the areas in question and payment will be made for actual quantities.

1280

(b) Measured Quantities

When payment is specified on a volume basis, all accepted excavation and borrow will be measured in its original position by cross sectioning the area excavated, which measurements will include over-breakage or slides in common excavation and unclassified excavation, not attributable to carelessness, and authorized excavation of

rock, shale, peat, or other unsuitable material. Volumes will be computed from cross section measurements by the average end area method.

1290 Measurement for payment will not include material excavated beyond authorized cross sections. Where material is excavated beyond authorized cross sections and wasted without authority, the material so wasted will be measured and deducted from the excavation quantities. Unless otherwise authorized, the amount of waste to be deducted, when common excavation, rock excavation, unclassified excavation, borrow, or other excavation has been wasted along embankments or elsewhere without authority shall be that portion of the embankment or fill which is outside a 1/4 to 1 slope in excess of that shown on the plans, and all portions outside a line from the shoulder point to a point 4 ft, measured horizontally, outside the theoretical toe of the slope. In determining waste, no tolerance in widths of shoulders will be allowed unless additional widths are authorized in writing before shoulders are finally constructed.

1300 Measurements will be made for unsuitable materials actually excavated and removed to obtain proper compaction in cut sections and in foundations for fill sections.

Where it is impracticable to measure material by the cross section method due to the erratic location of isolated deposits, acceptable methods involving three-dimensional measurements may be used to measure the material in its original position.

1310 The cubic yards of peat excavated will be determined by cross sections, as described above, with the final cross sections taken after complete excavation and before placing granular backfill, if peat is removed by excavation. When removal by displacement is necessary, final cross sections will be derived from cased test holes through the completed granular treatment in accordance with 203.17. Such test holes shall be located at intervals which clearly define the bottom of the treatment between lateral limits. Pay quantities of peat excavation will be limited to the volume of peat lying between vertical lines as shown on the plans for lateral limits.

1320 Cased test holes and exploratory drilling will be measured by the linear foot; Borrow by the cubic yard, in accordance with 211.09. However, measurement to neat lines will not apply unless specifically designated. Breaking pavement will be measured by the square yard in place before breaking.

(c) Measurement on a Linear Basis

Linear grading will be measured by the linear foot. Measurement will be made once along each survey centerline for all linear grading completed on the line. Deductions will be made for bridges. Classes of excavation, except for required borrow, involved in linear grading will not be measured.

(d) Measurement of Excavation Items on a Weight Basis

1330 A pay item for excavation may be specified to be measured and paid for on a

weight basis. When a weight basis is specified, the material will be weighed in accordance with 109.01(b).

(e) Measurement of Embankments

When specified, embankments constructed will be measured in accordance with the terms set forth.

1340 When embankment is specified as a separate pay item, the volume as constructed will be measured in place in accordance with 203.27(b). However, no measurement will be made for excavation or borrow, except as noted herein. The volume shall be computed in cubic yards from the dimensions of the embankment cross sections and to the depth below completed grade to which this method of construction applies. No shrinkage factor shall be used in computing the embankment volume. Measurements will be made for unsuitable materials actually excavated and removed to obtain proper compaction in cut sections and in foundations of fill sections in accordance with 203.27(b). B borrow from off the right-of-way placed within embankment areas will be measured in accordance with 211.09.

(f) Measurement of Borrow

1350 Borrow will be measured by the cubic yard. Except as otherwise provided herein, borrow will be cross sectioned in its original position before excavation is started, again after it is completed, and the volume computed by the average end area method. No material shall be excavated as borrow until unsuitable material, vegetation, and other perishable matter have been removed and cross sections taken over the cleared area. None of this removed unacceptable material shall be moved back into the pit before final sections are taken.

1360 If borrow is obtained from a source where it is impracticable to measure the material in its original position, such material will be measured after being placed in embankment with no allowance made for a compaction factor. The borrow may be measured in truck beds in accordance with 211.09 for contracts having a proposal quantity less than 500 cu yds. If such source is contemplated, approval shall be obtained in writing before this part of the work is started. For quantities less than 5,000 cu yds, the material may be weighed in accordance with 109.01(b) and converted from pounds shown on the weigh tickets to cubic yards using a factor of 3,000 lb/cu yd.

1370 If borrow is specified outside the limits of B borrow and if the requirements of the work do not otherwise prohibit, material in accordance with these specifications for B borrow, may be furnished and placed at the contract unit price for borrow, in which case measurement will be in accordance with 211.09. Measurement of borrow in accordance with 211.09 will be limited to nominal quantities outside the limits of structure backfill. The quantity of borrow measured for payment will not exceed the theoretical quantity of B borrow furnished.

(g) Measurement of Embankment Foundation Soils Treatment

Mechanical treatment of embankment foundation soils will be measured by the square yard. Chemical treatment of embankment foundation soils will be measured in accordance with 217.

1380

(h) Measurement of Water for Shale, Shale and Soft Rock Mixtures, or Soft Rock

When payment for water for shale is specified in the contract, the water for shale used will be measured by the 1,000 gal. by means of calibrated tanks or distributors, or by means of accurate water meters. When water for shale is not specified as a pay item in the contract, the water for shale that is used will not be measured directly. Such measurement will be included in that required for other pay items.

(i) Lump Sum

1390 If the pay unit for a pay item for excavation is lump sum, no measurement will be made.

(j) Measurement of Exploratory Cores

Exploratory cores will be measured by the linear foot of rock core.

(k) Measurement of Coal Ash

If coal ash is used as borrow, it will be measured in accordance with 203.27(f).

1400 If coal ash is encountered during excavation, it will be measured as common excavation in accordance with 203.27.

203.28 Basis of Payment

1410 The accepted quantities of excavation and embankment will be paid for at the contract price per unit of measurement for each of the pay items listed below which is included in the Schedule of Pay Items. Common excavation and unclassified excavation will be paid for on the unit basis of contract quantities in accordance with 203.27(a), without any quantity limit, unless otherwise shown in the Schedule of Pay Items. Combined quantities of borrow, common and unclassified excavation not exceeding 15,000 cu yds will be paid for on the basis of contract quantities in accordance with 203.27(a) with no adjustment to plan shrinkage factor. Except as noted above, borrow, as well as all other excavation, will be paid for on the basis of measured quantities in accordance with 203.27(b), unless otherwise shown in the Schedule of Pay Items. Linear grading will be paid for at the contract unit price per linear foot.

If the class of excavation is linear grading, additional borrow and the excavation of and disposal of unsuitable material not included as pay items will be paid for as follows:

1420 If the total quantity exceeds 5,000 cu yds at a given location, it will be paid for at \$8.00 per cu yd. If the total quantity exceeds 1,000 cu yds, but does not exceed 5,000

cu yds at a given location, it will be paid for at \$12.00 per cu yd. If the total quantity does not exceed 1,000 cu yds at a given location, it will be paid for at \$15.00 per cu yd.

Linear grading includes only such grading within the construction limits. All grading the Contractor is directed to perform outside the construction limits, except for the Contractor's convenience, will be paid for in accordance with 104.03 or 109.03 unless such grading is shown on the plans or in the Contract Information book.

1430

Existing concrete building foundations, concrete walls, concrete columns, or concrete steps not visible and not shown on the plans within the limits of the planned excavation will be paid for at 10 times the contract unit price per cubic yard for common or unclassified excavation, whichever is set out as a pay item. Unless a waste area is established within the contract limits, the minimum pay for this work will be \$80.00 per cu yd.

1440

Excavation and disposal of unsuitable material will be paid for at the contract unit price for the class of excavation involved. If no such pay item is included in the contract and embankment is included as a pay item, the excavation and disposal will be paid for at the contract unit price for embankment, unless otherwise directed.

If there is no pay item for rock excavation and such is encountered, it will be paid for at \$125.00 per cu yd for quantities less than or equal to 100 cu yds. For quantities greater than 100 cu yds pay will be determined in accordance with 104.03.

If there is no pay item for common excavation and if such is encountered, it will be paid for at the contract unit price per cubic yard for borrow.

1450

If the contract includes a pay item for waterway excavation, and if class Y excavation is encountered and there is no pay item for such, the class Y excavation will be paid for at 10 times the contract unit price per cubic yard for waterway excavation, or \$100.00 per cu yd, whichever is greater.

If the contract does not include a pay item for waterway excavation and such is encountered, pay will be determined in accordance with 104.03.

1460

If excavation is necessary to investigate or to seal sinkholes, or to explore underground drainage, the accepted quantity involved at each location will be paid for as follows. The first 10 cu yds or fraction thereof will be paid for at 10 times the contract unit price for the class of excavation encountered. The next 40 cu yds or fraction thereof will be paid for at seven times the contract unit price for the class of excavation involved. Additional quantities will be paid for at three times the contract unit price per cubic yard for the class of excavation involved.

Material overlying the peat deposits which is excavated and used in embankment will be considered as common excavation and will be paid for as such. Excavation for

1470 standard side ditches or other side ditches which are constructed through peat areas at locations shown on the plans, or where directed, will be paid for at the contract unit price per cubic yard for common excavation.

Mechanical treatment of embankment foundation soils will be paid for by the square yard as embankment foundation soils treatment.

Cased test holes and exploratory drilling will be paid for at the contract unit price per linear foot.

1480 If there is no pay item for borrow, the costs of identifying the borrow areas, the archeological investigation, all required permits, and the opening and closing of the borrow area will be included in a change order developed in accordance with 109.05 and paid for as borrow area.

If the contract documents do not identify excess excavation or require removal of any items from the site, the cost of identifying a disposal area, archeological investigation, all required permits, and the opening and closing of the disposal area will be included in a change order developed in accordance with 109.05 and paid for as disposal area.

1490 If a type of excavation for which no pay item exists is required and the new type of excavation requires the Contractor to use equipment not otherwise being used on the contract, all cost involved in determining the type of equipment necessary to complete the work and making this equipment available for the project will be included in a change order developed in accordance with 109.05 and paid for as additional mobilization and demobilization.

1500 If a type of excavation for which no pay item exists is required and the new type of excavation requires additional traffic control not shown on the plans or results in traffic control being required for an additional period of time, all cost involved in providing the additional traffic control will be included in a change order developed in accordance with 109.05 and paid for as additional maintaining of traffic.

Coal ash used as borrow will be paid for at the contract unit price for borrow.

Excavation of coal ash will be paid for at the contract unit price for common excavation.

Payment will be made under:

1510	Pay Item	Pay Unit Symbol
	Borrow.....	CYS
	Breaking Pavement.....	SYS
	Cased Test Holes	LFT

	Embankment.....	CYS
	Embankment Foundation Soils Treatment	SYS
	Excavation, Common	CYS
	Excavation, Peat	CYS
	Excavation, Rock.....	CYS
	Excavation, Unclassified	CYS
1520	Excavation, Waterway.....	CYS
	Excavation, Y	CYS
	Exploratory Cores.....	LFT
	Exploratory Drilling	LFT
	Linear Grading	LFT
	Water for Shale.....	kGAL.

1530 If embankment is specified as a pay item, borrow and common excavation, unless otherwise specified, will not be paid for directly. The costs thereof shall be included in the cost of embankment. Such price shall be full compensation for preparation of the natural ground on which the embankment is to be placed and excavating, hauling, placing, spreading, and compaction of materials in accordance with 203.23. The costs of labor, equipment, tools, and necessary incidentals shall be included in the cost of embankment. The cubic yards of suitable material used in the embankment excavated from the right-of-way and paid for under a specific pay item will not be deducted from the embankment quantities. The quantity of material to be paid for as B borrow and placed within the embankment area as specified will be deducted from the quantity of embankment.

1540 The costs of excavating, backfilling, disposal of surplus material, labor, equipment, tools, and necessary incidentals necessary shall be included in the cost of excavation required to seal sinkholes or explore underground damage.

The costs of all excavated or displaced peat, regardless of depth, peat disposal, temporary surcharge, machine operation, and machine availability shall be included in the cost of peat excavation. However, the Department may provide temporary right-of-way for peat disposal when so specified.

1550 Cost for providing additional lighting for grading operations shall be included in the cost of other pay items in this section.

No payment will be made for the construction or restoration of borrow or disposal sites.

No payment will be made for the inspection of disposal and borrow areas for wetland identification, obtaining of permits, the development and construction of all mitigation measures, or the fulfillment of permit requirements.

1560 The cost of boring the holes, casings and fittings, labor, equipment, tools, and all necessary incidentals shall be included in the cost of cased test holes or exploratory drilling.

204.01

The cost of reshaping scoured or eroded areas shall be included in the cost of other pay items.

The cost of surface roughening shall be included in the cost of other pay items.

The cost of identification of borrow areas, archeological investigations, and changes to construction operations caused by the identification of an archeological site shall be included in the cost of borrow, unless otherwise agreed to in writing.

1570

The cost of all classes of excavation, except required borrow, within the limits of linear grading shall be included in the cost of linear grading.

The cost of geotextiles shall be included in the cost of other pay items.

The costs for the use of coal ash in embankment construction, including, but not limited to testing of the material, encasement, additional erosion and sediment control measures, lateral underdrains and all incidentals shall be included in the cost of other pay items in this section.

1580

SECTION 204 – GEOTECHNICAL INSTRUMENTATION

204.01 Description

This work shall consist of providing, installing and maintaining of geotechnical instrumentation including settlement plates, settlement stakes, lateral stakes and standpipe piezometers as directed and in accordance with 105.03.

MATERIALS

10 204.02 Materials

Materials shall be in accordance with the following:

B Borrow	211.02
Coarse Aggregate, Class D or Higher, Size No. 53.....	904.03
Ottawa Sand*	AASHTO T 252
Structure Backfill, Size No. 30	904.05

* Ottawa Sand shall have a minimum permeability of 25 ft/day.

20 Bentonite chips shall consist of commercially processed angular fragments of pure bentonite, without additives.

Bentonite-cement grout shall consist of a mixture with the ratio of 25 lb of bentonite with 94 lb of portland cement, Type I in accordance with 901.01(b) and 30 gal. of water.

CONSTRUCTION REQUIREMENTS

204.03 Settlement Plates

30 Settlement plates consist of 1/2 in. by 3 ft by 3 ft steel plate equipped with sections
of 3/4 in. pipe and 2 in. galvanized threaded pipe and couplings to act as a cover or
guard.

(a) Installation Requirements

Each settlement plate shall be placed on a horizontal plane consisting of a
compacted leveling layer of B borrow, whose surface is not less than 1 ft below the
elevation of the adjacent area. The first section of pipe shall then be installed by
welding to the settlement plate. The bottom elevation of the settlement plate will be
recorded. The area is backfilled with B borrow and thoroughly compacted. The
couplings shall be tack welded and the top elevation of the first pipe section will be
40 recorded before starting the first lift of grading operations.

The pipe sections for the settlement plates shall be 3/4 in. steel pipe, 4 ft long and
threaded on both ends with proper fittings so that such pipe sections can be extended
vertically from the center of the plates up through the new embankment as it increases
in height during grading operations. A cover pipe 2 in. shall be slipped over and
centered on the standpipe, and not welded to plates. The 3/4 in. steel and cover pipes
shall extend a minimum of 2 ft or more above the grade of the new embankments at
all times during grading operations and monitoring period.

50 Settlement stakes and lateral stakes, if required, shall be installed as shown on the
plans or as directed by the Engineer. The stakes shall be 3/4 in. by 4 ft steel rods and
shall be driven at least 12 in. into the ground. These stakes shall be set firmly in a
vertical position and initial readings will be taken.

B borrow shall be used as compaction material around the settlement plates and
pipes and shall be placed in accordance with the applicable requirements of 211.

(b) Instrument Readings and Settlement Period

60 During the construction of the embankment, elevation readings will be taken on
all settlement plate extension pipes and settlement stakes at the end of each seven-day
period, or more frequently if required. After the embankment is constructed to the
bottom of the subgrade, additional readings will be taken every seven days until the
settlement rate per week is 1/4 in. or less for four consecutive weeks. The monitoring
period may be reduced as directed by the Department's Geotechnical Engineering
Division.

If the results of any readings indicate that the new embankment has settlement
greater than 1/4 in., the monitoring period will be extended until the settlement
requirements are met.

70 Settlement stakes will be used to measure the vertical movement, in conjunction

with settlement plates if specified. Settlement stakes and settlement plates will be monitored at the same time and interval. Measurements will be made to the nearest 1/4 in. Within one day of the readings, settlement data will be sent electronically to the Department's Geotechnical Engineering Division and will be subject to approval.

Lateral stakes will be used to monitor horizontal movement of the ground or new fill. If lateral movement is noticed during the construction of the fill, the work will be suspended and the Department's Geotechnical Engineering Division will be contacted.

80 Measurements will be made to the nearest 1/4 in.

Settlement plates, extension pipes, cover pipes, and stakes shall be protected during construction operations and during the monitoring period.

(c) Protection and Maintenance

The settlement stake and settlement plate shall remain in a vertical position. The Contractor shall ensure that settlement plates and settlement stakes are not damaged or displaced. Settlement stakes and settlement plates deviating from a vertical position, becoming uncoupled, or broken shall be repaired or replaced by the Contractor, as directed by the Engineer.

90

The Contractor will not be held responsible for repair or replacement of any settlement plate assembly which is damaged as a result of instability of the embankment caused by factors beyond the control of the Contractor, as determined by the Engineer.

204.04 Standpipe Piezometers

The standpipe piezometers shall be installed by a geotechnical consultant on the Department's Qualified Geotechnical Consultant's List prior to placing the first lift of embankment. Piezometer consists of a 1/2 in. leak proof, flush-coupled Schedule 80 PVC pipe or ABS standpipe extending to the surface of the embankment with an attached polyethylene tip in accordance with AASHTO T 252.

100

(a) Installation Requirements

A separate water-monitoring borehole shall be installed outside the influence of the fill as shown on the plans. This shall be a minimum 2 in. diameter borehole, cased with slotted pipes, drilled to a recommended depth and location or as directed by the Engineer, to establish groundwater elevation prior to piezometer installation.

110

The installation of the standpipe piezometer shall precede placement of any embankment by at least two weeks to allow time for testing of the installation. The piezometer shall be maintained and protected during the embankment construction. The hollow stem auger shall be advanced to an approximate depth of 6 in. below the recommended piezometer tip elevation. Augers shall be cleaned and washed inside for their full length, until the wash water runs clear.

The auger shall be withdrawn 6 in. by means of jacking or other steady pull operations. The hole shall be filled to the bottom with saturated Ottawa sand and

120 tamped with an annular tamping hammer. The elevation shall be measured and provided to the Engineer.

The tip shall be attached to the standpipe and tested for free flow of water. The bottom end of the tip shall be plugged and soaked in water if a porous stone tip is used. The tip and standpipe shall be filled with clean water. The tip shall be lowered into the auger until it rests on the top of the sand placed and the elevation of the tip should be documented. Excess head shall be maintained in the standpipe during lowering to ensure that a small amount of water flows out of the tip.

130 The auger shall then be pulled or jacked a distance equal to the length of the tip in increments of 6 in. The hole shall be filled with water saturated Ottawa sand at each increment. This layer of sand shall not be tamped in order to avoid damage to the tip.

The auger shall be raised 12 in. and the hole filled with saturated Ottawa sand in 6 in. increments until the backfilling reaches a minimum of 6 in. below the elevation of the strata change or as directed by the Engineer. In locations where there is no strata change, the Ottawa sand shall be placed a minimum of 12 in. above the top of the tip.

140 The augers shall then be raised and the hole sealed with bentonite chips in accordance with AASHTO T 252 which shall be placed in 6 in. lifts. The top of the seal shall be a minimum of 6 in. above the strata break. A weighted line shall be used to ensure the bentonite seal is in place. The remainder of the hole shall then be backfilled with bentonite-cement grout as the augers are withdrawn. The riser pipe shall be kept in tension and shall be centered in the auger while backfilling. Depths for various stages shall be recorded on the Engineer's logs.

150 If the piezometer location is not in an area of proposed fill, an approximately 3 ft long protective metal cover shall be installed at the top with approximately 2 ft below the surface and 12 in. above the surface. A 12 in. diameter by 6 in. thick circular pad of coarse aggregate shall be filled around the cover. A lockable cap shall be securely attached onto the protective metal cover.

If the piezometer location is in an area of proposed fill, a PVC casing shall be used around the piezometer standpipe in order to protect the pipes during embankment construction. Borrow shall be placed and compacted around the casing without disturbing the casing.

160 The casing and standpipe shall be extended as the fill is placed, by adding extra lengths not to exceed 5 ft. The top of the standpipe shall be at least 12 in. above the grade of the new fill. Each time the casing and standpipe are extended, the casing shall be filled with structure backfill. The last extension of pipe shall be of such length that it extends 12 in. above grade. It shall be filled with structure backfill to within 9 in. of the top of the casing. A 12 in. diameter by 6 in. thick circular pad of coarse aggregate shall be filled around the pipes. A lockable cap shall be securely attached onto the protective cover.

When the standpipe is completed it shall be checked for obstructions by dropping a weighted line through the pipe. The standpipe shall then be filled with water and periodic readings made of the water level until the groundwater level is stabilized. Hydrostatic time lag required for equalization will be provided by the Geotechnical report. If required, the standpipe shall be flushed and retested at the direction of the Engineer. Groundwater readings shall be provided to the Engineer.

Standpipe piezometers, and cover pipes shall be protected during construction operations and during the monitoring of the fill. In the event of damage, fill construction shall be suspended in this area until the piezometer is restored.

(b) Readings and Maintenance of Piezometer

The Engineer will conduct and record all observations and measurements required to determine natural groundwater elevations and pore pressures induced by embankment construction. Monitoring intervals will be once every day for the first seven days, once every other day for the next eight, and then, once every three days through the end of construction of the fill. The elevation of the natural groundwater existing at the time of installation, prior to placement of any fill, will be used as a reference to determine baseline pore pressures. Groundwater and pore pressure test results will be made available to the Contractor.

The pore pressure measurement in conjunction with the settlement data will be sent electronically to the Department’s Geotechnical Engineering Division within one day of the readings, and will be subject to approval. If it is determined that pore-water pressures have not sufficiently dissipated, fill placement shall be suspended, and the monitoring period extended as directed.

If monitoring is to be continued after paving in a traffic accessible area, then the pipe shall be cut off 6 in. below the finished grade and a handhole in accordance with 807.09, shall be installed for monitoring access. When the evaluation is completed, the water monitoring borehole and piezometers shall be backfilled with bentonite-cement grout.

204.05 Method of Measurement

Settlement plates, settlement stakes, lateral stakes, standpipe piezometers, and water monitoring boreholes will be measured by the number of units installed.

204.06 Basis of Payment

Settlement plates, settlement stakes, lateral stakes, standpipe piezometers, and water monitoring boreholes will be paid for at the contract unit price per each.

Payment will be made under:

Pay Item	Pay Unit Symbol
Settlement Plate	EACH

Stake, Lateral.....	EACH
Stake, Settlement	EACH
Standpipe Piezometer	EACH
Water Monitoring Borehole.....	EACH

220 The cost of furnishing, installing, and maintaining settlement plates, extension pipes, cover pipes, B borrow, structure backfill, coarse aggregate and all necessary incidentals shall be included in the cost of settlement plates.

The cost of backfilling water monitoring boreholes will be included in cost of water monitoring boreholes.

The cost of handholes, protective covers, bentonite chips, bentonite-cement grout, Ottawa sand, tips, casing, drilling, tubing or PVC pipe, backfilling and measurements will be included in the cost of standpipe piezometers.

230 No additional compensation will be made for any costs incurred related to the repair of settlement plates, pipes, settlement stakes, lateral stakes or standpipe piezometers as the result of damage by the Contractor.

SECTION 205 – STORMWATER MANAGEMENT

205.01 Description

This work shall consist of furnishing, installing, inspecting, maintaining, and removing BMPs in accordance with 105.03, the Department’s Design SWPPP, the submitted and accepted SWQCP or an approved written site plan developed by the Contractor.

MATERIALS

10

205.02 Materials

Materials shall be in accordance with the following:

	Coarse Aggregate, Class F or Higher	904.03
	Fertilizer	914.03
	Filter Sock	914.09(h)
	Geotextile	918.02
	Grass Seed, Temporary	914.02
	Manufactured Surface Protection Products	205.04(c)
20	Metal End Sections.....	908.06
	Mulch	914.05(a)
	Pipe Drains	715.02(d)
	Plastic Net.....	914.09(g)
	Revetment Riprap.....	904.04*
	Stakes	914.09(b)

Staples 914.09(f)
 Top Soil 914.01
 Water 914.09(a)

* The minimum depth does not apply.

30

CONSTRUCTION REQUIREMENTS

205.03 General Requirements

For contracts requiring waterway permits, a Construction Stormwater General Permit, or a 327 IAC 15-5 permit, an SWQCP shall be developed and submitted to the Engineer for review.

The Contractor shall furnish, install, inspect, maintain, and remove BMPs for land-disturbing activity areas, and develop an SWQCP in accordance with the Construction Stormwater General Permit or 327 IAC 15-5. The Contractor’s SWQCP shall be a required contract specific component to the Department’s Design SWPPP. The submitted and accepted Contractor’s SWQCP shall interrelate with the Department’s Design SWPPP in order to satisfy the requirements of the Construction Stormwater General Permit, or 327 IAC 15-5.

40

(a) Stormwater Quality Control Plan Development

The Contractor’s SWQCP shall be developed by a professional engineer who holds a current CPESC certification or approved equivalent. The SWQCP developer shall be familiar with the project site and be able to develop the SWQCP in accordance with the site conditions. In the event of conflict between requirements, pollution control laws, rules, or regulations of other Federal, State or local agencies, the Contractor’s SWQCP shall adhere to the more restrictive laws, rules, or regulations. The SWQCP developer shall issue clarifications, correct errors and omissions, and revise the SWQCP as required. The Contractor’s SWQCP shall be signed and sealed by the SWQCP developer, as defined above.

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The Contractor shall develop the SWQCP in accordance with the Construction Stormwater General Permit, 327 IAC 15-5, the IDEM “Indiana Storm Water Quality Manual”, ITM 803, and all other applicable contract documents.

60

(b) Stormwater Quality Control Plan Content

The Contractor’s SWQCP shall include the processes and procedures of how the Contractor intends to meet the requirements outlined in this section and in accordance with ITM 803.

70

The Contractor may elect to prepare and submit the SWQCP in multiple phases. The first phase shall show the location, installation, and maintenance of BMPs for the existing topography of the project and identify the total number of proposed construction phases for the contract. Additional phases shall be submitted for review prior to land-disturbing activities for those phases and shall show the progression from the existing topography to final grade. Each phase of the SWQCP shall be modified to meet existing field conditions as needed.

Any individual phase of the SWQCP shall be submitted to the Engineer for review a minimum of 14 calendar days prior to commencing land-disturbing activities for that phase. Upon receipt, the Engineer will perform a review of the submitted phase of the SWQCP within 14 calendar days for acceptance.

At a minimum, the SWQCP shall include the following:

- 80
1. Description of the site.
 2. Locations of all proposed soil stockpiles.
 3. Locations of all proposed equipment storage areas, fueling locations, construction trailers, batch plants, and designated concrete truck washout areas.
 - 90 4. Proposed construction sequence and phasing of BMPs including plans for installation, inspection, maintenance, and removal of BMPs. The total number of proposed construction phases shall also be specified.
 5. Locations of offsite areas that drain onto project limits. The SWQCP shall include BMPs properly sized and placed to accommodate runoff from outside of the project limits and from within the project limits.
 - 100 6. Locations of all construction entrances where vehicles and equipment will enter and exit the site.
 7. An updated stormwater management budget including a complete list of all proposed BMPs with price calculations based upon the established unit prices or contract prices. If the total proposed budget exceeds the original stormwater management budget pay item, the Contractor shall submit a Change Order Request form, in accordance with 109.05, to provide an explanation and justification for the additional BMPs. Proposed BMPs and costs will be reviewed by the
110 Engineer. If accepted, the changes shall be included into the SWQCP. Additional accepted costs will be included in the contract in accordance with 109.05.
 8. Material handling and spill prevention plan. A plan for the collection, storage, and disposal of concrete washout wastewater shall be in accordance with 205.03(d).
 9. Statements that the BMPs for the project shall, at a minimum,

205.03

120 be inspected each calendar week and by the end of the next work day following every 1/2 in. rain event.

10. Provisions to ensure that pollutants such as fuels, lubricants, asphalt, sewage, wash water, wastewater, or waste from concrete mixing operations, and other harmful materials shall not be discharged into existing bodies of water.

11. Provisions to ensure that all applicable regulations and statutes relating to the prevention and abatement of pollution shall be complied with in the performance of the contract.

130

When Waters of the United States, wetlands, or other protected resources are identified in the plans within or adjacent to the project limits the following shall also be addressed in the SWQCP:

1. The location of protected resource fencing, or protected resource signs. These measures shall be used to provide clear delineation for protected resources that have the potential to be impacted by construction operations.

140

2. A method for conducting work located in or adjacent to bodies of water and protected resources. The method shall indicate how the work in these locations shall be conducted to comply with all conditions of the project permits.

Based on changes in scope, in accordance with 104.02 and 104.03, the Engineer may request a cost breakdown of the stormwater management implementation item.

150 The Contractor's SWQCP shall incorporate all narrative information, plan sheets, and implementation information necessary for stormwater management utilized for the project. The SWQCP shall include any revisions to the Department's Design SWPPP and the plans. The revisions shall comply with all known permit requirements applicable to the construction phase of the project including waterway permits, or a Construction Stormwater General Permit, or a 327 IAC 15-5 permit, and those required by the Contractor in accordance with 107.01 and 205.03(c). Electronic files of any plan sheets and narratives included as part of the SWQCP submittal shall be provided in PDF format.

160 On projects requiring an SWQCP, an updated field copy of the SWQCP shall be retained in the office of the Engineer or at a mutually agreed upon location. Any accepted revisions shall be annotated in the field copy of the SWQCP and initialed and dated by the SWQM and the Engineer.

A copy of the Contractor's offsite operations permits for items such as offsite stockpiles, borrow sites, waste sites, or storage areas shall be submitted to the Engineer

prior to any land-disturbing activities at those sites.

Revisions to the SWQCP shall be submitted and signed and sealed by the SWQCP developer, for items that are hydraulically sized or calculated such as sediment basins or other similar measures. The SWQM may submit revisions for items that are not hydraulically sized or calculated. Adjustments to the BMPs shall be subject to the Engineer's acceptance.

If a governmental agency or a local governmental authority finds a violation of NPDES or other surface waterway permits provided in the contract documents, if any BMPs are incomplete, or the Contractor's SWQCP is incomplete, full responsibility shall be borne by the Contractor to make the necessary corrections. In addition, if an assessment, damage judgment or finding, agreed order, fine, or any other expense for a violation of the contract requirements is leveled against the Department, the Contractor shall reimburse the State for that amount within 30 days. The Contractor agrees to indemnify and hold harmless the Department and will reimburse the Department for any assessments, damage judgments or finding, fine, penalty, or other expense relating to this portion of the contract. The Department may withhold the amount owed from the Contractor's subsequent pay estimates. Delays caused by stop work orders from regulatory agencies, suspension of work orders from the Department, or any other delays caused by inadequate submittals or implementation will be considered Non-Excusable Delays in accordance with 108.08(c).

(c) Stormwater Quality Manager

On contracts requiring an SWQCP, the Contractor shall designate one person as the contract SWQM. The name of the SWQM shall be furnished to the Engineer at, or prior to, the pre-construction conference. If the designated individual is replaced during the contract, the replacement shall be designated, and notification given to the Engineer within 24 h. The designated individual shall be trained as a level 1 or level 2 SWQM as specified within the contract documents. The SWQM training level shall meet or exceed the level required within the contract documents.

1. Level 1 SWQM

A level 1 SWQM shall have successfully completed the Department's Construction Stormwater Training course and hold a current training verification document for that course.

2. Level 2 SWQM

A level 2 SWQM shall meet the requirements of 205.03(c)1, and hold a current certification as a CESSWI, or a CISEC, or a CPESC, or an approved equivalent.

3. SWQM Responsibilities

The SWQM shall attend the pre-disturbance meeting, in accordance with 205.03(d). The SWQM shall attend at least one meeting with the Contractor, relevant Subcontractors, and the Engineer per calendar month in any month in which weekly and post-event inspections are being completed and work is ongoing. The requirement

to attend these meetings may be waived entirely or in part upon written approval from the Engineer.

220 The SWQM shall be responsible for ensuring that the Contractor's SWQCP has been submitted for review prior to implementation. Implementation of stormwater features shall include installation, inspection, maintenance, and removal of all BMPs. The SWQM shall also be in responsible charge of inspecting the implementation of the Contractor's SWQCP or the contract site plan. The SWQM shall be in responsible charge of the weekly and post-event inspections. Anyone performing inspections under the responsible charge of the SWQM shall, at a minimum, meet the training requirements of a level 1 SWQM.

The SWQM shall accompany personnel from IDEM or other regulatory or governmental agencies, as required, during site visits by those agencies.

(d) Pre-Disturbance Meeting

230 On contracts requiring an SWQCP, a pre-disturbance meeting shall be held on-site prior to beginning land-disturbing activities. The meeting invitees shall include the SWQM, the Contractor, the SWQCP Developer, appropriate Department field staff, the District Erosion Control Specialist, District Environmental Section Manager, Ecology and Waterway Permitting Specialist, and all relevant subcontractors for the work being performed. The pre-disturbance meeting shall be held not more than 30 days prior to the start of land-disturbing activities. The following shall be reviewed:

1. Stormwater management implementation including phasing and sequencing.
2. Permit conditions and authorized impacts.
- 240 3. Relevant Unique and Recurring Special Provisions.
4. Relevant commitments.

If requested in writing, pre-disturbance meeting requirements may be waived in part or in full subject to the approval by the Engineer. No land-disturbing activity shall begin until this meeting has occurred or until written approval to waive the meeting has been received.

(e) Temporary BMPs

250 Incoming and outgoing drainage areas impacting a work location shall have temporary BMPs installed as soon as practicable and prior to land-disturbing activities at those locations. Pipe end sections and anchors shall be installed when the structure is installed. If the pipe end sections or anchors cannot be placed at the same time, temporary riprap splashpads shall be placed at the outlets of the pipes until end sections or anchors can be installed.

Adjustments of the BMPs shall be made to satisfy field conditions and shall be subject to the Engineer's approval. Adjustments made to meet field conditions shall be made as soon as practicable, shall be maintained as necessary, and shall be noted
260 in the SWQCP.

The Contractor shall provide a stable construction entrance at the points where construction traffic will enter onto an existing road. Where there is insufficient space for a stable construction entrance, other measures shall be taken to prevent the tracking of sediment onto the pavement. These temporary entrances shall be the responsibility of the Contractor to completely install, inspect, maintain, and remove.

A copy of the current manufacturer's installation and maintenance recommendations shall be provided prior to installation of manufactured BMPs.
270 Shipping, handling, storage, and installation of manufactured BMPs shall be in accordance with the manufacturers' recommendations or as directed. In the event of conflict between the Department's specifications and the manufacturer's recommendations, the Contractor shall adhere to the more restrictive regulation or as directed.

Within the SWQCP, the Contractor shall provide a written plan for the collection, storage, and disposal of concrete wastewater that is adequate for the size of the concrete pour, the environmental conditions of the job site, and in accordance with
280 327 IAC 15-5-7(2) and 327 IAC 15-13-17(2)(F). An emergency concrete washout container shall be available, be part of the material handling and spill prevention plan, and available on-site during concrete pours. Straw bale washout pits will not be allowed. Concrete washout wastewater may either be recycled back into the truck, washed out into an adequately sized and lined roll off container or lined in-ground pit, an approved manufactured product, or taken back to the batch plant. Lining shall consist of a minimum of one sheet of 10 mil plastic, be continuous with no over lapping, and shall be free of leaks.

Concrete washout capacity shall not be exceeded. Concrete wastewater shall not be allowed to leak onto the ground, run into storm drains, or into any body of water.
290 Where concrete wastewater leaks onto the ground, all contaminated soils shall be excavated and disposed of in accordance with 202.08 except that all costs associated with excavation and disposal shall be the responsibility of the Contractor.

The installation of BMPs shall include those necessary or required by permits at off-site locations such as borrow and disposal areas, field office sites, batch plants, locations where the Contractor's vehicles enter and leave public roads, and other locations where work pertaining to the contract is occurring. The Contractor's SWQM shall be responsible for the installation, inspection, maintenance, and removal of these
300 measures.

The Contractor shall employ dust control measures in accordance with 107.08(b).

(f) Posting Requirements

On contracts requiring a Construction Stormwater General Permit, or a 327 IAC 15-5 permit, directions to the updated field copy of the SWQCP, a copy of the NOI, and a copy of the NOS shall be posted and maintained so they are legible and visible at an agreed upon and publicly accessible location for the contract. In lieu of posting the NOI and NOS, an NOI with an IDEM time stamp 48 h prior to the beginning of operations shall also meet the posting requirements. On contracts requiring waterway
 310 permits the Contractor shall follow the posting requirements of those permits.

(g) Inspections

Inspections shall be required on all work areas associated with any waterway permit, a Construction Stormwater General Permit, or a 327 IAC 15-5 permit. This shall include drainage areas within contract limits leading to BMPs, areas of land-disturbance, and areas with impacts or potential impacts to protected resources. For contracts that have multiple work sites, inspections shall only be required for areas operating under a Construction Stormwater General Permit, or 327 IAC 15-5 permit, or a waterway permit.
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On contracts requiring waterway permits and not requiring a Construction Stormwater General Permit or a 327 IAC 15-5 permit, inspections shall be conducted at a minimum of once per calendar week. Inspections for these contracts shall stop once the Engineer has accepted, in writing, that the disturbed areas are permanently stabilized and that all temporary measures have been removed.

On contracts requiring a Construction Stormwater General Permit or 327 IAC 15-5 permit, inspections shall be performed at a minimum of once per calendar week and also by the end of the next work day following every 1/2 in. or greater rain event. A
 330 single inspection performed after a rain event shall satisfy the requirement for both the rain event and the weekly inspection. Inspections for these contracts shall stop once all disturbed areas are permanently stabilized, all temporary measures have been removed, and the NOT has been obtained.

Inspection reports shall be submitted by the SWQM within 24 h of the day of the inspection. The inspection reports shall be documented and submitted electronically using the current version of the Department's stormwater inspection management report which is available on the Department's website. A paper inspection form shall only be used in the event that the electronic inspection form is out of service or as
 340 directed. Inspections shall begin when the installation of BMPs start, when land disturbing activities begin, or if potential impacts to protected resources will occur, whichever is earliest.

On contracts not requiring a Construction Stormwater General Permit or 327 IAC 15-5 permit, and if requested in writing, the Engineer may temporarily waive the requirement to complete weekly inspections during the winter months, or when the prosecution of work is temporarily discontinued, or when the inspection areas are stabilized to minimize the potential for off-site sedimentation.

350 **(h) Permanent BMPs**

Permanent BMPs shall be incorporated into the work at the earliest practicable time.

205.04 Temporary Surface Stabilization

Non-vegetated areas shall be temporarily stabilized if the area remains inactive for more than seven days. The area will be considered inactive when no meaningful work toward accomplishing a pay item has been performed at a site of land-disturbing activity. Stabilization methods shall be in accordance with the SWQCP, or as directed.

360 **(a) Seed**

Temporary seeding shall be placed on disturbed areas that are expected to be inactive for more than seven days, or as agreed to by the Contractor and the Engineer. Seed shall be placed either by drilling in, spraying in a water mixture, or by use of a mechanical method which places the seed in direct contact with the soil. Where inaccessible to mechanical equipment, or where the area to be seeded is small, a hand operated cyclone seeder or other approved equipment may be used. Seed shall not be covered more than 1/2 in. Seed shall be distributed utilizing approved methods which allow for even distribution of the seed. If as a result of a rain event, the prepared seed bed becomes rutted, crusted or eroded, or depressions exist, the soil shall be reworked
370 until it is smooth. Reworked areas shall be re-seeded. All seeded areas shall be mulched within 24 h after seeding.

Temporary seed shall be used for surface stabilization and temporary ground cover. Temporary cover mixtures shall be placed and be subject to seasonal limitations as defined herein. This mixture is not intended to be used as a permanent seed mixture. This mixture shall not be used to satisfy the requirements of the warranty bond. The mix shall be spray mulched where the slope is steeper than 3:1. From June 16 through August 31, mulching alone shall be used to stabilize the soil.

380 **1. Spring Mix**

Spring mix shall be used from January 1 through June 15. This mixture shall be applied at the rate of 150 lb/ac. The mix shall consist of oats.

2. Fall Mix

Fall mix shall be used from September 1 through December 31. This mixture shall be applied at the rate of 150 lb/ac. This mix shall consist of winter wheat.

Unless otherwise specified in the SWQCP or the contract site plan, fertilizer shall be spread uniformly over the area to be seeded and shall be applied at 1/2 the rate
390 shown in 621.05(a). Fertilizer shall only be applied during the active growing season March through November.

(b) Mulch

Mulch shall be applied uniformly in a continuous blanket at the rate of 2.5 t/ac. If

areas are seeded, mulch shall be placed within 24 h after seeding. The percent of moisture in the mulch shall be determined in accordance with 621.14(c). Mulch shall be placed in accordance with one of the following types or as directed.

400 On a slope flatter than 3:1, or where specified, type A shall be used. On a slope of 3:1 or steeper but flatter than 2:1, or where specified, type B or type C may be used. On a slope of 2:1 or steeper, or where specified, a manufactured surface protection product, in accordance with 205.04(c), shall be used.

1. Type A

Mulch shall be punched into the soil so that it is partially covered. The punching operation shall be performed parallel to the contour of the slope. The tools used for punching purposes shall be disks that are notched and have a minimum diameter of 16 in. The disks shall be flat or uncupped. Disks shall be placed a minimum of 8 in. apart. Shaft or axle sections of disks shall not exceed 8 ft in length.

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The disk for punching shall be constructed so that weight may be added or hydraulic force may be used to push puncher into the ground. An even distribution of mulch shall be incorporated into the soil.

2. Type B

The mulch shall be held in place by means of commercially produced water borne mulch binder product. The product shall be manufactured and used in accordance with all applicable State and Federal regulations and shall be applied in accordance with the manufacturer's written instructions. A copy of the written instructions shall be supplied to the Engineer prior to the seeding work. The product shall include a coverage indicator to facilitate visual inspection for evenness of application. If the mulch fails to stay in place, the Contractor shall repair all damaged areas.

420

3. Type C

The mulch shall be held in place with a polymeric plastic net. The plastic net shall be unrolled such that it lays out flat, evenly, and smoothly, without stretching the material. The plastic net shall be held in place by means of staples. The staples shall be driven at a 90° angle to the plane of the soil slope. Staples shall be spaced not more than 4 ft apart with rows alternately spaced. The plastic net shall be secured along the top and bottom of the soil slope with staples spaced not more than 1 ft on center. The ends and edges of the plastic net shall be overlapped approximately 4 in. and stapled. Overlaps running parallel to the slope shall be stapled 1 ft on center and overlaps running perpendicular to the slope shall be stapled at least 3 ft on center. The plastic net shall be placed with the length running from top of slope to toe of slope, or the plastic net shall be placed with the length running horizontally or parallel to the contour.

430

(c) Manufactured Surface Protection Products

440 Prior to placing a manufactured surface protection product, the area to be covered shall be free of all rocks or clods of over 1 1/2 in. in diameter, and all sticks or other

foreign material, which prevent the close contact of the blanket with the seed bed.

After the area has been properly shaped, fertilized, and seeded, the manufactured surface protection product shall be laid out flat, evenly, and smoothly, without stretching the material.

Manufactured surface protection products may be used for covering an area that has not been seeded. Soil cover shall not be used to cover seeded areas.

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1. Excelsior Blanket

An excelsior blanket may be used as mulch for seeding where seeding is specified or where erosion control blanket is specified. Excelsior blankets shall be placed within 24 h after seeding operations have been completed. Excelsior blankets shall be installed in accordance with the manufacturer's recommendations.

2. Straw Blanket

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A straw blanket may be used as mulch for seeding where mulched seeding is specified or where erosion control blanket is specified. Straw blankets shall be placed within 24 h after seeding. The straw blanket shall be unrolled over the designated area so that the plastic mesh is on top and the straw fibers are snugly and uniformly in contact with the soil surface. The rolls shall be butted together and stapled in place. The staples shall be driven through the blanket at a 90° angle to the plane of the ground surface. Each staple shall anchor the plastic mesh. The staples shall be spaced in accordance with the manufacturer's recommendations.

For placement on a slope, the straw blankets shall be placed with the length running from the top of slope to the toe of slope and shall extend a minimum of 3 ft over the crown of the slope. The blanket shall be stapled in accordance with the manufacturer's recommendations.

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For placement in ditch lines, the straw blanket shall be unrolled parallel to the centerline of the ditch. The blanket shall be placed so that there are no longitudinal seams within 24 in. of the bottom centerline of the ditch. In a ditch line, the blanket shall be stapled in accordance with the manufacturer's recommendations with a minimum of six staples across the upstream end of each roll.

3. Rolled Erosion Control Products

The Contractor shall use degradable RECPs including netting, open weave textile, and erosion control blankets.

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Seed shall be applied in accordance with 621 unless soil infilling is required.

If soil infilling is required, RECP shall be first installed and then seed applied and brushed or raked 1/4 to 3/4 in. of topsoil into voids in the RECP filling the full product thickness. Staples of at least 6 in. in length shall be used to secure the RECP. The RECP shall be unrolled parallel to the primary direction of flow and placed in direct

contact with the soil surface. The RECP shall not bridge over surface inconsistencies. Edges of adjacent RECP shall be overlapped by 2 to 4 in. Staples shall be placed to prevent seam separation in accordance with the manufacturer's recommendations.

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4. Geotextile

Disturbed soil shall be covered with geotextile. The covering shall be placed over the exposed soil in a shingle like fashion with a 2 ft minimum overlap covering all loose or disturbed soil. The geotextile, if new, shall be in accordance with 918.02. The geotextile used for soil covering need not be new but shall not have holes or unrepaired rips or tears. All repairs shall be made in accordance with the manufacturer's recommendation.

205.05 Concentrated Flow Protection

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(a) Check Dam

Check dams and modified check dams shall be constructed as shown on the plans. Geotextile for check dams shall be in accordance with 616 unless otherwise specified. Temporary revetment riprap shall be in accordance with 616. No. 5 and No. 8 filter stone shall be in accordance with 904.

(b) Check Dam, Traversable

Traversable check dams shall be composed of 8 in. minimum diameter socks filled with straw, ground wood chips, shredded bark, or other approved material for site specific conditions. Rolls and socks may be stacked in a triangle pattern as shown on the plans. Check dams shall be staked as shown on the plans or as specified by the manufacturer.

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(c) Diversion Interceptors

Grading for diversion interceptors shall be in accordance with 203 with the exception that compaction requirements will not apply. The Contractor shall identify the construction areas which shall utilize diversion type A or B. Slope drains shall be provided at the low points of the diversion interceptor. Perimeter diversion, type C shall be installed prior to earth moving activities and shall be immediately stabilized.

520 Type A or B shall be stabilized if anticipated to be left in place for more than seven calendar days.

(d) Sediment Traps

Sediment traps shall be constructed with revetment riprap, filter stone and geotextile.

(e) Sediment Basins

Embankment construction shall be in accordance with 203. Temporary revetment riprap used for overflow protection shall be in accordance with 904, unless otherwise specified in the SWQCP. Sediment basins shall be constructed as shown on the plans, or as specified in the SWQCP. Sediment basins shall be designed to provide a minimum storage volume to contain the runoff from a 10 year 24 h storm event. When

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required, water shall be withdrawn from the top of the water column. Basin slopes shall be stabilized upon achieving design grades. Outfalls shall be stabilized within 24 h of installation of the basin outlet.

(f) Slope Drains

Slope drain pipes shall be lengthened as required due to the construction of the embankment.

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(g) Vegetative Filter Strips

Designated vegetative filter strips shall not be disturbed. Rills that form shall be repaired. Fertilizer shall be applied as specified in the SWQCP.

(h) Splashpads

Splashpads shall be constructed using revetment riprap on geotextile, or other approved material for site specific conditions and shall be sized to prevent erosion or scour.

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(i) Inlet Protection

All inlets shall have sediment control measures installed when the drainage area contributing to the inlet is affected by land-disturbing activity, adjacent to hauling operations, adjacent to disturbed areas, or as directed. A copy of the current manufacturer's installation and maintenance recommendations shall be provided prior to installation of manufactured inlet protection in accordance with 205.03(e). All inlet protection devices shall provide a means of emergency overflow. Geotextile wrapped under or over a grate shall not be used.

205.06 Perimeter and Resource Protection

560

(a) Silt Fence

Shipping, handling and storage shall be in accordance with the manufacturer's recommendations. Silt fence material shall be in accordance with 918.02(d). The silt fence material will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, storage, or installation. Each roll shall be labeled or tagged to provide product identification.

Joints shall be made from the ends of each section of fence wrapped around a wood stake and joined together or other method recommended by the manufacturer.

570 Copies of all current manufacturer manuals shall be provided prior to installation. Silt fence shall not be used in conveyance channels, areas prone to flooding, or areas of concentrated flow.

(b) Filter Sock

Filter sock shall be designed for filtration or diversion depending on its intended use. Filter sock shall be installed, secured and overlapped in accordance with the standard drawings. The manufacturer's specifications for installation may be substituted with the approval of the Engineer. Filter sock shall be in accordance with 914.09 (h).

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(c) Filter Berm

Filter berms shall be constructed of filter sock, or a combination of riprap or No. 5 and No. 8 filter stone.

(d) Protected Resource Fence

Protected resource fence shall be a commercially available material marketed as snow fencing, have a minimum height of 4 ft and be made of high density polyethylene. All protected resource fence shall be orange in color. Protected resource fence shall be installed using T-posts spaced no more than 10 ft apart and secured with plastic fence ties. Pull posts and corner posts will not be required. T-posts shall be buried to 1/3 of their height.

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(e) Protected Resource Signs

Within areas prone to flooding, or concentrated flow “Do Not Disturb” signs in accordance with 622.20 may be accepted in lieu of fencing, if requested and accepted in writing prior to installation. If “Do Not Disturb” signs are used in lieu of fencing, they shall be spaced at a distance of 25 ft apart to delineate the entire length of concern. At a minimum, two signs shall be used.

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205.07 Maintenance

BMPs shall be inspected in accordance with 205.03(g). If conditions do not allow the Contractor access to the location of the BMPs using normal equipment and maintenance, the Contractor shall submit to the Engineer an acceptable written alternate schedule, within 48 h, to bring the BMPs back into compliance.

(a) Filter Sock

Accumulated sediment shall be removed once it reaches 1/2 of the height of the filter sock when used for perimeter protection and 1/3 the height when used for inlet protection. The filter sock shall be inspected to ensure that it is holding its shape and allowing adequate flow. Eroded and damaged areas shall be repaired.

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(b) Silt Fence

If the fence fabric tears, starts to decompose, or becomes ineffective, the affected portion shall be replaced. Deposited sediment shall be removed once it reaches 1/3 the height of the fence at its lowest point. Once the contributing drainage area has been stabilized, the Contractor shall remove the fence and sediment deposits, grade the site to blend with the surrounding area, and stabilize the graded area.

(c) Filter Berm

Accumulated sediment shall be removed once it reaches 1/4 of the height of the filter berm. The filter berm shall be inspected to ensure that it is holding its shape and allowing adequate flow. Eroded and damaged areas shall be repaired.

620

(d) Inlet Protection

Accumulated sediment shall be removed once identified and after each storm

event. Flushing with water will not be allowed. The sediment shall not be allowed to re-enter the paved area or storm drains. Manufactured inlet protection shall be maintained in accordance with the manufacturer's recommendations.

630 **(e) Check Dams**

Sediment shall be removed once it reaches 1/2 the height of the check dam. Sediment shall be removed and disposed of in accordance with 201.03 and 203.08. The Contractor shall rebuild or repair each damaged check dam to maintain the design height, cross section, and control function.

(f) Sediment Traps

640 Following each rain event, the Contractor shall repair slope erosion and piping holes as required. Sediment shall be removed once it has accumulated to 1/2 design volume. The Contractor shall replace the coarse aggregate filter stone if the sediment pool does not drain within 72 h following a rain event.

(g) Sediment Basin

Sediment shall be removed once it has accumulated to 1/2 the design volume. The filter stone around the riser pipe shall be replaced if the sediment pool does not drain within 72 h following a rain event.

(h) Concrete Washout

650 The containment system shall be inspected for leaks, spills, and tears, and shall be repaired or replaced as necessary. The Contractor shall ensure that each containment system maintains adequate capacity. Solidified waste concrete shall be disposed of in accordance with 202.

(i) Protected Resource Fence

Protected resource fence shall be maintained in an upright position with no tears or missing sections.

(j) Protected Resource Signs

660 Protected resource signs and posts shall be maintained in an upright and legible condition.

205.08 Stormwater BMP Deficiencies

If the Engineer documents deficient BMPs at any time during a contract, including the time during seasonal suspension, written notification of the deficiency will be provided to the Contractor.

(a) Emergency Deficiencies

Emergency deficiencies shall include:

- 670 1. Discharge of wastewater into a drainage structure, jurisdictional waterway, or similar environmental resource.

2. Failure to comply with the conditions and commitments of the contract waterway permits and regulations.
3. Beginning land-disturbing activities without the Engineer's acceptance of a submitted SWQCP or prior to the pre-disturbance meeting, if not waived by written permission.

680 Corrective actions for emergency deficiencies shall be completed no later than 24 h after notification, including weekends or holidays.

(b) General Deficiencies

General deficiencies shall include:

1. Failure to install, construct, or maintain BMPs as shown on the plans or the accepted SWQCP.
2. Failure to perform a site inspection as required by 205.03(g).
- 690 3. Deficiencies as listed in 205.08(c).

Corrective actions for general deficiencies shall be completed within 48 h of notification or as directed.

For unresolved emergency or general deficiencies, the Engineer may suspend work on the contract except for that work necessary to correct the deficiencies, for traffic maintenance, and for the protection of life and property until the deficiencies are corrected. Delays caused by these deficiencies will be considered non-excusable delays in accordance with 108.08(c).

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(c) Quality Adjustments

If emergency deficiencies are not remedied within 24 h after written notification, or within 48 h after written notification for general deficiencies, the Contractor may be assessed quality adjustments. When an alternate schedule is accepted by the Engineer, in accordance with 205.07, and that schedule is not met, the Contractor may be assessed quality adjustments.

710 In accordance with 109, the Contractor may be assessed quality adjustments of \$200 for each deficiency per calendar day, or part thereof, that the deficiency remains uncorrected after the initial notification period. No quality adjustments will accrue without prior written notification from the Engineer of the deficiency.

Permit postings will be considered deficient and subject to quality adjustments if they do not meet the requirements of the permitting agency or the requirements listed in 205.03(f).

Each contiguous 100 ft section, or portion thereof, of silt fence will be considered

720 deficient and subject to quality adjustments if the fence material has a cut or tear exceeding 1 ft in length, or a seam has separated, or the retained sediment exceeds 1/2 of the height of the fence, or the fence is not installed as shown on the standard drawings.

Each contiguous 50 ft section, or portion thereof, of filter sock will be considered deficient and subject to quality adjustments if it is not installed and maintained in accordance with the standard drawings and the manufacturer's recommendations.

730 Each check dam, sediment basin, or sediment trap will be considered deficient and subject to quality adjustments if stormwater circumvents the measure, or the retained sediment exceeds 1/2 of the design volume, or they are not installed in accordance with the accepted SWQCP, as shown on the plans, or the contract site plan.

Inlet protection devices will be considered deficient and subject to quality adjustments if stormwater circumvents the measure, or they are not installed and maintained in accordance with the manufacturer's recommendations, or they do not provide a means of emergency overflow lower than the adjacent roadway, or the accumulated sediment exceeds 1/2 of the capacity of the device.

740 Manufactured BMPs will be considered deficient and subject to quality adjustments if stormwater circumvents the measure, or they are not installed and maintained in accordance with the manufacturer's recommendations.

Other BMPs will be considered deficient and subject to quality adjustments if they are not installed in accordance with the accepted SWQCP, as shown on the plans, the contract site plan, or they are not maintained adequately to perform their intended function.

750 For any specific deficiency, quality adjustments will cease accruing when that specific deficiency is corrected. Site inspection quality adjustments will cease accruing when the next acceptable inspection is performed.

205.09 Removal

BMPs shall be removed as soon as an area becomes stable. All BMPs shall be removed prior to application for the NOT. The Contractor shall remove and dispose of all excess silt accumulations, dress the area, and reestablish vegetation to all bare areas in accordance with the contract requirements. Use or disposal of the BMPs shall be as specified in the SWQCP.

205.10 Method of Measurement

760 Temporary silt fence and traversable check dams will be measured by the linear foot.

Protected resource fence will be measured by the linear foot, installed and removed. Measurement will be made along the top of the fence from outside to outside

205.10

of end posts for each continuous run of fence.

Protected resource signs, temporary sediment basins, standard metal end sections, and temporary inlet protection will be measured by the number of complete units installed.

770 Temporary revetment riprap check dams, temporary revetment riprap, temporary sediment traps, splashpads, temporary filter stone, temporary mulch, No. 2 stone for stable construction entrances, and fertilizer will be measured by the ton.

Temporary mulch stabilization, manufactured surface protection products, and temporary geotextile will be measured by the square yard.

Temporary seeding will be measured by the pound.

Removal of sediment will be measured by the cubic yard.

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Temporary slope drains will be measured by the linear foot. Measurement will be made for the maximum footage in place at one time, per drain location regardless of the number of times the material is moved.

Temporary filter berms and filter sock will be measured by the linear foot complete in place. Overlapping sections of filter sock will not be measured for payment.

790 Revetment riprap and filter stone used in sediment basins will be measured by the ton.

Excavation for detention ponds, temporary sediment traps and temporary sediment basins will be measured as common excavation in accordance with 203.27.

Diversion interceptors type A and B, and interceptor ditches will not be measured for payment. Diversion interceptors type C will be measured by the linear foot.

Mobilization and demobilization for surface stabilization will be measured by each trip as provided in the submitted and accepted SWQCP.

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Weekly inspections will be measured by the number of specified weekly inspections conducted after the original contract completion date.

SWQCP preparation and stormwater management implementation will not be measured for payment.

BMPs used at the off-site locations in accordance with 205.03 and concrete washouts will not be measured for payment.

810 **205.11 Basis of Payment**

The accepted quantities of diversion interceptors type C, protected resource fence, silt fence, and traversable check dams will be paid for at the established unit price per linear foot.

Protected resource signs, temporary sediment basins, standard metal end sections, and temporary inlet protection will be paid for at the established unit price per each unit installed.

820 Temporary revetment riprap check dams, temporary revetment riprap, temporary sediment traps, splashpads, temporary filter stone, temporary mulch, No. 2 stone for stable construction entrances, and fertilizer will be paid for at the established unit price per ton.

Temporary mulch stabilization, manufactured surface protection products, and temporary geotextile will be paid for at the established unit price per square yard.

Temporary seeding will be paid for at the established unit price per pound.

830 Removal of sediment will be paid for at the established unit price per cubic yard.

Temporary slope drains, temporary filter berms, and filter sock will be paid for at the established unit price per linear foot. No additional payment will be made for any required overlapping sections of filter sock.

Revetment riprap and filter stone used in sediment basins will be paid for at the established unit price per ton.

840 The accepted quantities of excavation for detention ponds, temporary sediment traps, and temporary sediment basins will be paid for as common excavation in accordance with 203.28.

Mobilization and demobilization for surface stabilization will be paid for at the established unit price per each and will be made for the initial movement to the project site, and for each occurrence as specified in the submitted and accepted SWQCP, or as directed.

850 Weekly inspections will be paid for at the established unit price per each for inspections conducted after the original contract completion date. No payment will be made for inspections during the time when liquidated damages, in accordance 108.09, are assessed.

The Department will include the pay item Stormwater Management Budget, with an established dollar amount, in the proposal to pay for BMP work. This established amount is the Department's estimate of the total cost of the BMP work required to be performed for the contract. The established amount shown in the proposal is included

in the total bid amount. The Department will pay for those items installed and listed with established prices for the quantities installed as specified in the submitted and accepted SWQCP. If the BMP work exceeds the Department's estimated amount, the additional BMPs shall be explained and submitted as a revision to the SWQCP. The additional work will be reviewed for acceptance in accordance with 104.03 except that the additional BMP work will be paid for at the pre-determined established prices shown.

The Department will pay to replace BMPs that have failed due to differing site conditions or significant changes in the character of work in accordance with 104.02, if those BMPs have been installed and maintained in accordance with the accepted SWQCP, as shown on the plans, or the contract site plan.

The Department will pay to replace BMPs that have failed after exceeding the lifespan of the BMP, as specified in the manufacturer's guidelines, if those BMPs were installed and maintained in accordance with the accepted SWQCP, as shown on the plans, or the contract site plan. Payment will be at the established prices shown in 205.11 and may occur no more than once per year.

The item SWQCP Preparation will be paid for based on the highest total number of construction phases for the contract. The highest total number of phases will be based on either the number of phases established within the original contract documents or the number of phases proposed in the SWQCP. The initial submitted and accepted SWQCP shall list the number of construction phases. Payments on the item will be made after a SWQCP phase has been reviewed and accepted. The payment of the SWQCP Preparation lump sum item will be calculated as follows:

$$\text{SWQCP payment} = P_{SA}/P_t$$

where:

P_{sa} = Total number of submitted and accepted phases of the SWQCP.

P_t = Total number of construction phases established for the contract.

After the contract site plan or the initial phase of the SWQCP has been submitted and accepted, 25% of the Stormwater Management Implementation contract bid price will be paid. The balance will be paid as the plan is implemented over the life of the contract. Stormwater Management Implementation shall include any costs beyond the established prices associated with the inspection, installation, maintenance, and removal including mobilization and demobilization of all temporary BMPs.

Items shown with an established price will be paid for at the prices shown. If any of the following items are shown in the schedule of pay items, the bid item and price will prevail over the established prices shown.

Payment will be made under:

	Pay Item	Pay Unit Symbol	Price Established
	Diversion Interceptor Type C	LFT	\$22.50
	Fertilizer	TON	\$775.00
	Filter Sock	LFT	\$5.50
	Manufactured Surface Protection Product.....	SYS	\$1.35
	Mobilization and Demobilization for Surface Stabilization	EACH	\$700.00
910	No. 2 Stone.....	TON.....	\$30.00
	Protected Resource Fence.....	LFT	\$2.00
	Protected Resource Sign.....	EACH	\$80.00
	Sediment, Remove.....	CYS.....	\$22.00
	Splashpad	TON	\$60.00
	Standard Metal End Section	EACH	\$365.00
	Stormwater Management Budget	DOL	
	Stormwater Management Implementation	LS	
	SWQCP Preparation.....	LS	
	Temporary Check Dam, Revetment Riprap	TON	\$65.00
920	Temporary Check Dam, Traversable.....	LFT	\$16.00
	Temporary Filter Berm.....	LFT	\$16.00
	Temporary Filter Stone.....	TON.....	\$45.00
	Temporary Geotextile.....	SYS	\$2.75
	Temporary Inlet Protection.....	EACH	\$110.00
	Temporary Mulch Stabilization.....	SYS	\$0.30
	Temporary Mulch.....	TON	\$425.00
	Temporary Revetment Riprap	TON	\$60.00
	Temporary Sediment Basin	EACH	\$3,200.00
	Temporary Sediment Trap.....	TON	\$42.50
930	Temporary Seed	LBS	\$2.75
	Temporary Silt Fence	LFT	\$2.15
	Temporary Slope Drain	LFT	\$21.50
	Weekly Inspection.....	EACH	\$425.00

The cost for revisions or amendments to permits required due to the Contractor's means and methods shall be included in the cost of SWQCP Preparation.

The cost for any future revisions to the SWQCP due to the Contractor's means and methods shall be included in the cost of SWQCP Preparation.

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The costs for trenching, backfilling, posts, fencing, and all necessary incidentals shall be included in the cost of temporary silt fence.

The costs for protected resource fence shall include all materials, placement, removal, maintenance, and all necessary incidentals.

205.11

The costs for protected resource signs shall include all materials, placement, removal, maintenance, and all necessary incidentals.

950 The cost for stakes, trenching, backfilling, posts, and all necessary incidentals shall be included in the cost of temporary check dams, traversable.

The payment for temporary sediment basin shall include all costs involved with construction of the basin except for excavation, revetment riprap, and filter stone.

The payment for temporary sediment trap shall include all costs involved with construction of the trap except for excavation.

960 Temporary entrances utilized by the Contractor for borrow and waste areas will not be paid for directly.

The costs for diversion interceptor types A and B and interceptor ditches shall be included in the cost of other earth moving items.

The cost for anchors and all incidentals necessary to perform the work shall be included in the cost of temporary slope drains.

970 The costs of materials, installation, inspection, maintenance, and removal of BMPs at off-site locations designated in 205.03 will not be measured for payment.

The payment for BMPs specified herein shall include materials, installation, maintenance, removal and proper disposal.

The costs associated with sediment removal due to BMP maintenance shall be included in the cost of sediment removal.

The costs associated with the replacement of temporary filter stone due to BMP maintenance will be paid for as temporary filter stone.

980 The costs of constructing, maintaining, and removal of the construction entrance, other than those constructed by the Contractor for borrow and waste sites, shall be included in No. 2 stone. No direct payment will be made for construction entrances for borrow and waste sites.

The costs associated with concrete washout will not be paid for directly but shall be included in the costs of other concrete pay items.

990 All costs associated with the weekly and post-event inspections, including inspections required by regulatory agencies, and all other inspections conducted prior to the original contract completion date, shall be included in the cost of Stormwater Management Implementation.

SECTION 206 – STRUCTURE EXCAVATION

206.01 Description

This work shall consist of the excavation and backfill or disposal of all materials required for the construction of foundations for substructures of bridges, culverts, and retaining walls. It shall also consist of the furnishing and subsequent removal of all necessary materials and equipment for and the construction of cribs, cofferdams, caissons, and similar items, together with their dewatering. The work shall be in accordance with 105.03.

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All excavation for structures below the designed slope or subgrade line as shown on the plans shall be included under this item.

Unless otherwise specified, structure excavation shall include all pumping, bailing, draining, sheeting, bracing, and incidentals required for proper execution of the work.

206.02 Class X Excavation

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(a) General Excavation

If one or more of the following materials is encountered within the limits of foundation excavating, such shall be defined as class X excavation.

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1. solid rock, hard ledge rock, slate, hard shale, or conglomerate, any of which is actually removed by blasting or use of pneumatic or equivalent tools and which could not reasonably be removed by any other method;
2. loose stones or boulders more than 1/2 cu yd in volume;
3. concrete, masonry, or other similar materials which are parts of an old structure not shown on the plans;
4. timber grillages, old foundation piling, buried logs, stumps, or similar materials which extend beyond the limits of excavation so that they must be cut off. Such obstructions shall be removed back to cofferdam limits and the portions so removed within cofferdam limits will be considered as class X.

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Material commonly known as hardpan will not be considered as class X. If material is encountered during excavation which seems to be in accordance with that defined herein as class X, notification shall be made in writing, and ample time shall be allowed to make necessary investigations and measurements to determine the class and volume of the material in question.

(b) Excavation for Foundation of Traffic Support Structures

If class X material as defined in 206.02(a) is encountered within the limits of foundation excavation for traffic support structures, overhead sign structure foundations, strain pole, or high mast lighting foundations, the foundation shall be
50 located as directed.

If class X material in accordance with 206.02(a)1 is encountered at foundations for overhead sign structures, strain poles, signal cantilever structures, high mast lighting poles, and ITS towers, the material shall be excavated to allow the foundation to be embedded as shown on the plans or as directed.

If class X material in accordance with 206.02(a)1 is encountered at foundations for wide flange sign supports, signal pedestals, conventional light poles, the material shall be excavated to allow the foundation to be embedded a distance that is equal to
60 1/2 of the remaining depth of the foundation before the material was encountered or to a minimum 3 ft depth, whichever is greater.

If class X material in accordance with 206.02(a)2, 206.02(a)3, or 206.02(a)4 is encountered, the material shall be removed to the total depth of the foundation as shown on the plans.

206.03 Wet Excavation

Wet excavation shall be defined as that portion of foundation excavation, except class X, which is below a horizontal plane designated on the plans as the upper limit
70 of wet excavation and above the bottom of the footing as shown on the plans. If wet excavation is a pay quantity and the elevation of the upper limit of wet excavation is not shown on the plans, an elevation of 1 ft above the elevation of low water level as shown on the plans shall be used as such limit.

206.04 Dry Excavation

Dry excavation shall be defined as that portion of foundation excavation, except class X, which is above the upper limit of wet excavation.

206.05 Foundation Excavation, Unclassified

80 If the Schedule of Pay Items provides a pay quantity of foundation excavation, unclassified, and none for wet excavation or dry excavation, then foundation excavation, unclassified shall include all work described as wet excavation and dry excavation, regardless of whether or not water is encountered, but shall not include class X. Even though designated herein as foundation excavation, unclassified, it shall be regarded in these specifications as a class of excavation.

If no upper limit of foundation excavation, unclassified is shown on the plans, it shall be at the original ground except where waterway excavation, common excavation, or other classified excavation overlaps the area of foundation excavation
90 and is a pay item. The upper limit of foundation excavation, unclassified shall be the lower limit of the overlapping classified material.

CONSTRUCTION REQUIREMENTS

206.06 General Requirements

The drainage requirements of 203.14 shall apply to excavation for structures and, in addition, adequate outlets shall be provided as shown on the plans or as directed, if within the limits of the excavation.

- 100 All excavation shall be adequately shored to avoid damage to the structure, its approaches, adjacent roadway, embankments, tracks, buildings, or other property.

Footing excavation shall, in general, conform with the outlines of footings as shown on the plans, or as revised, and shall be of sufficient size to enable construction of the footings to their full required dimensions. If an existing structure is being extended, the old footings shall be adequately protected. Boulders, logs, or other unforeseen obstacles encountered shall be removed.

- 110 The elevations of bottoms of footings as shown on the plans shall be considered approximate. The final elevations shall depend on conditions encountered during excavation, at which time other elevations may be ordered in writing if necessary to secure satisfactory foundations.

Where existing foundation material would not support the contemplated load safely, the plans may require, or it may be directed that foundation piles be driven in the footing area. This piling shall be furnished, driven, and paid for in accordance with 701.

206.07 Disposal of Excavated Material

- 120 Except as otherwise herein provided, material excavated for a structure or its approaches, including any material excavated beyond the pay limits of foundation excavation or its specified or approved extensions, shall, if suitable, be used for filling around the new structure, for spandrel filling, approach embankment, regular embankment, or for any combination of these, all as specified or directed.

If excavated material, in accordance with 211.02, is required at the structure or in its approaches, then this material shall be used as special fill and placed in accordance with the applicable provisions of 211.

- 130 Surplus or unsuitable material shall not be disposed of in any manner that would obstruct or pollute the stream or otherwise impair the efficiency or appearance of the structure. If there are piers in the water, permission may be granted to waste excavated material adjacent to these piers provided such waste does not obstruct the waterway. If usable excavated material is wasted without authority, the quantity so wasted will be deducted from the quantities of common excavation, borrow, or B borrow, depending on the nature of the waste and its use.

Disposal of surplus or unsuitable material, including class X excavation, outside the right-of-way shall be in accordance with 201.03 and 203.08.

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206.08 Preparation of Foundation Surfaces

Excavation for foundations on rock without piles shall extend a minimum of 2 ft into solid rock. All rock or other hard material, if to be left in place as a foundation surface, shall be freed of loose material, cleaned, and cut to a firm surface. The final surface shall be level, stepped, or serrated as directed. Seams shall be cleaned and filled with concrete, cement mortar, or grout. These conditions shall prevail when the foundation masonry is placed.

150 Where the masonry is to rest on a foundation surface other than those described above, the approximate bottom of the excavation shall not be disturbed. The final removal of material to the required grade shall be done carefully just prior to placing the foundation masonry. The final surface shall be left smooth and, unless otherwise designated, be level.

Notification shall be given after final excavation of each foundation is completed. No masonry shall be placed until the depth of the excavation and the character of the foundation material have been approved.

160 Rock at the bottom of spread footings shall be proof-tested. For state-administered contracts, the Department's Geotechnical Engineering Division shall be contacted prior to proof-testing. For local public agency contracts, the Engineer shall be contacted prior to proof-testing. Proof-testing with a small diameter test hole of a minimum 2 in. inside diameter shall be drilled into the foundation base using rotary or percussive drilling methods. Holes shall be drilled into sound rock to a depth of 5 ft or as directed. Three holes shall be drilled into each foundation base. Observations shall be made at each hole as follows:

1. speed of drilling
- 170 2. drill pressure
3. dropping or clogging of drill bit
4. loss of drill water, if used
5. probing of the sides of the holes with a right angled chisel point.
The chisel shall be formed from a rod of 3/8 or 1/2 in. diameter
6. continuity of bearing material
- 180 7. rock quality designation in accordance with ASTM D6032
8. photos shall be taken of the rock core and the sidewall of the borehole from which core has been extracted.

A professional engineer shall supervise the proof testing work. A report for each hole shall be prepared and submitted to the Engineer for review and approval.

206.09 Cofferdams and Temporary Construction Dikes

190 Working drawings shall be submitted in accordance with 105.02. They shall show the proposed method of cofferdam construction and other details left open to choice or not fully shown on the plans.

Working drawings for dikes to be used in lieu of cofferdams or to be used for access to the work shall be submitted in accordance with 105.02, if such dikes are to be constructed within the waterway. Approval of such drawings will only be given if the probability of stream pollution and stream flow restriction is minimal.

200 Cofferdams shall be constructed for all abutments and piers where water or unstable soil is encountered or where the soil may become unstable; excessive stream pollution or stream flow restriction might occur with other construction procedures; or if necessary to support the sides of excavated areas, embankment, adjacent buildings, tracks, or other premises. In general, they shall be carried down well below bottoms of footings, shall be well braced, and as nearly watertight as practicable. The interior dimensions shall be sufficient to provide ample clearance to enable pile driving, the construction of forms, and clearance for pumping equipment outside the forms. Cofferdams shall be constructed to protect plastic concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion.

210 No timber or bracing that would extend into substructure masonry shall be left in cofferdams except with written permission.

Cofferdams which become tilted or moved laterally during the process of sinking shall be righted or enlarged to provide ample clearance. Any necessary correction shall be made with no additional payment.

Except as otherwise provided herein, cofferdams shall be dewatered and sediment controlled in accordance with 108.04. Pumping will not be allowed for 24 h after concrete placement, unless otherwise approved.

220 When conditions are encountered under which it is established that no reasonable pumping will dewater the cofferdam when every practicable effort has been made to reduce the inflow of water, or other conditions are such that a foundation seal is necessary, the construction of a concrete foundation seal may be required of such dimensions as necessary. This seal shall be constructed in accordance with 702.20(f).

230 Unless otherwise specified, all cofferdam bracing shall be removed and all sheeting removed or cut off at least 2 ft below the finished ground line, except within the low-water channel it may either be removed or cut off even with the stream bed. Removal shall be such that the finished masonry will not be marred or disturbed.

206.10 Method of Measurement

Structure excavation, except wet excavation, will be measured in cubic yards in its original position below the limits of roadway excavation. Wet excavation will be the theoretical quantity in accordance with 206.11(b). When structures are to be placed in embankment sections, the natural ground line, as cross sectioned, will be the uppermost level of computation unless otherwise specified or shown on the plans.

240 Class X material encountered and removed during the excavation of foundations for traffic support structures will be measured to the foundation neat lines as shown on the plans below the surface of class X material.

If the pay unit for any item of excavation in the Schedule of Pay Items is lump sum, no measurement will be made.

Extended excavation for footings will be measured to include the entire depth needed for the deeper footing and the entire width needed to comply with OSHA or IOSHA requirements.

206.11 Basis of Payment

250 The accepted quantities of structure excavation will be paid for at the contract unit price per cubic yard or lump sum.

Unless otherwise provided, excavation for bridges will be paid for at the contract unit price or prices per cubic yard for the respective class or classes involved.

If cofferdams are specified as a pay item, they will be paid for at the contract lump sum price for cofferdams.

260 If a foundation seal is constructed, it will be paid for in accordance with 702.28.

The quantity of class X excavation to be paid for will be the cubic yards of such material actually removed from within vertical planes defining the neat lines of the footings, except where material classified as class X excavation overlays other material which shall be excavated to cofferdam limits. Such overlying strata will be paid for to the limits of the material excavated beneath it. Unless otherwise provided, no additional payment will be made for such excavation made outside these limits.

270 If class X excavation is encountered and there is no contract unit price for class X excavation, payment will be made at a unit price per cubic yard as follows:

1. \$1,000.00 per cu yd if the quantity of class X excavation is less than or equal to 1 cu yd per foundation.
2. When the quantity of class X excavation is greater than 1 cu yd per foundation, payment will be made at \$1,000.00 per cu yd for the quantity up to 1 cu yd. The quantity in excess of 1 cu yd, payment will be made at \$125.00 per cu yd.

280 Except as otherwise provided, the quantity of dry excavation to be paid for will be the amount of such excavation actually removed from its original position within vertical planes which are 18 in. outside the neat lines of the footings and parallel thereto. Regardless of the quantity actually removed, the quantity of wet excavation to be paid for will be the theoretical volume bounded by the bottom of the footings, the upper limit of wet excavation, and vertical planes which are 18 in. outside the neat lines of footings and parallel thereto. Additional payment will not be made for such excavation outside these limits.

290 Where it is necessary to carry a footing or a portion of a footing deeper than its elevation shown on the plans, such additional excavation, except a portion thereof classified as class X which is carried down to a plane which is 4 ft below the bottom of footing as shown on the plans, will be paid for as extended dry excavation, extended wet excavation, or extended foundation excavation unclassified, at a price to be determined by multiplying the contract unit price for dry excavation, wet excavation, or foundation excavation, unclassified, respectively by the factors shown below.

1. For footings or portions thereof lowered not more than 1 ft, the factor will be 2.0.
- 300 2. For footings or portions thereof lowered more than 1 ft and not more than 2 ft, the factor will be 2.5.
3. For footings or portions thereof lowered more than 2 ft and not more than 3 ft, the factor will be 3.5.
4. For footings or portions thereof lowered more than 3 ft and not more than 4 ft, the factor will be 5.0.

310 For a footing lowered more than 4 ft below its elevation shown on the plans, all such extended excavation below the bottom of footing elevation shown on the plans to the revised bottom of footing shall be done as extra work in accordance with 104.03. Payment will be made in accordance with 109.05.

All backfill material or sub-footing material required whose source is other than structure excavation will be paid for at the contract unit price for the material being used or as extra work if no unit price has been established. A change order will be prepared in accordance with 109.05.

320 The cost of furnishing all materials and labor associated with proof testing of rock shall be included in the cost of other pay items.

If a borrow area is required and borrow is not specified as a pay item, payment will be made in accordance with 203.28.

If a waste area is required and the contract documents do not identify excess excavation or require removal of any items, payment will be made in accordance with 203.28.

330 Except for sign foundations, traffic signal foundations, and highway illumination foundations, if a type of excavation for which no pay item exists is required and the new type of excavation requires the Contractor to use equipment not otherwise being used on the contract, payment will be in accordance with 203.28.

If a type of excavation for which no pay item exists is required and the new type of excavation requires additional traffic control not shown on the plans or results in traffic control being required for an additional period of time, payment will be made in accordance with 203.28.

Payment will be made under:

340	Pay Item	Pay Unit Symbol
	Cofferdam.....	LS
	Excavation, Dry.....	CYS
	Excavation, Foundation, Unclassified.....	CYS
	Excavation, Wet.....	CYS
	Excavation, X.....	CYS

350 The cost of placing and compacting of all backfill when the materials used are obtained from excavation, clearing and grubbing required and not paid for under another pay item, formation of embankments made with material from structure excavation, and disposal of all surplus or unsuitable excavation, unless otherwise specified shall be included in the cost of the pay items.

The cost for disposing of surplus or unsuitable excavated materials outside the right-of-way shall be included in the various pay items in this section.

(a) Culverts

360 This requirement will not include pipe culverts. Excavation for culverts will not be paid for directly. The cost thereof shall be included in the cost of the structure or structure extension. The cost of all necessary removal and satisfactory disposal of all or part of the existing old structure unless its removal is otherwise provided for, cleaning out an old channel or constructing a new channel within the right-of-way limits and widening it to the grade of the existing or proposed new stream bed as shown on the plans or as directed, construction of all necessary curbs and cofferdams and their subsequent removal, subsoil borings or soundings below bottom of footings, dewatering, disposal of excavated materials, and all labor, equipment, tools, and necessary incidentals shall be included in the cost of this work.

If a culvert is lowered or relocated at the direction of the Engineer, or material of

370 such nature is encountered so that additional excavation is necessary, the additional excavation will not be paid for if it is 10 cu yds or less. Additional excavation in excess of 10 cu yds will be paid for at \$125.00 per cu yd. If the additional excavation in excess of 10 cu yds is identified as class X excavation, and there is no pay item for class X excavation, the additional work will be paid for at \$125.00 per cu yd for the quantity in excess of 10 cu yds, regardless of the depth the culvert is lowered.

(b) Bridges

380 The cost of clearing right-of-way within the project limits; constructing, dewatering, and removal of cofferdams, if not a pay item; subsoil borings or soundings below bottoms of footings; final preparation of foundation surfaces; disposal of excavated material; and all labor, equipment, tools, and incidentals necessary to the satisfactory completion of the excavation shall be included in the cost of this work.

The cost of all required working drawings; furnishing, hauling, and placing necessary materials; construction; maintenance; dewatering; removal of bracing; removal of or cutting off the sheeting; and labor, equipment, tools, and necessary incidentals shall be included in the cost of cofferdams.

390 If cofferdams are not specified as a pay item, and if cofferdams are necessary, their cost shall be included in the cost of excavation or the concrete requiring their use.

If there is no pay item for dry excavation, the cost of this part of the work shall be included in the cost of the foundation concrete or for other concrete requiring such excavation. However, where waterway excavation, common excavation, or other classified excavation overlaps the area of dry foundation excavation, no deduction will be made in the pay volume of such overlapping classified material. This exception will apply only if dry excavation is not a pay item.

400 Except as otherwise provided in 206.05, the cost of foundation excavation unclassified shall include all work and elements of volume, and excavation described above for wet excavation and dry excavation, regardless of whether or not water is encountered. The cost of foundation excavation unclassified shall not include the cost of class X excavation.

410 The classifications for necessary excavation for a cantilevered wing outside the limits of foundation excavation shall be the same as those governing the excavation inside such limits. The quantity to be paid for will be that actually removed from its original position within vertical planes 18 in. outside the neat lines shown on the plans and parallel thereto and above a plane 1 ft below and parallel to the bottom surface of the wing.

The classifications for necessary excavation for arch superstructures outside the limits of foundation excavation or waterway excavation shall be those governing the excavation inside the limits of foundation excavation or waterway excavation, depending on the location of the excavation for the arch superstructure. Such

207.01

excavation shall be bounded by vertical planes which are 1 ft outside the outside faces of the arch ring and parallel thereto, by a vertical plane passing through the intersection of the intrados of the arch ring and the original ground line and parallel to the face of the abutment, and the vertical plane bounding the foundation excavation on the side adjacent to the arch ring. The lower limit shall be a sloping plane which is 1 ft below a plane connecting the intersection of the intrados of the arch ring and the original ground, and the intersection of the intrados of the arch ring with the vertical plane bounding the foundation excavation.

For U-abutments, the limits of dry excavation to be paid for will be extended to include all material removed from between the limits of the wing excavation and above the elevation of the bottom of the lowest tie beam. If the bottom of the lowest tie beam is below the upper limits of wet excavation, the limits of wet excavation and dry excavation to be paid for will be extended to include material actually and necessarily removed from between the limits of the wing excavation.

Where it is necessary to excavate outside the foundation excavation limits for superstructure or extensions other than those described above, the pay limits will be extended to include all such excavation, as determined necessary.

If a suitable sump is constructed outside the pay limits as described above, such limits will be extended to include the actual lines of the sump. The additional pay limits added for the sump will not exceed 4% of the area of the footing involved.

440 (c) Traffic Structure Supports

The cost of excavation for traffic structure supports, except for class X material in accordance with 206.02(a)1, shall be included in the cost of the foundation material.

SECTION 207 – SUBGRADE

207.01 Description

This work shall consist of the construction of the subgrade in accordance with 105.03.

MATERIALS

207.02 Materials

10 Materials shall be in accordance with the following:

Chemical Modifiers	215.02
Coarse Aggregate, Class D or Higher, Size No. 5, 8, 43, 53, or 73	904.03
Geogrid, Type IB.....	918.05
Geocell Confinement System	214
Geotextile for Pavement and Subgrade	918.02(c)
Water	913.01

- 20 Air-cooled blast furnace slag shall not be used for subgrade treatment Types ID, IV, and IVA.

Soil Property	Test Method	Requirements
Dry Weight Organic Material	AASHTO T 267	$\leq 3\%$
Max Dry Density	AASHTO T 99	≥ 100 pcf
Liquid Limit	AASHTO T 89	≤ 50
Soluble Sulfate	ITM 510	≤ 1000 ppm
Note: Only soils meeting these requirements will be allowed within the specified thickness of the subgrade treatment in cut sections. Only soils meeting these requirements will be allowed within 24 in. of the finished subgrade elevation in fill sections.		

CONSTRUCTION REQUIREMENTS

207.03 Construction Requirements

(a) Subgrade Construction Methods

- 30 The subgrade shall be constructed uniformly transversely across the width of the pavement including shoulders or curbs unless shown otherwise on the plans, by one of the following methods:

1. chemical modification in accordance with 215;
2. aggregate No. 53 in accordance with 301;
3. geogrid in accordance with 214 placed under aggregate No. 53 in accordance with 301, or
- 40 4. soil compaction to 100% of maximum dry density;
5. geotextile in accordance with 214 placed under aggregate No. 5, 8, and 53 in accordance with 301.

Longitudinally, the treatment may vary depending on the method of construction.

(b) General Requirements

- 50 All rock greater than 3 in. shall be removed or broken off and placed at least 6 in. below the specified subgrade. Holes or depressions resulting from the removal of unsuitable material shall be filled with soils in accordance with 207.02 or B borrow and compacted in accordance with 203.23.

Coal within the specified thickness of the subgrade shall be excavated if directed,

207.04

and disposed of in accordance with 202.02.

During subgrade preparation, adequate drainage shall be provided at all times to prevent water from standing on the subgrade. The grade and cross section of the subgrade shall be finished within a tolerance of 1/2 in. from the subgrade elevation shown on the plans.

60

Even though the subgrade has been previously accepted, the condition of the subgrade shall be in accordance with 105.03 and 207.04 at the time paving material is placed.

Finishing within this tolerance by blading or other mechanical means without the use of side forms will be allowed. If these methods do not finish within this tolerance, side forms shall be used.

207.04 Subgrade Treatment Types

70

The subgrade treatment type shall be as specified on the contract plans. If required, the subgrade foundation shall be corrected as directed by the Engineer prior to subgrade treatment.

Type	Subgrade Description
I	24 in. of soil compacted in accordance with 203.23
IA	[blank]
IBC	14 in. chemical soil modification using cement
IBL	14 in. chemical soil modification using lime
IC	12 in. coarse aggregate No. 53 in accordance with 301
ID	12 in. coarse aggregate with Type 2B geotextile in accordance with 918.02(c)
II	6 in. coarse aggregate No. 53 in accordance with 301
III	In-place compaction in accordance with 203.23
IV	12 in. coarse aggregate No. 53 with Type IB geogrid in accordance with 214
IVA	12 in. coarse aggregate with geocell confinement system in accordance with 214
V	3 in. of subgrade excavated and replaced with 3 in. coarse aggregate No. 53

Type ID subgrade treatment shall be constructed with 9 in. of coarse aggregate No. 53 over 3 in. of coarse aggregate No. 5 or No. 8. Geotextile Type 2B in accordance with 918.02(c) shall be placed above and below the layer of No. 5 or No. 8 coarse aggregate.

80

In areas where shallow utilities are encountered or chemical modification is not allowed, the Contractor may submit a request to the Engineer to substitute Type IC for Type IBC or Type IBL.

Where the strength or density and moisture control option is used, compaction of embankment areas shall be in accordance with 203.23. In cut and transition areas, the

top lifts shall be removed, and the bottom 6 in. compacted in-place in accordance with 203.23. The excavated material shall then be replaced and compacted in 6 in. lifts in accordance with 203.23. Removal of the lifts may be waived and only the upper 6 in. compacted in accordance with 203.23 when it is determined, through testing in
 90 accordance with 203.24, that the lower lifts comply with 203.23.

In sections where rock, shale, sandstone or its mixtures are encountered, these materials shall be undercut 24 in. below the subgrade elevation and replaced with coarse aggregate No. 53 or No. 73 and compacted in accordance with 301.06. Geotextiles used shall be in accordance with 918.02. All irregularities and holes shall be graded with either coarse aggregate No. 53 or No. 73. If an aggregate base is part of the HMA pavement structure, the 24 in. excavation depth shall be reduced by the thickness of the aggregate base.

100 The 3 in. compacted aggregate as part of the subgrade treatment Type V shall be compacted to 100% prior to the placement of the pavement.

When conditions are encountered below the specified subgrade treatment depth that prevent achieving the specified subgrade compaction, such conditions shall be corrected in accordance with 203.09, or as directed.

Proofrolling shall be performed in accordance with 203.26.

207.05 Method of Measurement

110 Subgrade treatment will be measured in both cut and fill areas by the square yard per type. Chemicals for soil modification using cement or lime, excavation, aggregates, geotextile, and geogrid materials will not be measured.

The undercutting of rock, where encountered, will be measured in accordance with 203.27(b).

207.06 Basis of Payment

120 The accepted quantities of subgrade treatment will be paid for at the contract unit price per square yard per type, complete in place. In areas where shallow utilities are encountered or the Contractor elects to use Type IC for Type IBC or Type IBL, payment will be made at the price of Type IBC or Type IBL.

The undercutting of rock, where encountered, will be paid for in accordance with 203.28.

Payment will be made under:

	Pay Item	Pay Unit Symbol
130	Subgrade Treatment, Type _____	SYS

208.01

The cost of subgrade treatments including testing, sampling, aggregates, chemicals for soil modification with cement or lime, geogrid, geotextile and geocell confinement system, coarse aggregate for subgrade Type IC, Type ID, Type II, Type IV, Type IVA, Type V, water, and the excavation required, shall be included in the cost of the pay item.

140 The cost of excavation and grading of existing railroad ballast and railroad bed material shall be included in the cost of subgrade treatment, Type V.

Where conditions exist below the specified subgrade compaction depth that prevent achieving the specified compaction, payment for correcting such conditions will be made based on the directed method of treatment.

SECTION 208 – FINISHING SHOULDERS, DITCHES, AND SLOPES

208.01 Description

This work shall consist of the final shaping and dressing of shoulders, ditches, and slopes by hand or machine methods, or both, to the required smoothness in accordance with these specifications and in reasonably close conformance with the elevations and cross sections shown on the plans or as directed.

10 Where divided pavement is constructed, each roadway with its shoulders, ditches, and slopes will be considered a separate roadway.

CONSTRUCTION REQUIREMENTS

208.02 Finishing Shoulders

20 Unless otherwise provided, shoulders shall be constructed of earth or other approved material which contains no sod, weeds, sticks, roots, or other perishable matter. The inside edges shall be built up slightly above the finished surface of the adjoining pavement and compacted thoroughly with a roller weighing no less than 5 t and with the roller wheel slightly overlapping the pavement. Rolling shall continue until there is no break between the pavement and shoulders, and until the required cross section is obtained.

If rolling is not practicable on shoulders for approach pavement or other miscellaneous areas, compaction shall be obtained with mechanical tamps, vibrators, or other satisfactory means.

Except where permission has been granted to widen shoulders to dispose of surplus excavation, the outside edges shall be parallel to the pavement edges.

30 Where cuts are widened beyond the typical cross sections shown on the plans in order to obtain additional material for constructing shoulder widths required or where fills are widened to dispose of excess excavated material, the shoulders shall be finished to the widths as finally constructed.

It may be necessary to finish shoulders after the pavement is opened to traffic. As a matter of safety to traffic, the pavement shall be kept as free as possible from shoulder material and equipment. The adjacent pavement over which traffic is being routed shall be cleaned at the close of each work day.

40 **208.03 Finishing Ditches**

Ditches shall be finished to the lines and grades shown on the plans or as otherwise laid out. The edges shall be parallel to the pavement unless it is necessary to have the gradients different from that of the pavement in order to obtain proper drainage, in which case the edges shall be as determined.

208.04 Finishing Slopes

50 All cut and fill slopes shall be constructed to the cross sections shown on the plans or to revised sections where cuts are widened to obtain additional material or fills widened to utilize excess. Cut and fill slopes shall be finished to the degree ordinarily obtained by a blade grader, scraper, or hand shovel.

208.05 Blank

208.06 Finishing at Contract Drainage Structures

If the contract work is for bridges or culverts or for extensions thereof, the requirements of this specification shall apply to the right-of-way within the contract structure limits, unless otherwise specified.

208.07 Method of Measurement

60 Finishing will not be measured for payment unless otherwise provided.

208.08 Basis of Payment

Finishing shoulders, ditches, and slopes will not be paid for directly. The cost thereof shall be included in the cost of other pay items.

SECTION 209 – FINISHING EARTH GRADED ROADS

209.01 Description

This work shall consist of leveling, shaping, and otherwise completing an earth graded road ready for acceptance when the contract is for grading or for grading and structures, but not when the contract includes paving or surfacing.

209.02 Construction Requirements

10 After all grading is substantially complete and structures, if any, are finished, the roadbed and cut and fill slopes shall be shaped properly and, where necessary, compacted.

Shaping and compacting shall be with approved equipment supplemented with

209.03

hand methods if necessary. Reasonably smooth surfaces shall be obtained and finished at least to within ± 0.1 ft of the required profile and cross sections shown on the plans or as directed.

20 All rock greater than 6 in. encountered shall be removed or broken off at least 6 in. below the subgrade surface. Holes or depressions resulting from the removal of unsuitable material shall be filled with an acceptable material and compacted to conform with the surrounding subgrade.

Final trimming and cleaning shall be in accordance with 210.

209.03 Method of Measurement

Finishing earth graded roads will not be measured for payment unless otherwise provided.

209.04 Basis of Payment

30 Finishing earth graded roads will not be paid for directly. The cost thereof shall be included in the cost of other pay items.

SECTION 210 – FINAL TRIMMING AND CLEANING

210.01 Description

This work shall consist of trimming and cleaning the otherwise completed highway between right-of-way lines for its entire contract length.

210.02 Construction Requirements

10 At the time of acceptance, the following conditions shall prevail for the entire contract length and also for the full right-of-way width except as hereinafter provided.

Debris and rubbish shall be removed and disposed of in accordance with 201.03.

Remaining loose stones and broken masonry meeting the aggregate requirements for hand laid or grouted riprap shall be stored in neat piles on the right-of-way as directed.

Weeds, brush, and stumps shall be cut close to the ground. Disposal shall be in accordance with 201.03 and 203.08.

20 Cut and fill slopes made or disturbed shall be left reasonably smooth and uniform. Loose and overhanging rock shall be removed.

Floors, roadways, railings, bottom chords, shoes, and seats of bridges shall be cleaned of rubbish, sand, stone, gravel, and dirt. Waterways shall be left unobstructed. Culverts and other drainage structures shall be left clean for their entire length.

30 If the contract is for construction of a new pavement or for grading and structures only on a right-of-way acquired for divided highway construction, one roadway of which has been constructed and on which the Department has assumed normal maintenance, the provisions of this specification shall not apply to the maintained portion except to those areas of such which are disturbed by the operations.

If the contract is for construction of a portion of a divided highway on a right-of-way on which no previous construction has been done or on a divided highway right-of-way on which a previous grading-only contract has been completed, then the provisions of this specification shall apply to the entire right-of-way for the full contract length.

40 Unless otherwise set out in the special provisions for a contract which includes work for patching, widening, resurfacing, surface treating, undersealing, or for a combination of these, or for a contract through which traffic is being maintained during construction, these requirements will apply only to that portion of the right-of-way disturbed by the operations.

210.03 Method of Measurement

Final trimming and cleaning will not be measured for payment unless otherwise provided.

210.04 Basis of Payment

50 Final trimming and cleaning will not be paid for directly. The cost thereof shall be included in the cost of other pay items.

SECTION 211 – B BORROW AND STRUCTURE BACKFILL

211.01 Description

This work shall consist of backfilling excavated or displaced peat deposits; filling up to designated elevations of spaces excavated for structures and not occupied by permanent work; constructing bridge approach embankment; and filling over structures and over arches between spandrel walls, all with special material.

MATERIALS

10

211.02 Materials

Materials shall be in accordance with the following:

B Borrow	As Defined*
Flowable Backfill	213
Geotextile	918.02
Structure Backfill	904.05

* The material used for special filling shall be of acceptable quality, free from large or frozen lumps, wood, or other extraneous matter and shall be known as B borrow. It shall consist of suitable sand,

20

gravel, crushed stone, ACBF, GBF, or other approved material. The material shall contain no more than 10% passing the No. 200 (75 µm) sieve and shall be otherwise suitably graded. The use of an essentially one-size material will not be allowed unless approved.

Aggregate for end bent backfill shall be No. 8 or No. 9 crushed stone or ACBF, class D or higher.

30 The Contractor has the option of either providing B borrow or structure backfill from an established CAPP source, or supplying the material from another source. The Contractor has the following options for supplying B borrow or structure backfill from a local site:

- (a) the establishment of a CAPP Producer Yard at the local site in accordance with 917; or
- (b) use a CAPP Certified Aggregate Technician or a consultant on the list of Qualified Geotechnical Consultants For Gradation Control Testing.

40

For material excavated within the project limits, gradation control testing will be performed by the Department if the Contractor is directed to use the material as B borrow or as structure backfill.

The frequency of gradation control testing shall be one test per 2,000 t based on production samples into a stockpile or by over the scales measurement, with a minimum of two tests per contract, one in the beginning and one near the mid-point. The sampling and testing of these materials shall be in accordance with applicable requirements of 904 for fine and coarse aggregates. The Contractor shall notify the Engineer in writing of the plan to measure the material.

50

CONSTRUCTION REQUIREMENTS

211.03 General Requirements

If B borrow or structure backfill is obtained from borrow areas, the locations, depths, drainage, and final finish shall be in accordance with 203.

Unless otherwise specified, if excavated material complies with 211.02 and if B borrow or structure backfill is required for special filling, the excavated material shall be used as such. If there is a surplus of this material, such surplus shall be used in embankment. The provisions of 203.19 shall apply to placing this material at structures. All surplus in excess of the directed or specified use on the right-of-way shall be disposed of in accordance with 201.03.

60

If fill or backfill as described in this specification is within embankment limits, and if it is not required that the entire fill or backfill be of B borrow and placed as such,

then that portion above the free-water level shall be placed in accordance with applicable provisions of 203 and compacted to the required density.

70

If borrow is required outside the specified limits of B borrow, material in accordance with the specifications for B borrow may be furnished at the contract unit price for borrow; however, the quantity of borrow measured for payment outside the limits of structure backfill will not exceed the theoretical quantity of B borrow furnished.

Unless otherwise specified, all spaces excavated for and not occupied by bridge abutments and piers, if within embankment limits, shall be backfilled to the original ground line with B borrow, and placed in accordance with 211.04.

80

Where B borrow or structure backfill is required as backfill at culverts, retaining walls, sewers, manholes, catch basins, and other miscellaneous structures, it shall be compacted in accordance with 211.04.

Where specified, aggregate for end bent backfill shall be placed behind end bents and compacted in accordance with 211.04. Prior to placing the aggregate, a geotextile shall be installed in accordance with 616.11.

211.03.1 Structure Backfill Types

90

The structure backfill type shall be as specified.

Within each of the following structure backfill types, the Contractor shall choose from the listed options for each type:

(a) Type 1

1. Structure backfill in accordance with 904.05.
2. Non-removable or removable flowable backfill in accordance with 213.

100

(b) Type 2

1. Crushed stone aggregate or ACBF structure backfill in accordance with 904.05, except No. 30, No. 4, and 2 in. nominal size aggregate shall not be used.
2. Non-removable or removable flowable backfill in accordance with 213.

110

(c) Type 3

Structure backfill in accordance with 904.05, except only nominal size aggregates 1 in., 1/2 in., No. 4 or No. 30, and coarse aggregate No. 5, No. 8, No. 9, No. 11, or No. 12 shall be used. If ACBF is used, it shall only be used in sizes that meet the size

requirements for coarse aggregate No. 5 or No. 8.

A type A certification in accordance with 916 shall be provided for the additional structure backfill. The results of the following shall be shown on the certification.

Property	Criteria	Test Method
pH (Note 1)	$5 < \text{pH} < 10$	AASHTO T 289
Organic Content (Note 2)	1% max.	AASHTO T 267
Permeability, min. (Note 3)	30 ft/day	AASHTO T 215
Notes:		
<ol style="list-style-type: none"> One PH test is required for each bench of stone, each source of air-cooled blast furnace slag, and each source of gravel. One organic content test is required for each source of gravel. One permeability test is required for the smallest aggregate size from each source. Sizes No. 5, No. 8, and No. 9 do not require a permeability test. 		

120

The gradation shall be performed on the material used in the permeability test. Testing for permeability shall be performed on the sample of the material compacted to 95% in accordance with AASHTO T 99, Method C or D. All of the tests listed above shall be performed a minimum of once every 12 months per source.

In addition to the criteria above, structure backfill for retaining wall systems containing metal components in contact with structure backfill shall also be in accordance with the following criteria:

Property	Criteria	Test Method
Chlorides	$< 100 \text{ ppm}$	AASHTO T 291
Sulfates	$< 200 \text{ ppm}$	AASHTO T 290
Resistivity, min.	$3,000 \Omega\text{-cm}$	AASHTO T 288
Internal friction angle, ϕ , min.	34°	AASHTO T 236* or T 297*
* under consolidated drained conditions		

130

If the minimum resistivity exceeds $5,000 \Omega\text{-cm}$, the requirement for the testing of chlorides and sulfates will be waived. The resistivity shall be tested at 100% saturation. All of the tests listed above shall be run a minimum of once every 12 months per source. The Department's Division of Materials and Tests will evaluate the material from each source and determine the appropriate tests to be performed.

Testing for ϕ shall be performed using a sample of the material compacted to 95% in accordance with AASHTO T 99, Method C or D. Testing for ϕ will not be required when using coarse aggregate No. 5, No. 8, or No. 9.

140

(d) Type 4

Removable flowable backfill in accordance with 213.

(e) Type 5

Non-removable flowable backfill in accordance with 213.

211.04 Compaction

150 B borrow and structure backfill types 1, 2, and 3 shall be compacted with mechanical tamps or vibrators in accordance with the applicable provisions of 203.23 except as otherwise set out herein.

Aggregate for end bent backfill and coarse aggregate used for structure backfill shall be deposited in layers not to exceed 12 in. loose measurement. Each layer shall be mechanically compacted with a compactor having a plate width of 17 in. or larger that delivers 3,000 to 9,000 lb per blow. Each lift shall be compacted with two passes of the compactor.

211.05 Embankment for Bridges

160 When special filling is required, the embankment for bridges shall be constructed using B borrow within the specified limits shown on the plans. All embankment construction details specifically set out in this specification for embankment for bridges shall be considered in accordance with the applicable requirements of 203.

At the time B borrow is being placed for approach embankment, a well compacted watertight dam shall be constructed in level lifts, the details of which are shown on the plans. Except as hereinafter specified for material to be used in constructing the enclosing dam, and for growing vegetation, and unless otherwise provided, the material for constructing bridge approach embankment shall be B borrow compacted by mechanical methods.

170

If approach embankment or shoulders are constructed of material not suitable for growing seed or sod, and if one or both of these is required, then such areas shall, unless otherwise specified, be covered with a layer of clay, loam, or other approved material. This layer shall be approximately 1 ft thick after being compacted into place.

211.06 B Borrow Around Bents

180 When specified, B borrow shall be placed around all bents falling within the limits of the approach grade as shown on the plans. Before placing, the surface of the ground on which it is to be placed shall be scarified or plowed as directed. The embankment slope shall be 2:1 on the sides and beneath the structure, and shall be 6:1 from the end of the bridge down to the average ground line, or it may be required to complete the approaches back to the existing grade. An enclosing dam and provisions for growing vegetation shall be constructed in accordance with 211.05.

211.07 Blank**211.08 Spandrel Filling**

Unless otherwise specified, spandrel fills for arch structures shall be composed of

211.09

190 B borrow. The fill shall be carried up symmetrically in lifts from haunch to crown and simultaneously over all piers, abutments, and arch rings. Compaction shall be in accordance with 211.04.

211.09 Method of Measurement

200 B borrow, structure backfill types 1, 2, or 3, and aggregate for end bent backfill will be measured by the cubic yard as computed from the neat line limits shown on the plans. If cubic yards are set out as the pay item for B borrow or structure backfill in the Schedule of Pay Items and if neat line limits are not specified for measurement of volume for the material, measurement will be made by the cubic yard at the loading point in truck beds which have been measured, stenciled, and approved. The B borrow may be weighed and converted to cubic yards by assuming the weight per cubic foot to be 90% of the maximum wet density in accordance with AASHTO T 99. The material may be cross sectioned in its original position and again after excavation is complete, and the volume computed by the average end area method. If B borrow is used for backfill in areas where unsuitable material is present or peat excavation has been performed, unless otherwise directed, the B borrow will be cross sectioned, and the volume will be computed by the average end area method.

210 Structure backfill types 4 or 5 will be measured by the cubic yard as computed from the neat line limits shown on the plans. If neat line limits are not shown on the plans, the volume in cubic yards of flowable backfill furnished and placed as structure backfill type 4 or 5 will be computed from the nominal volume of each batch and a count of the batches. Unused and wasted flowable backfill will be estimated and deducted.

If the material is to be paid for by the ton, it shall be weighed in accordance with 109.01(b).

220 If the material comes from a wet source such as below water or a washing plant, and weighing is involved in the method of measurement, there shall be a 12 h drainage period prior to the weighing.

Geotextile will be measured in accordance with 616.12.

211.10 Basis of Payment

The accepted quantities of B borrow will be paid for at the contract unit price per cubic yard or per ton as specified, complete in place.

230 Structure backfill will be paid for at the contract unit price per cubic yard of the type specified, provided the material comes from outside the permanent right-of-way.

B borrow material placed outside the neat lines will be paid for as borrow when such B borrow eliminates required borrow material. Otherwise, no payment will be made for backfill material placed outside the neat lines.

Aggregate for end bent backfill will be paid for at the contract unit price per cubic yard, based on the neat line limits shown on the plans.

Geotextile will be paid for in accordance with 616.13.

240 If topsoil, loam, or other suitable material in accordance with 211.05 is used for expediting the growth of seed or sod, it will be paid for at the contract unit price per cubic yard for borrow, unless otherwise provided.

Payment will be made under the following:

Pay Item	Pay Unit Symbol
Aggregate For End Bent Backfill	CYS
B Borrow	CYS
250 Structure Backfill, Type _____	TON
	CYS

No payment will be made under this section for material obtained within the excavation limits of the project if the Contractor is directed to use the material as B borrow or structure backfill in a pipe trench, culvert, construction of an embankment or fill, or if the Contractor uses the material for its own convenience. Material obtained from within the excavation limits of the project and which the Contractor is directed to use as B borrow or structure backfill for other purposes including replacement of undercut areas, support for a retaining wall system, and end bent fill will be paid for at the contract unit price of \$5.00 per cubic yard for B borrow/structure backfill handling.

260

The cost of disposal of excavated material shall be included in the cost of the pay items in this section.

SECTION 212 – STOCKPILED SELECTED MATERIALS

212.01 Description

This work shall consist of excavating selected road material from within the construction limits and stockpiling it on the right-of-way at designated locations. It also includes any subsequent removal of the material from the stockpile, if to be used in the work.

212.02 Materials

10 Any material to be excavated and stockpiled will be specifically named and described in the special provisions and may include rock, top soil, material in accordance with 211.02, or any other material selected, any of which may be excavated as common excavation.

After the selected material is stockpiled it shall be known as stockpiled selected material and if any of this material is required to be removed from the stockpile and used in the work, its removal and its incorporation into the work shall be known as salvaged stockpiled selected material.

20 **212.03 Construction Requirements**

Selected material shall be excavated from specified areas and stockpiled on the right-of-way at designated locations. The depth of excavation shall be as directed.

If the material is required to be taken from the stockpile and utilized in the work, the material so utilized shall be placed in accordance with these specifications as they apply to the nature of the material and the use to which it is put.

212.04 Method of Measurement

30 Stockpiled selected material will be measured in the stockpiles by means of cross sections by the cubic yard, computed by the average end area method. The volume measured as salvaged stockpiled selected material will be the difference in cubic yards between that of the existing stockpile and that remaining after the material has been removed from the stockpile and used. Both stockpiles will be measured by means of cross sections. The volume will be computed by the average end area method.

If stockpiled selected material is obtained from within the excavation pay limits of new construction, the volume of the material will be deducted from the pay quantities for excavation as shown on the original cross sections.

40 **212.05 Basis of Payment**

The accepted quantities of stockpiled selected material and salvaged stockpiled selected material will be paid for at the contract unit price per cubic yard, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Stockpiled Selected Material	CYS
50	Stockpiled Selected Material, Salvaged	CYS

The cost of excavation, hauling, removing material from the stockpile, placing materials, and necessary incidentals shall be included in the cost of the pay items.

SECTION 213 – FLOWABLE BACKFILL

213.01 Description

This work shall consist of placing flowable backfill in trenches for pipe structures, culverts, utility cuts, other work extending under pavement locations, cavities beneath slopewalls and other locations in accordance with 105.03.

Flowable backfill will be classified as either removable or non-removable. Wherever type 5, non-removable flowable backfill is specified, type 4, removable backfill may be substituted, following notification to the Engineer.

MATERIALS

213.02 Materials

Materials shall be in accordance with the following:

	Concrete Admixtures*	912.03
	Fine Aggregate	904.02(a)
	Fly Ash	901.02
20	Portland Cement	901.01(b)
	Water	913.01

* Other admixtures that increase flowability may be used as approved by the Engineer.

The supplier may elect to use nominal size No. 23 and No. 24 gradations in accordance with 904.02(h) or may propose the use of alternate gradations. The alternate gradation and proposed tolerances of material passing each sieve shall be included in the flowable backfill mix design.

30 213.03 Flowable Backfill Mix Design

The Contractor may either design their own flowable backfill mix or may choose to use one of the four standard mix designs shown in 213.03(a).

If the flowable backfill is being placed around a pipe, the mix shall contain a minimum of 150 lb/cu yd of fly ash.

(a) Standard Flowable Backfill Mix

The following two type 4, removable flowable backfill mixes and two type 5, non-removable flowable backfill mixes may be used. The final mix results may vary due to variations in cement and other materials. The Contractor shall be responsible for the performance of the flowable backfill and the mix shall meet the mix criteria in accordance with 213.04, and the minimum spread and blow counts in accordance with 213.07.

Component	Removable		Non-Removable	
	Type 4-1	Type 4-2	Type 5-1	Type 5-2
Cement Content, lb/cu yd	50	50	85	100
Fly Ash, lb/cu yd	0	150	0	150
Fine Aggregate, lb/cu yd	2,900	2,125	2,870	2,085
Water, lb/cu yd	500	400	500	400
Entrained Air, %	0 - 10	15 - 35	0 - 10	15 - 35

(b) Contractor - Designed Flowable Backfill Mix

The Contractor shall submit a flowable backfill mix design, FBMD, to the DTE a minimum of seven days prior to the trial batch. The FBMD will be accepted in accordance with 213.04. The FBMD shall be submitted in a format acceptable to the
50 DTE and shall include the following:

- (a) a list of all ingredients
- (b) the source of all materials
- (c) the gradation of the aggregates
- (d) the batch weight with the aggregates at the SSD condition
- (e) the names of all admixtures
- (f) the admixture dosage rates and manufacturer's recommended range.

A FBMD in accordance with these specifications, which has been approved for
60 use on a previous contract, may be submitted to the DTE for approval. The submittal shall include copies of test results in accordance with 213.04 and 213.05.

Changes in the FBMD will not be allowed except for adjustments to compensate for routine moisture fluctuations or a change in sand source in accordance with 213.05 based on the dry flow determined from the trial batch testing. All other changes will require a new FBMD.

213.04 Flowable Backfill Mix Criteria

The FBMD shall produce a workable mixture with the following properties:
70

(a) Flow Consistency

Flow consistency will be measured in accordance with ASTM D6103. The diameter of the spread shall be at least 8 in.

(b) Lightweight Dynamic Cone Penetration Blow Count Number

A lightweight dynamic cone penetration test will be performed in accordance with ITM 216 after the flowable backfill mix has cured for three days. The average penetration resistance blow count number for removable flowable backfill shall not be less than 12 or greater than 30. Non-removable flowable backfill mixes shall have an
80 average penetration resistance blow count greater than 30.

(c) Removability Modulus

The removability modulus, RM, will be determined for the FBMD by the formula as follows:

$$RM = 0.000104 (U_w)^{1.5} \sqrt{1.72N_{14} - 15.64}$$

where:

- 90 N_{14} = average lightweight dynamic cone penetration blow count after 14 days in accordance with ITM 216.
- U_w = dry unit weight, lb/cu ft, of flowable backfill after 14 days in accordance with ITM 218.

The RM shall be 1.0 or less for removable flowable backfill.

After all test results have been reviewed for compliance with the specifications, a mixture number will be assigned by the DTE.

100

213.05 Flowable Backfill Trial Batch**(a) For Standard Flowable Backfill Mix**

If one of the four standard flowable backfill mix designs in 213.03(a) is used, a trial batch will not be required. The Contractor may still choose to perform a trial batch in accordance with 213.05(b), if desired.

(b) For Contractor - Designed Flowable Backfill Mixes

- 110 A trial batch shall be produced by the Contractor and will be tested by the Department to verify that the FBMD meets the flowable backfill mix criteria. The Department will verify the classification of the mix as either removable or non-removable from the results of the trial batch. The flowable backfill shall be batched within the proportioning tolerances of 508.02(b). The Department will determine the test results and provide them to the Contractor. The trial batch shall be of sufficient quantity to allow the Department to perform all required tests from the same batch.

- 120 The Department will obtain a sample of the fine aggregate and fly ash described in the FBMD. The Department will test the dry flow in accordance with ITM 217 and record the results on the FBMD.

If the Contractor requests to change the source of the fine aggregate identified in an approved FBMD the Contractor shall submit a revised FBMD to the DTE. The Department will obtain a sample of the new fine aggregate and, if applicable, a sample of the fly ash as identified in the approved FBMD. Dry flow will be tested in accordance with ITM 217. If the test result is within ± 2.0 s of the value shown on the

213.06

approved FBMD, the revised FBMD will be approved and a new trial batch will not be required. Failure to meet the dry flow test requirement will require the Contractor to submit a new FBMD and perform a new trial batch for approval of the proposed new fine aggregate.

213.06 Mixing Equipment

The mixing equipment shall be in accordance with the applicable requirements of 702 or 722.

CONSTRUCTION REQUIREMENTS

213.07 Placement

The flowable backfill shall not be placed on frozen ground. Flowable backfill shall be protected from freezing for 72 hr. Flowable backfill shall not be placed into or through standing water unless approved by the Engineer in writing.

The diameter of the flowable backfill spread shall be at least 8 in. at time of placement. Water may be adjusted from the FBMD to meet the minimum spread requirement if the initial measured spread is between 7 and 8 in.

If using mixing equipment in accordance with 722, the yield will be checked using the 1/4 cu yd box method as follows:

- (a) The chute shall be cleaned and the box shall be positioned on a level surface to receive the discharged flowable backfill.
- (b) The mixer shall be operated until the cement or fly ash counter indicates that 1/4 cu yd of flowable backfill has been yielded.
- (c) The contents of the box will be consolidated and struck off. If the box is not full, the gates shall be adjusted and the procedure shall be repeated until the actual and calculated volumes of flowable backfill agree.
- (d) Yield will be checked on the first load of each truck and every third load per truck thereafter. Additional yield tests will be required after making any adjustments.

The flowable backfill shall be brought up uniformly to the fill line as shown on the plans or as directed. When used as structure backfill, flowable backfill shall be placed uniformly so as not to induce unbalanced loading on any part of a structure.

The flowable backfill shall not be subjected to load or disturbed by construction activities until a lightweight dynamic cone penetration test has produced a minimum blow count. The minimum blow count shall be as follows:

Construction Activities with Vibratory Compaction after Backfill12
 Construction Activities without Vibratory Compaction after Backfill7

213.08 Method of Measurement

Flowable backfill will be measured by the cubic yard of the type specified as computed from the neat line limits shown on the plans. If neat line limits are not shown on the plans, the volume in cubic yards of flowable backfill furnished and placed will be computed from the nominal volume of each batch and a count of the batches. Unused and wasted flowable backfill will be estimated and deducted. Drilled holes will be measured by the number of holes drilled.

If removable flowable backfill is approved for use in lieu of non-removable flowable backfill, it will be measured by the cubic yard as non-removable flowable backfill.

213.09 Basis of Payment

The accepted quantities of flowable backfill will be paid for at the contract unit price per cubic yard for the type specified, furnished and placed. Holes drilled in the pavement will be paid for at the contract unit price per each.

If removable flowable backfill is approved for use in lieu of non-removable flowable backfill shown on the plans, it will be paid for as non-removable flowable backfill. Substitutions by the Contractor shall be at no additional cost to the Department.

Payment will be made under:

200	Pay Item	Pay Unit Symbol
	Drilled Hole for Flowable Backfill.....	EACH
	Flowable Backfill, Non-Removable	CYS
	Flowable Backfill, Removable	CYS

SECTION 214 – GEOSYNTHETICS

214.01 Description

This work shall consist of furnishing and installing geosynthetics as shown on the plans or as directed by the Engineer and in accordance with 105.03.

MATERIALS

214.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate	904.03
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214.03

Geocell Confinement System	918.04
Geogrid.....	918.05
Geotextile for Pavement and Subgrade	918.02

Notes: Coarse Aggregate No. 2, 5, 43, 53, 73 shall be used only.
ACBF Slag shall not be allowed.

CONSTRUCTION REQUIREMENTS

20

214.03 Foundation Preparation

The embankment foundation shall be cleared and grubbed in accordance with 201 and excavated using lightweight equipment to minimize disturbance of the embankment foundation surface soils. Construction activities using equipment which cause pumping and rutting of the embankment foundation soils shall be prevented where possible and shall otherwise be minimized. Fine grading may be waived where impractical. When very soft soil is encountered, the embankment foundation shall be cleared of all trash and rubbish materials without disturbing the vegetation cover or root mat. The embankment foundation shall be subject to approval prior to placement of geosynthetics. Proofrolling of the embankment foundation will not be required in accordance with 203.09 when geosynthetics are used in construction of embankment foundation treatment.

30

(a) Geotextile as a Drainage Blanket

Geotextile shall be stored in such a manner as to prevent exposure to direct sunlight and damage by other construction activities. Geotextile shall be placed taut and transversely after backfilling all wheel tracks. Geotextile shall be overlapped by 3 ft and sewn in accordance with the manufacturer’s guidelines.

40

Coarse aggregate No. 2 or No. 5 shall be placed as directed and encapsulated with geotextile. Coarse aggregate shall be placed by spreading dumped material over previously placed material with light equipment in such a manner as to prevent damage to the geotextile. Dumping of coarse aggregate will be allowed on initial working platform. The overlap shall be staggered throughout the roadway profile. Coarse aggregate shall be placed to the full required thickness and compacted before any loaded trucks are allowed on the blanket. The drainage blanket shall have positive drainage.

50

No vehicles or construction equipment shall be allowed on the geotextile prior to placement of the coarse aggregate. Damaged geotextile shall be repaired or replaced as directed. Damaged geotextile may be patched by placing a piece of the same geotextile over the damaged area. The overlap shall be at least 3 ft wide. The remaining lifts of the embankment shall be in accordance with 203.23.

(b) Geotextile Placement for Pavement, Subgrade, or Embankment

The subgrade or embankment shall be proofrolled in accordance with 203.26 and any defect or rut shall be repaired as directed prior to the geotextile placement. Geotextile shall be placed taut, without wrinkles and stretched in tension. Coarse aggregate shall be placed with a minimum disturbance to grade. Any damage to

- 60 geotextile shall be repaired in accordance with 214.03(a). The remaining grade shall be constructed in accordance with 207.

Geotextile shall be covered within three calendar days of placement.

(c) Geogrid Placement in Embankment and Subgrade

- The geogrid shall be installed in accordance with the Engineer's designs or the manufacturer's recommendations. The geogrid shall be kept taut during placement of the initial lift of backfill. Installation shall require the use of stakes, staples, sandbags, pile of granular fill, or other approved means to hold the geogrid in place during fill placement operations. Type IA geogrid shall be used for embankment foundation treatment. Type IB geogrid shall be used for subgrade treatment, type IV. When placing type IA geogrid, any rutting in the granular material shall not exceed 3 in. in the embankment foundation. The Engineer may increase the lift thickness to obtain stability of the granular material.
- 70

If required by the Engineer, the geogrid material supplier shall provide a qualified manufacturer's representative on the contract site at the start of the work to assist the Contractor. The representative shall also be available during the construction when required by the Engineer or the Contractor.

80

When type IB geogrid is used, proofrolling shall be performed in accordance with 203.26 prior to placing the type IB geogrid. Deflection or rutting shall not exceed 1 in. Any defect shall be repaired as directed. The first 6 in. of coarse aggregate No. 53 shall be spread and compacted with a 10 t roller in static mode. The spreading and compaction of the aggregate shall be performed so that adequate interlocking of the aggregate and geogrid is obtained. The second 6 in. of coarse aggregate No. 53 shall be constructed in accordance with 301.

- The geogrid shall be overlapped a minimum of 2 ft side to side and end to end for type IB. The type IA geogrids shall be overlapped 3 ft in areas where foundation conditions cannot support foot traffic or where 2 ft is found to be inadequate during fill placement. Overlaps shall be oriented in the direction of fill placement, or shingled, to prevent advancing fill from lifting any geogrid roll edges. Overlaps shall be further secured to prevent separation during fill placement. Damaged geogrid shall be patched. Patching shall include placement of a minimum of 3 ft of overlapped geogrid beyond the damaged area. If the damaged portion extends for more than 50% of the roll in the width direction, the entire width shall be replaced.
- 90

- Geogrid shall be covered with fill within three calendar days after placement.
- 100 Only that amount of geogrid required for pending work shall be placed to minimize exposure of the geogrid.

(d) Geocell Confinement System

The Contractor shall construct the grade in accordance with 203. A layer of geotextile shall be placed in accordance with 214.03(b) and shall be anchored at the

roadway edge when widening or when intersecting an existing roadway. The geocell confinement system, GCS, shall be placed and anchored as shown on the plans, or as directed. The Contractor shall ensure that the GCS is anchored vertically and the geocell shall be filled with a minimum of 3 in. of coarse aggregate No. 5, No. 8, or
 110 No. 43. If the Contractor chooses No. 5 or No. 8, geotextile in accordance with 918.02(a), Type 1B shall be placed on the GCS before placing No. 53 or No. 73. The GCS shall be oriented with the smaller cell dimension perpendicular to the roadway. The remaining GCS shall be filled with No. 53 or No. 73 and at least 9 in. of No. 53 or No. 73 shall be placed on the GCS. The aggregate shall be back dumped and compacted with a light roller in accordance with 301. No trucks or construction vehicles shall be allowed on the GCS. A light tracked bulldozer or other equipment may be used as directed. A 6 in. lift above GCS shall be compacted with low frequency and amplitude, with a minimum of six passes. The remaining aggregate shall be placed and compacted lightly at first, then with high amplitude. Efforts shall be made to
 120 ensure that the geotextile and GCS are in tension. The Contractor may propose an alternate means of providing a typical section for the GCS, and shall submit the proposal to the Engineer for review and approval. The proposal shall be certified by a professional engineer licensed in the State of Indiana.

GCS shall be constructed in accordance with 207 and 214.

214.04 Fill Placement

Construction vehicles shall not be on the geogrid. The placement of the fill shall proceed forward along the roadway centerline and outward to the embankment edges
 130 and compacted in accordance with 203.23. The Engineer may waive density requirements for the first lift of embankment foundation treatment if the fill is determined to be too weak to support compaction equipment.

214.05 Method of Measurement

Geotextile for pavement, and subgrade will be measured by the square yard, for the type specified. Geotextile for coarse aggregate and drainage blankets will be measured in accordance with 301 and 616, respectively. Geogrid will be measured by the square yard, for the type specified. The quantity will be computed based on the total area of geosynthetics shown on the plans. The aggregate used for the embankment
 140 foundation improvement will be measured in accordance with 301.09. The geogrid reinforced subgrade will be measured in accordance with 207.05.

The GCS and the excavation required to place the GCS will not be measured.

214.06 Basis of Payment

The accepted quantity of geotextile will be paid for at the contract unit price per square yard per type of geotextile. The accepted quantities of geogrid will be paid for at the contract unit price per square yard per type of geogrid. The aggregates will be paid for in accordance with 301.10. The geogrid reinforced subgrade will be paid for
 150 in accordance with 207.06.

Payment will be made under:

Pay Item	Pay Unit Symbol
Geotextile for Pavement, _____ type	SYS
Geotextile for Subgrade, _____ type	SYS
160 Geogrid, _____ type	SYS

The cost of furnishing the materials, manufacturer’s representative, all labor and equipment required for furnishing and placing the geotextile or geogrid, all work necessary to establish grades, geogrid splices, overlaps, stakes or pins, supplemental product test data, and patching or replacement of damaged geotextile or geogrid shall be included in the cost of this work.

170 The geocell confinement system, anchors, restraint clips, pins, necessary incidentals required to provide a complete in place system, and the Type IB geotextile if required for the GCS, shall be included in the cost of subgrade treatment in accordance with 207.06.

SECTION 215 – CHEMICAL MODIFICATION OF SOILS

215.01 Description

This work shall consist of the modification of soils by uniformly mixing portland cement, fly ash, or lime with soil to aid in strength gain and achieving the workability of soils.

MATERIALS

10 **215.02 Materials**

Materials shall be in accordance with the following:

Fly Ash, Class C	901.02
Lime	913.04(b)
Portland Cement, Type I.....	901.01(b)
Water	913.01

Note: Quicklime or portland cement may be used dry or as a slurry.

Soils for chemical modification shall meet the following requirements.

20

Soil Property	Test Method	Requirement
Maximum Dry Density	AASHTO T 99	≥ 90 pcf
Organic Material	AASHTO T 267	≤ 6%
Sulfate Content	ITM 510	≤ 1,000 ppm

CONSTRUCTION REQUIREMENTS

215.03 Testing and Mix Design

The Contractor shall be responsible for the mix design. The mix design shall be performed by a Qualified Geotechnical Consultant in accordance with the Department's Design Procedures for Soil Modification or Stabilization.

30 The quantities for hydrated lime, quicklime, or portland cement shall be based on 5.0% of the maximum dry density of the soils. The quantities for lime by-products shall be based on 6.0% of the maximum dry density of the soils. The quantities for fly ash class C shall be based on 12.0% of the maximum dry density of the soils. Class F fly ash shall not be used.

If hydrated lime, quick lime, lime by-products or portland cement are used, test results and the geotechnical consultant recommendations shall be submitted to the Engineer prior to use. If fly ash is used, the test results and the geotechnical consultant recommendations shall be submitted to the Engineer and to the Department's Geotechnical Engineering Division for approval at least three business days prior to use. If the modifier as bid is not appropriate for the soils encountered, portland cement shall be used. Portland cement, fly ash, lime, and lime by-products shall be from the Department's QPLs of Cement Sources, Pozzolan Sources, and Soil Modifiers, respectively.

40

The quantity of chemical modifier may be adjusted for different soil types. However, the source or type of chemical modifier shall not be changed during the progress of the work without approval. A change in source or type shall require a new mix design.

50 215.04 Storage and Handling

The chemical modifier shall be stored and handled in accordance with the manufacturer's recommendations.

215.05 Weather Limitations

The chemical soil modification shall be performed when the soil has a minimum temperature of 45°F, measured 4 in. below the surface, and with the air temperature rising. The chemical modifier shall not be mixed with frozen soils or with soil containing frost. Chemical soil modification shall only be performed in areas which are going to be paved during the same construction season.

60

215.06 Preparation of Soils

The soils shall be prepared in accordance with 207.03. All aggregates which are larger than approximately 3 in. encountered before or after mixing the soils and chemical modifiers shall be removed.

215.07 Spreading of Chemical Modifiers

Where type A-6 or A-7 soils are used or encountered, the surface shall be scarified to the specified depth prior to distribution of the chemical modifier. The chemical modifier shall be distributed uniformly by a cyclone, screw-type, or pressure manifold type distributor. If a slurry is used, the surface shall be scarified prior to the distribution of the slurry. The chemical modifier shall not be applied when wind conditions create problems in adjacent areas or create a hazard to traffic on any adjacent roadway. The spreading of the chemical modifier shall be limited to an amount which can be incorporated into the soil within the same work day. If weather causes stoppage of work or exposes the chemical modifier to washing or blowing, additional chemical modifier may be spread when the work resumes.

215.08 Mixing

The chemical modifier, soil, and water when necessary, shall be thoroughly mixed by rotary speed mixers. The mixing shall continue until a homogenous layer of the required thickness has been obtained. One hundred percent of the material, exclusive of rock particles, shall pass a 1 in. (25 mm) sieve and at least 60% shall pass a No. 4 (4.75 mm) sieve. The mixing depth shall be 14 in. The gradation test shall be performed in accordance with ITM 516.

The chemically modified soil mixture shall be at least 1% above the optimum moisture content during mixing and compaction. Water shall not be added to the chemically modified soil when the moisture content of the soil exceeds 3% above optimum moisture. Water shall be added during mixing only.

215.09 Compaction

Compaction of the mixture shall begin as soon as practicable after mixing and shall be in accordance with 207.03 as applicable. Compaction after mixing shall be as follows:

- (a) For portland cement modified soils, mixing shall be completed within 1 h of portland cement placement and grading and final compaction shall be completed within 3 h after mixing.
- (b) Fly ash modified soils shall be compacted within 4 h.
- (c) Lime modified soils shall be compacted within 24 h.

Acceptance of chemically modified soils will be determined in accordance with ITM 508 or ITM 509. Testing of the chemically modified soils will begin a minimum of 24 h after compaction.

Acceptance of chemically modified soils will be determined by averaging three LWD tests obtained at random stations determined in accordance with ITM 802. The deflection shall be equal to or less than the allowable average deflection shown in the table below.

Material Type	Allowable Average Deflection, (mm)	Maximum Deflection at a Single Test Location (mm)
Cement Modified Soils	0.27	0.31
Lime Modified Soils	0.30	0.35

For measuring the compaction with a DCP, three random test locations will be determined in accordance with ITM 802. Blow counts of 15 and above will be used to determine the average for the top 6 in. of a 14 in. lift. Blow counts of 14 and above will be used to determine the average for the bottom 8 in. of a 14 in. lift. Blow counts of 18 and above will be used to determine the average for the 8 in. lift. Locations with test results less than the specified minimum blow counts will be retested and shall be reworked if the minimum blow count is not obtained. The frequency of LWD or DCP testing will be three tests for each 1,400 cu yds of chemically modified soils.

The chemically modified soil lift shall meet the following requirements for compaction:

- (a) The average DCP blow count shall not be less than 17 for the top 6 in. of a 14 in. lift.
- (b) The average DCP blow count shall not be less than 16 for the bottom 8 in. of a 14 in. lift.
- (c) Moisture tests for chemically modified soils mixture shall be performed in accordance with ITM 506 every 4 h during chemical and soils mixing.
- (d) One gradation test shall be performed for each 2,500 cu yds of chemically modified soil in accordance with 215.08 and ITM 516.

Construction traffic or equipment will not be allowed on the treated soils until the soil meets the compaction test requirements.

215.10 Curing

Moisture content shall be maintained at 1% above the optimum moisture content for the first 48 h after mixing.

215.11 Proofrolling

Proofrolling shall be performed in accordance with 203.26.

215.12 Method of Measurement

The accepted quantity of chemically modified soils, for the material specified, will be measured by the square yard, complete in place. All removal and replacement required to modify the soils below the specified depth will be measured in accordance with 203.27(b).

215.13 Basis of Payment

The accepted quantity of chemically modified soils, for the material specified, will be paid for by the square yard, complete in place.

160 Fly ash, when used, will be paid for as lime.

All removal and replacement required to modify the soils below the specified depth will be paid for in accordance with 203.28.

170 Adjustment of materials for chemical modification that exceeds the limits of 215.03 will be included in a change order for materials only and paid for as chemical modifier adjustments. If mix design test results show that the chemical modifier as bid by the Contractor is not appropriate and the strength of the modified soil can not be achieved, a price adjustment will be made for the use of portland cement. The price adjustment will be calculated at a cost equal to the difference in the invoice cost of the chemical modifier found to be appropriate for use and the invoice or quoted delivered cost of the chemical modifier as bid by the Contractor. This adjustment will be included in a change order and will be paid for as chemical modifier adjustments. Fly ash will not be considered for price adjustment. Payment for chemical modifier adjustments will be made for direct delivered material costs incurred by the Contractor in accordance with 109.05.

Payment will be made under:

180	Pay Item	Pay Unit Symbol
	Chemical Modification, Soils, _____ material SYS

190 The cost of performing the laboratory tests, providing a qualified geotechnical consultant, scarification of the soil, spreading and mixing of the chemical modifier and soil, compaction of the resultant mixture, shaping the soil, work required due to adjustments of modifier proportioning, additional modification required due to weather conditions, correction of deficient areas, water required for the modification process, modified soil trimming, moisture testing, gradation testing, proofrolling, and all operations needed to meet the requirements of this specification shall be included in the cost of the pay items of this section.

SECTION 216 – CELLULAR CONCRETE FILL, CCF

216.01 Description

This work shall consist of furnishing and placing a lightweight, low absorbability cellular concrete fill in accordance with 105.03.

MATERIALS

216.02 Materials

10 Materials shall be in accordance with the following:

Cement	901.01(b)
Fly Ash	901.02
Water	913.01

An admixture in accordance with 912.03 may be used as recommended by the CCF manufacturer.

20 A foam liquid concentrate in accordance with ASTM C796 shall be used to produce the CCF properties in accordance with 216.04. The foam liquid concentrate shall be chosen from those shown on the QPL of CCF Manufacturers/Installers.

CONSTRUCTION REQUIREMENTS

216.03 Mix Design

A mix design prepared in accordance with the geotechnical report shall be submitted to the Engineer for approval at least five work days before the CCF operations begin. A cellular concrete manufacturer shall be chosen from those shown on the QPL of CCF Manufacturers/Installers.

30

216.04 Properties and Tests

The CCF shall be in accordance with the manufacturer’s recommendations and the minimum physical properties as follows:

Properties	Class II	Class III	Class IV
Cast Density Mix	810 lb/cu yd	972 lb/cu yd	1,134 lb/cu yd
Compressive Strength, ASTM C495*, min.	40 psi	80 psi	120 psi
Freeze-thaw Resistance, at relative E = 70%, ASTM C666, modified, min.		80 cycles	300 cycles
Water Absorption, max.**	20%	16%	14%
Shear Modulus, G, ASTM D4015	25,000 psi	34,000 psi	
Young Modulus, E, ASTM D4015	67,000 psi	102,000 psi	
* Specimens shall not be oven dried for the compressive strength test. ** Percentage after 120 days. Long-term total immersion as a percent of cast density in accordance with ASTM C796.			

(a) CCF Cast Density

The density shall be monitored at the point of placement at hourly intervals during

40 placement. Adjustments shall be made as necessary to maintain the specified cast density, $\pm 10\%$. If two consecutive test results are failing, operations shall cease and corrective action taken before placement of the CCF resumes.

(b) Foam Density

Foam density shall be tested twice during each 24 h period for each mixer. The foam density shall be within 10% of the target provided in the approved mix design.

216.05 Storage and Handling

Protection of the material during and after placement shall be in accordance with the manufacturer's recommendations.

50

216.06 Weather Limitations

CCF shall be placed when the ambient temperature is 32°F or above. CCF shall not be placed on frozen subsoil. The installation procedure shall not begin if a temperature of less than 32°F is expected within a 10 h period from the completion of the CCF placement, unless recommended by the manufacturer.

216.07 Preparation of Subgrade

The subgrade shall be prepared in accordance with 207. All standing water shall be removed prior to placement of CCF.

60

216.08 Installation

CCF shall be proportioned, mixed, and placed in lifts as recommended by the manufacturer. Transit mixers will not be acceptable for mixing the CCF. The CCF shall not be subjected to load or disturbed by construction activities until a minimum compressive strength of 25 psi has been achieved.

The final surface finish shall be within ± 0.1 ft of the plan elevation.

216.09 Lots

70 Lots will be defined as 300 cu yds of CCF placed. A partial lot equal to or less than 60 cu yds shall be included in the previous lot. A partial lot greater than 60 cu yds but less than 300 cu yds will be considered a full lot.

216.10 Testing

80 Acceptance of the work will be based on successful test results for compressive strength. The Contractor shall cast four specimens for each lot. Testing of the specimens will be in accordance with ASTM C495, except test specimens shall be covered immediately after casting. The specimens shall be moist cured for 26 days and then air cured for two days prior to the compressive strength testing. The specimens shall not be oven dried. Test specimens will become the property of the Department after curing and will be tested at 28 days.

216.11 Method of Measurement

CCF will be measured by the cubic yard for each class as computed from the neat

216.12

lines shown on the plans.

216.12 Basis of Payment

CCF will be paid for at the contract unit price per cubic yard of the class specified.

90 Payment will be made under:

Pay Item	Pay Unit Symbol
Cellular Concrete Fill, _____ class	CYC

Water, curing, molds, equipment, materials, and other incidentals necessary for finishing CCF specimens shall be included in the cost of CCF.

100 No payment will be made for replacement of damaged CCF.

SECTION 217 – SOILS DRYING WITH CHEMICAL MODIFIERS

217.01 Description

This work shall consist of drying soils by uniformly mixing fly ash or lime with soil to aid in achieving the workability of soils having moisture over 2% above optimum moisture content.

MATERIALS

10 **217.02 Materials**

Materials shall be in accordance with the following:

Fly ash	901.02
Lime	913.04(b)
Water	913.01

20 Soils containing organic content greater than 6% by dry weight or having a maximum dry density of less than 95 pcf, or with soluble sulfate content greater than 1,000 ppm shall not be used. The maximum dry density shall be determined in accordance with AASHTO T 99, the organic content shall be determined in accordance with AASHTO T 267, and the sulfate content shall be determined in accordance with ITM 510.

CONSTRUCTION REQUIREMENTS

217.03 Testing and Mix Design

The Contractor shall be responsible for all tests required to determine the chemical modifier type and the relationship between the soils, chemical modifier, and moisture content. The modifier selection, laboratory testing, and mix design shall be performed

- 30 by a qualified geotechnical consultant in accordance with the Department's Design Procedures for Soil Modification or Stabilization.

Chemical modifier, mix design, test results, and the geotechnical consultant recommendations shall be submitted to the Engineer and to the Department's Geotechnical Engineering Division for approval at least three business days prior to use. Fly ash and lime shall be from the Department's QPLs of Pozzolan Sources and Soil Modifiers, respectively.

- 40 The quantity of chemical modifier may be adjusted for different soil types and moisture content.

217.04 Storage and Handling

The chemical modifier shall be stored and handled in accordance with 215.04.

217.05 Weather Limitations

- 50 The chemical soil treatment shall be performed when the soil has a minimum temperature of 35°F, measured 4 in. below the surface, and with the air temperature rising. The chemical modifier shall not be mixed with frozen soils or with soil containing frost. When the soil temperature is expected to fall below 35°F prior to the next lift being placed, chemically treated soils shall be protected from freezing by placing a minimum of 12 in. thick soil.

217.06 Preparation of Soils

The preparation of the soil shall be in accordance with 215.06. The maximum loose lift shall be no more than 12 in.

217.07 Spreading of Chemical Modifiers

- 60 The specified quantity of chemical modifier shall be spread on the surface. The chemical modifier shall be distributed uniformly by a cyclone, screw-type, or pressure manifold type distributor. Where type A-7 soils are encountered, the soil shall be scarified prior to spreading the chemical modifier. The chemical modifier shall not be applied when wind conditions create problems in adjacent areas or create a hazard to traffic on any adjacent roadway. The spreading of the chemical modifier shall be limited to an amount which can be incorporated into the soil within the same work day. The chemical modifier spreading rate shall be adjusted to the current soil moisture content. If weather causes stoppage of work or exposes the chemical modifier to washing or blowing, additional chemical modifier may be spread when the work resumes. Any materials wasted or disturbed by the Contractor's actions shall be repaired or replaced at no additional cost.

70

217.08 Mixing

The chemical modifier, soil, and water when necessary, shall be thoroughly mixed by rotary speed mixers. The mixing shall continue until a homogenous layer of the required thickness has been obtained. One hundred percent of the material, exclusive of rock particles, shall pass a 1 in. (25 mm) sieve and at least 60% shall pass a No. 4

217.09

(4.75 mm) sieve. The mixing depth shall not exceed 12 in.

217.09 Compaction

80 The moisture content of the mixture shall be at the optimum moisture content or above the optimum moisture content as determined by the mix design in accordance with 215.03. Moisture content will be determined in accordance with ITM 506. Aeration or drying by further mixing may be done to obtain the required moisture content. Compaction of the mixture shall begin as soon as practical. Compaction shall be in accordance with 203 or 207.03, as applicable.

Acceptance of chemically modified soils will be performed on the finished grade with a Dynamic Cone Penetrometer, DCP, in accordance with ITM 509. The chemically treated soil lift shall meet the following requirements for compaction:

- 90 (a) A minimum DCP blow count of 20 for 12 in. of in place modification.
- (b) A minimum of two passing DCP tests for each 1,000 lft or less of chemically treated soil for each two-lane pavement section.
- (c) A minimum of one gradation test shall be performed every 2,500 lft for each two-lane pavement section.
- 100 (d) A minimum of one moisture test shall be performed for every 4 h of lime soils mixing. A moisture test shall be performed if soil changes.

During embankment construction, placing of the second 12 in. lift is allowed when the first lift meets the blow counts requirements of 203.23. A third lift will not be allowed until the first lift complies with 217.09(a).

Construction traffic or equipment will be allowed after the minimum DCP blow count is obtained. Construction traffic or equipment shall be routed in one direction so that the chemically modified soil does not pump or rut.

110 217.10 Method of Measurement

The accepted quantity for drying soils will be measured by the ton of chemical modifier complete in place. Soils required to construct the fill will be measured in accordance with 203.

217.11 Basis of Payment

The accepted quantity of chemically modified soils will be paid for by the ton of chemical modifier used for drying. Soils required to construct the fill will be paid for in accordance with 203.

120 Payment will be made under:

Pay Item **Pay Unit Symbol**

Drying Soils for Embankment..... TON

130 The cost of performing the laboratory tests, providing a qualified geotechnical consultant, scarification of in-situ soil, spreading, pulverization, mixing of the chemical modifier and soil, moisture compaction of the resultant mixture, shaping the grade, work required due to adjustments of modifier proportioning, correction of deficient areas, water required for the modification process, and all operations needed to meet the requirements of this specification shall be included in the cost of the pay item of this section.

SECTION 218 - BLANK

SECTION 219 - CEMENT STABILIZED SUBGRADE SOIL

219.01 Description

This work shall consist of stabilizing 12 in. of subgrade soils by uniformly mixing portland cement to achieve the specified unconfined compressive strength in accordance with 105.03.

MATERIALS

10 **219.02 Materials**

Materials shall be in accordance with the following:

Portland Cement, Type I..... 901.01(b)
 Water 913.01

Note: Portland cement may be used dry or as a slurry.
 Soils shall meet the requirements of 215.02.

CONSTRUCTION REQUIREMENTS

20 **219.03 Construction Requirements**

Construction requirements shall be in accordance with 207.03 and as specified herein.

219.04 Testing and Mix Design

30 Testing and mix design shall be in accordance with 215.03. The Contractor shall be responsible for all tests required to determine the optimum cement content for producing cement stabilized subgrade soil with a minimum unconfined compressive strength of 300 psi at seven days. The quantities of portland cement shall be based on 6% of the maximum dry density of the soils. Laboratory testing and mix design shall be performed by a qualified geotechnical consultant in accordance with the Department's Design Procedures for Soil Modification or Stabilization. The

unconfined compressive strength test shall be performed in accordance with AASHTO T 208. Sulfate tests for water shall be performed in accordance with ASTM D516.

The mix design, test results, and the geotechnical consultant recommendations shall be submitted to the Engineer and to the Department's Geotechnical Engineering Division for approval at least five business days prior to use.

40 The Contractor shall submit a QCP in accordance with ITM 803. The QCP shall address all of the testing requirements for the section as specified.

219.05 Storage and Handling

Storage and handling shall be in accordance with 215.04.

219.06 Weather Limitations

Weather limitations shall be in accordance with 215.05.

219.07 Preparation of Soils

50 Soil preparation shall be in accordance with 215.06. All rocks greater than 2 in. encountered before or after mixing the soils and chemical modifiers shall be removed.

When stabilization of foundation soils with cement is required in a cut or at-grade section, the top 12 in. of soil for cement stabilized subgrade soil shall be removed and stockpiled prior to constructing the 14 in. thick stabilization of foundation soils with cement. When the stabilization of foundation soils with cement is complete, the 12 in. of cement stabilized subgrade soil shall then be placed.

60 When stabilization of foundation soils with cement is required in a fill section, it shall be constructed prior to placement of the 12 in. of soil for cement stabilized subgrade soil.

219.08 Spreading and Mixing of Cement

Spreading of cement shall meet the requirements of 215.07. The soil, cement, and water shall be in accordance with 215.08.

70 Cement, soil, and water shall be mixed using a power-driven transverse type mixer equipped with a computer controlled volumetric water readout. Mixing shall continue until the cement is thoroughly incorporated into the soil and the mixed materials are a uniform color. Water shall be added in sufficient quantity to hydrate the cement. Water shall be introduced through the mixer to bring the mixed material to at least optimum moisture content. One hundred percent of the material, exclusive of rock particles, shall pass a 1 in. (25 mm) sieve and at least 80% shall pass a No. 4 (4.75 mm) sieve. Water shall not be added when the moisture content of the soil exceeds 3% above optimum moisture content. The mixing and compaction shall be completed once the water has been added to the mixture. The mixing depth shall be 12 in. The moisture content shall be determined during soils cement mixing in accordance with ITM 506.

219.09 Compaction

80 Compaction of the mixture shall begin as soon as practicable after mixing and shall be in accordance with 203 or 207.03 as applicable. Compaction after mixing shall be completed within 1 h of portland cement placement and grading, and final compaction shall be completed within 3 h after mixing.

Initial compaction equipment shall consist of a vibratory tamping-foot roller.

Final compaction shall be performed with a smooth drum roller.

219.10 Trimming

90 Stabilized soil shall be prepared, and adequate drainage shall be provided at all times to prevent water from standing on the subgrade. The grade and cross section of the subgrade shall be finished within a tolerance of 1/2 in. from the subgrade elevation shown on the plans.

Even though the subgrade has been previously accepted, the condition of the subgrade shall be in accordance with 105.03 and 207.04 at the time paving material is placed.

100 Finishing within this tolerance by blading or other mechanical means without the use of side forms will be allowed. If these methods do not finish within this tolerance, side forms shall be used.

219.11 QC Testing

QC testing shall be performed as follows:

110 (a) QC testing for compaction of cement stabilized subgrade soils shall be performed on the finished grade with an LWD in accordance with 203.24(b) with the exception that the interval for LWD testing shall be every 1,000 sq yds. Testing for the cement stabilized subgrade soils shall begin seven days after compaction. Construction traffic or equipment exceeding 5 t in weight shall not be allowed on the treated soils until the area has passed LWD testing.

(b) Moisture testing of soil cement mixtures shall be performed in accordance with ITM 506 at every 1,000 sq yds during cement and soils mixing.

120 (c) One gradation test shall be performed for every 1,000 sq yds of cement modified soil. Gradation tests shall be performed in accordance with ITM 516.

(d) Two test specimens shall be prepared at 95% of the Standard Proctor and cured for seven days. Specimens shall be taken every 1,000 ft of

length by lane width and shall be obtained by the Contractor. Unconfined compressive strength tests shall be performed in accordance with AASHTO T 208. The sample of the cement stabilized soils mixture shall be taken during pulverization and mixing.

- 130 (e) Cement spread rate shall be checked at every 2,000 ft of length by lane width. Spread rate shall be in accordance with ITM 516.
- (f) The soil cement mixing depth shall be checked at every 2,000 ft of length by lane width in accordance with ITM 516 after mixing and prior to compaction.
- (g) All tests performed by the Contractor shall be compiled and submitted to the Engineer on a weekly basis for documentation of strengths obtained.

140

219.12 Quality Assurance, QA, Testing

Moisture tests based on ITM 506 for soil cement mixtures will be performed at every 2,000 sq yds during cement and soils mixing.

Acceptance testing for compaction of cement stabilized subgrade soils will be performed on the finished grade with an LWD in accordance with 203.24(b) with the exception that the interval for LWD testing will be every 2,000 sq yds. The acceptance test for the cement stabilized subgrade soils will begin seven days after compaction.

- 150 The allowable average deflection and maximum deflection for cement stabilized subgrade soil shall be in accordance with the following:

Material Type	Allowable Average Deflection (mm)	Maximum Deflection at Single Test Location (mm)
Cement Stabilized Subgrade Soil	≤ 0.14	0.17

219.13 Curing

The surface shall be maintained in a moist condition with no visible dry areas for the first seven days after mixing with cement. Liquid membrane forming compound shall be applied in accordance with 504.04(a) to the surface and reapplied as applicable for the first seven days to aid in curing and prevent loss of moisture.

160

219.14 Proofrolling

The entire stabilized soil shall be proofrolled in accordance with 203.26. Deflection or ruts greater than 1/4 in. shall be corrected as directed.

219.15 Method of Measurement

The accepted cement stabilized subgrade soil will be measured by the square yard, complete in place.

219.16 Basis of Payment

170 The accepted quantity of cement stabilized subgrade soil will be paid for at the contract unit price per square yard.

Approved adjustments for cement that exceed the limit of 219.04 will be included in a change order for materials only and paid for as additional cement for subgrade soil stabilization. Payment for additional cement for subgrade soil stabilization will be made for direct delivered material costs incurred by the Contractor and will not include any other markups.

Payment will be made under:

180	Pay Item	Pay Unit Symbol
	Cement Stabilized Subgrade Soil	SYS

190 The cost of performing mix design, services of a qualified geotechnical consultant, scarification of the soil, spreading and mixing of the cement and soil, compaction of the resultant mixture, shaping the soil, work required due to adjustments of modifier proportioning, work required due to weather conditions, correction of deficient areas, water required for the stabilization process, soil trimming, liquid membrane forming compound, and all operations needed to meet the requirements of this specification shall be included in the cost of the pay item.

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DIVISION 300 – AGGREGATE PAVEMENT AND BASES

SECTION 301 – AGGREGATE BASE

301.01 Description

This work shall consist of placing coarse aggregate on a prepared grade in accordance with 105.03.

MATERIALS

301.02 Materials

10 Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher.....	904.03
Geosynthetic Materials.....	918

ACBF shall not be used for subgrade treatment types ID, IV, and IVA.

CONSTRUCTION REQUIREMENTS

301.03 Preparation of Subgrade

20 Subgrade shall be prepared in accordance with 207.04. Proofrolling will not be required in trench sections and other areas where proofrolling equipment cannot be used.

301.04 Temperature Limitations

Aggregate shall not be placed when the air temperature is less than 35°F. Aggregate shall not be placed on a frozen subgrade. Frozen aggregate shall not be placed.

301.05 Spreading

30 The moisture content of the aggregate shall be between 4% and the optimum moisture content when the aggregate is delivered to the project. Unless otherwise directed, water shall not be added to the aggregate on the grade.

Aggregate shall be spread in uniform lifts with a spreading and leveling device approved by the Engineer. The spreading and leveling device shall be capable of placing aggregate to the depth, width, and slope specified. The compacted depth of each lift shall be a minimum of 3 in. and a maximum of 6 in.

40 Aggregate shall be handled and transported to minimize segregation and the loss of moisture. In areas inaccessible to mechanical equipment, each lift shall be 3 in. and an approved hand spreading method may be used.

301.06 Compacting

Dense graded aggregate shall be compacted to achieve the allowable average

301.07

deflection as determined with LWD testing in accordance with 203.24(b).

The allowable average deflection for aggregate over the chemically modified soils and untreated soils shall be in accordance with the Tables shown in 203.24(b).

50 As an alternate, aggregates shall be compacted to a minimum of 100% of the maximum dry densities in accordance with AASHTO T 99. In situ density will be determined in accordance with 203.24(b). Aggregate shall meet the compaction requirements at the time subsequent courses are placed.

Coarse graded aggregates shall be compacted in accordance with 203.25.

In areas inaccessible to compaction equipment, such as private drives and mailbox approaches, the compaction requirements may be accepted by visual inspection.

60 All displacement or rutting of the aggregate shall be repaired prior to placing subsequent material.

301.07 Checking and Correcting Base

The top of each aggregate course shall be checked transversely to the cross section and all deviations in excess of 1/2 in. shall be corrected. If additional aggregate is required, the course shall be remixed and re-compacted.

301.08 Priming

A prime coat, when required, shall be in accordance with 405.

70

301.09 Method of Measurement

Compacted aggregate base will be measured by the cubic yard based on the theoretical volume to the neat line as shown on the plans. Geotextiles will be measured in accordance with 616.12.

301.10 Basis of Payment

The accepted quantities of compacted aggregate base will be paid for at the contract unit price per cubic yard, complete in place. Geotextiles will be paid for in accordance with 616.13.

80

Payment will be made under:

Pay Item	Pay Unit Symbol
Compacted Aggregate, No. 2	CYS
Compacted Aggregate, No. 5	CYS
Compacted Aggregate, No. 8	CYS
Compacted Aggregate, No. 53	CYS

90 The cost of placing, compacting, water, aggregate placed outside neat lines as

shown on the plans, and necessary incidentals shall be included in the cost of the pay item.

Payment will not be made for material placed outside of a 1:1 slope from the planned typical section.

Replacement of pavement damaged by the Contractor's operations shall be at no additional payment.

100

SECTION 302 – SUBBASE

302.01 Description

This work shall consist of a foundation course of selected materials, placed and compacted on a prepared subgrade in accordance with 105.03.

Subbase for PCCP shall consist of a 3 in. layer of coarse aggregate No. 8 as the aggregate drainage layer placed over a 6 in. layer of coarse aggregate No. 53 as the separation layer. Dense graded subbase shall consist of a 6 in. layer of coarse aggregate

10 No. 53.

MATERIALS

302.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate, Class B or Higher, Size No. 8 904

Coarse Aggregate, Class D or Higher, Size No. 53 904

20 Coarse aggregate No. 8 used as an aggregate drainage layer shall consist of 100% crushed stone or ACBF.

CONSTRUCTION REQUIREMENTS

302.03 Preparation of Subgrade

Subgrade shall be prepared in accordance with 207.

302.04 Temperature Limitations

Aggregate shall not be placed when the air temperature is less than 35°F.

30 Aggregate shall not be placed on a frozen subgrade. Frozen aggregate shall not be placed.

302.05 Spreading

Aggregate shall be spread in uniform lifts with a spreading and leveling device approved by the Engineer. The spreading and leveling device shall be capable of

302.06

placing aggregate to the depth, width, and slope specified. The compacted depth of each lift shall be a minimum of 3 in. and a maximum of 6 in.

40 Aggregate shall be handled and transported to minimize segregation and the loss of moisture. In areas inaccessible to mechanical equipment, approved hand spreading methods may be used.

The moisture content of the aggregate shall be between 4% and the optimum moisture content when the aggregate is delivered to the project. Water shall not be added to the aggregate on the grade.

302.06 Compacting

Subbases shall be compacted as follows:

50 (a) Aggregate Separation Layers and Dense Graded Subbase

Compaction shall be in accordance with 301.06.

All displacement or rutting of the aggregate separation layers shall be repaired prior to placing subsequent material.

(b) Aggregate Drainage Layer

60 Compaction shall consist of two passes with a vibratory roller before trimming, and one pass with the same roller in static mode after trimming. A vibratory roller shall be equipped with a variable amplitude system, a speed control device, and have a minimum vibration frequency of 1,000 vibrations per minute. A roller in accordance with 409.03(d)4 may be used.

Construction traffic shall not be allowed on the aggregate drainage layer, except where placement of the PCCP is restricted. Exceptions shall be subject to approval by the Engineer. Displacement or rutting of the aggregate drainage layers shall be repaired prior to placing subsequent material.

In areas inaccessible to standard size compacting equipment a specialty roller/compactor in accordance with 409.03(d)7 shall be used.

70

302.07 Checking and Correcting Subbase

The top of each aggregate course shall be checked transversely and all deviations in excess of 1/2 in. shall be corrected. If additional aggregate is required, the course shall be remixed and recompactd.

302.08 Method of Measurement

80 Subbase for PCCP or dense graded subbase will be measured by the cubic yard based on the theoretical volume to the neat lines as shown on the plans. The quantity shown in the Schedule of Pay Items will be adjusted if it is shown to be different by more than 2% of the measured quantity.

302.09 Basis of Payment

The accepted quantities of subbase for PCCP or dense graded subbase will be paid for at the contract unit price per cubic yard, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
90	Dense Graded Subbase	CYS
	Subbase for PCCP	CYS

The cost of compacting, water, aggregate placed outside neat lines as shown on the plans, and necessary incidentals shall be included in the cost of the subbase.

SECTION 303 – AGGREGATE PAVEMENTS OR SHOULDERS

303.01 Description

This work shall consist of placing a dense-graded compacted aggregate on prepared subgrade in accordance with 105.03.

MATERIALS

303.02 Materials

10 Materials shall be in accordance with the following:

- Coarse Aggregate, Class D or Higher, Size No. 53 904
- Coarse Aggregate, Class D or Higher, Size No. 73* 904
- * Surface courses only, when specified.

CONSTRUCTION REQUIREMENTS

303.03 Preparation of Subgrade

20 Subgrade shall be prepared in accordance with 207.04. Proofrolling will not be required in trench sections and other areas where proofrolling equipment cannot be used.

303.04 Temperature Limitations

Aggregate shall not be placed when the air temperature is less than 35°F. Aggregate shall not be placed on a frozen subgrade. Frozen aggregate shall not be placed.

303.05 Spreading

30 Aggregate shall be spread in uniform lifts with a spreading and leveling device approved by the Engineer. The spreading and leveling device shall be capable of placing aggregate to the depth, width, and slope specified. The compacted depth of each lift shall be a minimum of 3 in. and a maximum of 6 in., except where utilized as

a shoulder. The compacted depth of a lift for a shoulder shall be a minimum of 3 in. and a maximum of 9 in.

Aggregate shall be handled and transported to minimize segregation and the loss of moisture. In areas inaccessible to mechanical equipment, approved hand spreading methods may be used.

- 40 The moisture content of the aggregate shall be between 4% and the optimum moisture content when the aggregate is delivered to the project. Water shall not be added to the aggregate on the grade.

303.06 Compacting

Compaction shall be in accordance with 301.06.

All displacement or rutting of the compacted aggregate shall be repaired prior to placing subsequent material.

- 50 **303.07 Checking and Correcting Base and Surface**

The top of each aggregate course shall be checked transversely and all deviations in excess of 1/2 in. shall be corrected. If additional aggregate is required, the course shall be remixed and re-compacted.

303.08 Dust Palliative

A dust palliative, if required, shall be in accordance with 407.

303.09 Method of Measurement

- 60 Compacted aggregate will be measured by the ton in accordance with 109.01(b) for the type specified.

303.10 Basis of Payment

The accepted quantities of compacted aggregate will be paid for at the contract unit price per ton, for the type specified, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
70	Compacted Aggregate, No. 53	TON
	Compacted Aggregate, No. 73	TON

The cost of placing, compacting, water, and necessary incidentals shall be included in the costs of the compacted aggregate.

Payment will not be made for material placed outside of a 1:1 slope from the planned typical section.

80 Replacement or repair of pavement or shoulders damaged by the Contractor's operations shall be at no additional payment.

SECTION 304 – ASPHALT BASES

304.01 Description

This work shall consist of constructing an HMA base on a prepared surface or preparing an existing asphalt pavement for use as an asphalt base in accordance with 105.03.

MATERIALS

10 304.02 Materials

Materials shall be in accordance with the appropriate sections.

304.03 Sealing Cracks and Joints

Cracks and joints shall be sealed in accordance with 408.

304.04 Partial Depth and Full Depth Patching

20 Areas to be patched will be marked on the surface by the Engineer. The marked pavement shall be removed to the depth shown on the typical section or as directed. A minimum 2 in. vertical joint shall be constructed with the pavement that remains in place. If it is determined that the marked pavement is to be removed full depth, the patch depth shall be to the bottom of the existing asphalt material or as directed.

The subgrade of the aggregate base under the patches shall be compacted in accordance with 203.25. If the excavation for patches reveals unsuitable subgrade material, such material shall be removed to a depth of 6 in. and backfilled to the top of subgrade with compacted aggregate in accordance with 301. Unauthorized excavation beyond neat lines shall be replaced with compacted aggregate in accordance with 301.

30 The excavated patch areas shall be filled with HMA for patching of the type specified in the pay item and as shown on the plans. HMA used for patching shall be in accordance with 402. An MAF in accordance with 402.05 will not apply. The 175°F temperature requirement for the previously paved course in accordance with 402.13 will not apply. Mixtures will be accepted in accordance with 402.09.

Each course shall be compacted by approved mechanical equipment in accordance with 409.03(d).

40 A smooth riding surface shall be maintained on HMA patches at all times. Deformation due to traffic or other conditions shall be corrected immediately. HMA of the type specified in the pay item shall be used to maintain patches. Unless otherwise specified, patches shall be completed during daylight hours and opened to traffic at the close of the workday. Patches that cannot be completed prior to the end

90

Excavation for patching will not be paid for separately but shall be included in the cost of the patching material.

The cost of furnishing, storage, hauling, and placing of all materials; pavement removal as required; temporary pavement required to carry traffic; choke aggregate required to eliminate pickup; disposal; excavation; preparation of subgrade; compacting; and finishing except as otherwise provided shall be included in the cost of the patching materials.

100

The cost of excavation and disposal of existing materials required for the compacted aggregate or HMA widening material shall be included in the cost of the HMA widening material.

Replacement of pavement damaged by the Contractor's operations shall be at no additional payment.

SECTION 305 – CONCRETE BASES

305.01 Description

This work shall consist of constructing a PCC base on a prepared surface or preparing an existing concrete surface for use as a base all in accordance with 105.03.

MATERIALS

305.02 Materials

10 Materials shall be in accordance with the following:

Asphalt for Undersealing.....	612.02
Coarse Aggregate, Class A or Higher, Size No. 8.....	904
Coarse Aggregate, Class D or Higher, Size No. 53.....	904
Coarse Aggregate, Class D or Higher, Size No. 73.....	904

CONSTRUCTION REQUIREMENTS

305.03 New PCC Base

20

Construction of new PCC bases shall be in accordance with 502, except for 502.14, and 502.20. The CMDS shall be in accordance with 502.03 except utilization of the Department provided spreadsheet is not required. The surface shall be finished with wet burlap or by wood floats. Smoothness of the base will be controlled with a 16 ft long straightedge longitudinally and a 10 ft long straightedge transversely.

Joints shall be in accordance with 503, except for the following:

- (a) the second saw cut and sealing shall not be performed for transverse joints;

305.04

30

(b) sealing shall not be performed for longitudinal joints; and

(c) sawing and sealing shall not be performed for construction joints.

305.04 Existing PCCP

Preparation of PCCP for use as a base shall be in accordance with 507, except for:

(a) Patching

40 Patching PCC base shall be in accordance with 506 except the coarse aggregate shall be Class A or higher.

(b) Surface Milling

Surface milling shall be in accordance with 306.

(c) Retrofit Load Transfer

Retrofit load transfer shall be in accordance with 507.08.

(d) Rubblizing Existing PCCP

50 The existing pavement shall be rubblized with a self-contained, self-propelled, resonant frequency pavement breaking unit capable of producing low amplitude, 2,000 lbf blows at a rate of not less than 44 per second or with a self-contained, self-propelled, multiple headed, impact hammer with the heads directly adjacent to each other and the lift height of each head independently adjustable. The sequence of impacts shall be on a random basis. The unit shall be equipped with a water system to suppress dust generated by the operation.

60 The operating speed of the unit shall be such that the existing pavement is reduced to particles ranging from sand sized to pieces not exceeding 6 in. in the largest dimension, the majority being a nominal 1 to 2 in. in size. The concrete from the surface to the top of the reinforcement shall be reduced to the 1 to 2 in. size to the fullest extent possible. Continuous coverage, overlapped if necessary, with the breaking shoe or impact hammers shall be used. Additional passes of the resonator or multiple headed impact hammer may be required if larger sizes remain above the reinforcement.

Subsurface drains shall be installed along the edges of the pavement prior to the rubblization.

70 Rubblizing shall begin at the edge of pavement and proceed to the center of the pavement. The rubblization of the first lane shall extend 6 in. into the adjoining lane.

Prior to placing HMA mixtures, the complete width of the rubblized pavement shall be compacted by means of vibratory steel wheel and pneumatic-tired rollers in accordance with 409.03(d) in the following sequence: two initial passes with a vibratory roller, two passes with a pneumatic-tired roller, and then four final passes

with a vibratory roller. The last two roller passes shall be immediately prior to priming operations. When the multiple headed impact hammer is used, a Z-pattern grid cladding bolted to the surface of the drum of the vibratory roller shall be used at least for the final two passes.

80

The vibratory roller shall be operated in the vibration mode at a speed not to exceed 6 ft per s. All depressions 1 in. or greater in depth from that of the immediate surrounding area that result from the rubblizing or compaction effort shall be filled with coarse aggregate No. 53 or 73 and struck off level with the surrounding area. Filled depressions shall be compacted with the same roller and compactive effort previously described.

90

Reinforcement in the rubblized pavement shall be left in place. Any reinforcement protruding above the surface as a result of rubblizing or compaction operations shall be cut off below the surface and removed from the site. All loose joint fillers, expansion material, or other similar materials shall also be removed from the rubblized surface.

100

Traffic will not be allowed on the rubblized pavement before the HMA base or immediate courses are in place unless otherwise directed. Rubblized material dislodged by traffic shall be removed from the pavement. The initial HMA course shall be placed within 48 h of rubblizing. However, in the event of rain, this time limitation may be waived to allow sufficient time for the rubblized pavement to dry to the satisfaction of the Engineer. Crossover and ramp crossings shall be maintained in the same compacted state as other areas until the initial HMA course is placed.

The preceding rubblizing operations shall be scheduled after widening or shoulder work has progressed up to the elevation of the existing pavement grade. These areas may then be utilized to support the breaking unit while the existing pavement is being rubblized. Shoulders may then be completed in conjunction with the placement of HMA pavement courses over the compacted rubblized pavement.

110

A joint shall be saw cut full depth or load transfer devices shall be severed at an existing joint on ramps or mainline where the rubblizing abuts concrete pavement which is to remain in place.

305.05 Widening with PCC Base

The subgrade shall be prepared in accordance with 207. Subbase shall be in accordance with 302.

The concrete shall be placed directly against the existing pavement edges, which shall be free from all foreign materials. The surface of the concrete widening shall be at the same elevation as the top of the existing concrete base.

120

Materials and construction requirements shall be in accordance with the applicable requirements of 502, except the following:

170	PCC Base Patching, _____ in.....	SYS
	thickness	
	Rubblizing PCCP	SYS
	Widening with PCC Base, _____ in.....	SYS
	thickness	

If PCC base is found to be deficient in thickness, price adjustments in accordance with 502.23 will be determined.

180 The cost of excavation, disposal of existing materials, preparation of subgrade, and subbase required for the PCC base widening shall be included in the cost of widening with PCC base.

The cost of excavation, disposal of existing materials, preparation of subgrade, and subbase required for PCC base patching shall be included in the cost of PCC base patching.

Replacement of pavement damaged by the Contractor’s operations shall be without additional payment.

190 The cost of furnishing all labor, materials, and equipment necessary to rubblize, suppress dust, cut and remove exposed reinforcement, cut and remove joint fillers or similar materials, saw cutting of the pavement, severing existing joints, compacting and maintaining the compacted condition of the rubblized pavement shall be included in the cost of rubblized PCCP.

The cost of furnishing, hauling, placing, leveling, and compacting the aggregate to fill depressions in the rubblized PCCP shall be included in the cost of coarse aggregate No. 53 or 73.

SECTION 306 – MILLING

306.01 Description

This work shall consist of the milling of asphalt and concrete pavements and the disposal of milled materials in accordance with 105.03.

CONSTRUCTION REQUIREMENTS

306.02 General

10 Milling operations shall be described in the QCP in accordance with ITM 803. Where the milling operation in a partial-day closure results in a longitudinal vertical or near vertical face exceeding 2 in. in height, the adjacent lane shall be milled during the same day, the milled lane resurfaced during the same day, or the vertical face tapered at a 45° angle or flatter. Where located within 3 in. of a curb, surface material that cannot be removed by the cold-milling machine shall be removed by other approved methods.

Transverse milled vertical faces greater than 1 in. that are exposed to traffic shall be transitioned in an approved manner.

20

Castings located in milling areas that are not to be adjusted may remain in place during the milling, or may be removed and replaced at the Contractor's option.

Localized weak areas uncovered by the milling process shall be patched in accordance with 304 or 305.

The milled material shall become the property of the Contractor, unless otherwise specified.

30

The roadway shall be cleaned before opening to traffic.

306.03 Equipment

Equipment for milling shall be in accordance with the following.

(a) Roadway Milling Machine

A milling machine shall be a power operated cold-milling machine, equipped with automatic control devices to establish profile grades by referencing from either the existing pavement or from independent grade control. The equipment shall have a positive means of controlling cross slope elevations, have an effective means for removing excess material from the surface, preventing airborne dust escaping from the operation, and producing a finished surface that provides a good bond to the new overlay.

40

Sufficient cutting teeth shall be on the coarse milling or fine milling cutting drum to produce cuttings such that 90% of the conglomerate particles pass a 2 in. sieve. A coarse milling cutting drum shall have 5/8 in. spacing between the cutting teeth and be capable of producing a surface macrotexture ratio in accordance with ITM 812 equal to or greater than 1.8. A fine milling cutting drum shall have 5/16 in. or 3/8 in. spacing between the cutting teeth and be capable of producing a surface macrotexture ratio in accordance with ITM 812 equal to or greater than 5.0.

50

(b) Power Saw

Sawing equipment shall be capable of maintaining the specified alignment and depth of cut without damaging the pavement.

(c) Rotary Power Broom

A motorized, pneumatic tired unit with rotary bristle broom head.

(d) Straightedge

60

1. Straightedge – 16 ft

A 16 ft straightedge shall be a rigid beam mounted on two solid wheels on axles

16 ft apart. The straightedge has a mounted push bar to facilitate propelling the device along or across the pavement. Tolerance points are located at the 1/4, 1/2, and 3/4 points and may be composed of threaded bolts capable of being adjusted to the tolerance required.

2. Straightedge – 10 ft

70 A 10 ft straightedge is the same as a 16 ft straightedge except that the wheels are mounted 10 ft apart. A handheld rigid beam may be substituted.

306.04 Asphalt or PCCP Scarification Milling

Scarification milling shall consist of preparing a base for resurfacing by roughening the entire existing asphalt or PCCP surface. The milled pavement profile shall have a surface finish that does not vary longitudinally more than 1/4 in. from a 16 ft straightedge or as described in the QCP in accordance with 401.02.

80 A fine milling cutting drum in accordance with 306.03(a) shall be used when a single course overlay is specified with a lay rate as shown on the plans less than 165 lb/sq yd and the maximum scarification mill cut depth is expected to be less than 3/4 in. for asphalt or PCCP, otherwise, a coarse milling cutting drum in accordance with 306.03(a) shall be used.

The scarified milled surface shall have a macrotexture ratio in accordance with ITM 812 as follows:

- (a) equal to or greater than 5.0 when using a fine milling cutting drum for a single course overlay, or
- 90 (b) equal to or greater than 2.2 for a single course overlay, or
- (c) equal to or greater than 1.8 for multiple course overlays.

Frequency of macrotexture testing shall be a minimum of once per day and shall be described in the QCP. The cross-slope shall not vary more than 1/8 in. when measured with a 10 ft straightedge.

100 Milled traveled way areas left open to traffic for longer than five work days will be assessed \$1,600.00 per day per lane mile, or portion thereof, as liquidated damages, not as a penalty, but as damages sustained for each work day that the milled area remains open to traffic.

Milled non-traveled way areas such as auxiliary lanes and shoulders left open to traffic for longer than 10 work days will be assessed \$800.00 per day per lane mile, or portion thereof, as liquidated damages, not as a penalty, but as damages sustained for each work day that the milled area remains open to traffic.

306.05 Asphalt or PCCP Profile Milling to Correct Cross-Slope

Profile milling shall consist of preparing a base for resurfacing by removing the existing asphalt or PCCP material to the specified cross-slope as shown on the plans.

306.06

110 The milled pavement profile shall have a surface finish that does not vary longitudinally more than 1/4 in. from a 16 ft straightedge or as described in the QCP in accordance with 401.02.

A fine milling cutting drum in accordance with 306.03(a) shall be used when a single course overlay is specified with a lay rate as shown on the plans less than 165 lb/sq yd and the maximum profile mill cut depth is expected to be less than or equal to 1 1/2 in. for asphalt or 3/4 in. for PCCP, otherwise, a coarse milling cutting drum in accordance with 306.03(a) shall be used.

120 The profile milled surface shall have a macrotexture ratio in accordance with ITM 812 as follows:

- (a) equal to or greater than 5.0 when using a fine milling cutting drum for a single course overlay, or
- (b) equal to or greater than 2.2 for a single course overlay, or
- (c) equal to or greater than 1.8 for multiple course overlays.

130 Frequency of macrotexture testing shall be a minimum of once per day and shall be described in the QCP. The cross-slope shall not vary more than 1/8 in. when measured with a 10 ft straightedge.

Milled traveled way areas left open to traffic for longer than five work days will be assessed \$1,600.00 per day per lane mile, or portion thereof, as liquidated damages, not as a penalty, but as damages sustained for each work day that the milled area remains open to traffic.

Milled non-traveled way areas such as auxiliary lanes and shoulders left open to traffic for longer than 10 work days will be assessed \$800.00 per day per lane mile, or portion thereof, as liquidated damages, not as a penalty, but as damages sustained for each work day that the milled area remains open to traffic.

140

306.06 Approach Milling

Approach milling shall consist of milling the surface and cutting a wedge at the driveways, commercial or public road approaches. The existing approach shall be milled a minimum depth of no less than 1/4 in. to accommodate the approach pavement. The approach milling shall be completed to provide a smooth transition from the traveled way pavement to the termini of the approach. The existing approach pavement shall be cut to provide a vertical face of 1 1/2 in. for the termini of surface.

150 Mailbox approaches to be resurfaced shall be milled to maintain the traveled way profile and cross-slope.

Automatic control devices will not be required on surface milling equipment used for approach milling. Milling shall not damage any pavement that is to remain in place.

Approach milling shall not be performed at driveways unless it is required to meet a paved surface that continues beyond the construction limit. If the driveway is other than HMA or PCC beyond the construction limits, the approach milling is not required.

160 The transverse vertical cut face for commercial or public road approaches shall be transitioned at a rate of 24:1 or as directed.

306.07 Asphalt or PCCP Milling to a Specified Average Depth

Milling shall consist of preparing a base for resurfacing by removing the existing asphalt material or PCCP to the specified average depth as shown on the plans. The milled pavement shall have a surface finish that does not vary longitudinally more than 1/4 in. from a 16 ft straightedge or as described in the QCP in accordance with 401.02.

170 A fine milling cutting drum in accordance with 306.03(a) shall be used when a single course overlay is specified with a lay rate as shown on the plans less than 165 lb/sq yd and the average mill cut depth is less than or equal to 1 1/2 in. for asphalt or 3/4 in. for PCCP, otherwise, a coarse milling cutting drum in accordance with 306.03(a) shall be used.

The milled surface shall have a macrotexture ratio in accordance with ITM 812 as follows:

- (a) equal to or greater than 5.0 when using a fine milling cutting drum for a single course overlay, or
- (b) equal to or greater than 2.2 for a single course overlay, or
- 180 (c) equal to or greater than 1.8 for multiple course overlays.

Frequency of macrotexture testing shall be a minimum of once per day and shall be described in the QCP. The cross-slope shall not vary more than 1/8 in. when measured with a 10 ft straightedge.

If shoulders or turn lanes are not milled and the overlay material is not placed in the milled areas within the same day, drainage slots shall be provided to eliminate ponding of water.

190 Milled traveled way areas left open to traffic for longer than five work days will be assessed \$1,600.00 per day per lane mile, or portion thereof, as liquidated damages, not as a penalty, but as damages sustained for each work day that the milled area remains open to traffic.

Milled non-traveled way areas such as auxiliary lanes and shoulders left open to traffic for longer than 10 work days will be assessed \$800.00 per day per lane mile, or portion thereof, as liquidated damages, not as a penalty, but as damages sustained for each work day that the milled area remains open to traffic.

200 The transverse vertical cut face shall be transitioned by HMA, CMA or prefabricated materials at a rate of 24:1 or as directed.

306.08 Asphalt Overlay Removal

Asphalt removal shall consist of complete removal of an asphalt overlay by milling from a portland cement concrete or brick base and the satisfactory disposal of the milled materials. Minor amounts of asphalt pavement material bonded to a concrete base at joints or cracks may remain in place. If this material becomes displaced during subsequent operations, it shall be removed. Minor amounts of asphalt pavement material bonded to a brick base may remain in place. Removal of minor areas of portland cement concrete or brick base during the milling operations is acceptable.

Milled areas shall be cleaned prior to reopening to traffic or before continuing construction operations.

The transverse vertical cut face shall be transitioned by HMA, CMA or prefabricated materials at a rate of 24:1 or as directed.

306.09 Transition Milling

Transition milling shall consist of cutting a wedge at the beginning and ending of projects, and paving exceptions. The existing pavement shall be cut to provide a nearly vertical face of 1 1/2 in. or the minimum finished thickness of a course in accordance with 401.14, whichever is greater, for the termini of each overlay lift of base, intermediate, and surface. The existing pavement shall be milled at a rate of 720:1 or as directed to achieve the specified cut where the pavement transition overlay lifts differ from cut depth. The transverse vertical cut face shall be transitioned by HMA, CMA or prefabricated materials at a rate of 24:1 or as directed.

Automatic control devices will not be required on surface milling equipment used for transitions cut off the traveled way. Cutting shall not damage any pavement that is to remain in place.

306.10 Method of Measurement

Approach milling, asphalt milling, asphalt removal, PCCP milling, scarification milling, profile milling, and transition milling will be measured by the square yard of the milled area.

306.11 Basis of Payment

Approach milling, asphalt milling, asphalt removal, PCCP milling, scarification milling, profile milling, and transition milling will be paid for at the contract unit price per square yard.

Payment will be made under:

Pay Item	Pay Unit Symbol
Milling, Approach	SYS

five calendar days prior to the JITT. The QCP shall include the proposed FDR mix design, a start to finish process description including discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, the curing methods applied to the cement stabilized RBC and the stabilization process applied to the RBC and subgrade after a failed proofroll. All QC test results and responses to test results shall be maintained during the duration of the contract and made available to the Engineer upon request.

The following table provides the type and minimum frequency for tests.

QC Testing	
Test	Frequency ^{1,2}
Depth of Pulverization	1 per 500 ft
Pulverized Material Gradation	1 per 0.5 day of production
In-place Moisture of Pulverized Material	1 per 0.5 day of production
Cement Application Rate	1 per 500 ft
Maximum Density and Moisture Content of Stabilized Material	1 per 0.5 day of production
Compacted In-Place Field Density ³	1 per 1,000 ft
Proofrolling	proofroll the entire RBC
1. The Contractor shall perform all QC tests within the first 500 ft after startup and after any change in the mix design. 2. Testing frequency is based upon linear feet of FDR laydown. 3. The density probe shall be no more than 2.0 in. above the bottom of the FDR treatment.	

MATERIALS

307.04 Materials

RBC shall consist of a homogenous blend of reclaimed asphalt pavement, RAP, base, and subgrade materials that are combined with cement, water, and when required, recycling additives such as corrective aggregate. The cement may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the FDR mix design and project requirements.

Materials for use in RBC shall be in accordance with the following:

Corrective aggregate to adjust gradation or supplement material volume:

1. Coarse or Dense Graded Aggregate,
 - Class C or Higher 904.03
2. Fine Aggregate 904.02
3. RAP shall be the product resulting from the cold milling or crushing of an existing asphalt pavement. The RAP coarse aggregate shall be processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.

Portland Cement, Type I..... 901.01(b)
 Water 913.01

60 A type D certification in accordance with 916 shall be provided for the RBC.

307.05 Mix Design

The FDR mix design shall be in accordance with ITM 595 and comprised of existing RAP, existing base and subgrade materials, cement and if necessary, recycling additives. The 7-day unconfined strength shall be based on the overlay lay rate specified on the plans.

Test	Procedure	Requirement
7-Day Unconfined Strength	ASTM D1633, Method A	see notes 1, 2, 3
Notes:		
1. 300 psi minimum when an HMA overlay with a total lay rate \geq 330 lb/sq yd.		
2. 400 psi minimum when an HMA overlay with a total 165 lb/sq yd \leq lay rate < 330 lb/sq yd.		
3. 500 psi minimum when an HMA overlay with a total lay rate < 165 lb/sq yd or an applied seal coat surface.		

70 The mix design and all associated testing shall be performed using samples of the existing pavement, base, and subgrade material from the project site representing the reclaiming depth. Sampling, testing, and the mix design shall be performed by a design laboratory that is AASHTO Material Reference Laboratory, AMRL, accredited for soil, aggregates, and concrete.

The sulfate content for the subgrade material shall be less than or equal to 1,000 ppm as determined in accordance with ITM 510.

Additional mix designs shall be performed when the in-place material changes significantly in order to establish representative mixes for the entire job.

80

The Contractor shall obtain all samples required to develop the mix design. One sample per lane mile of planned RBC shall be the minimum sampling frequency for mix design preparation.

The mix design, or designs, shall be submitted for approval at least five calendar days prior to the JTT and shall include all test results performed.

If new materials are added, a new mix design, including the revised test results, shall be submitted at least one day prior to implementation.

90

CONSTRUCTION REQUIREMENTS

307.06 Roadway Preparation

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to FDR operations.

Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the RBC during milling operations.

- 100 Grade adjustments of existing structures shall be made in accordance with 720.04 except existing structures shall be lowered prior to FDR operations, properly covered and filled with material compatible with the FDR mix design to maintain traffic.

All areas of soft or yielding subgrade, as shown on the plans, shall be corrected prior to pulverization operations.

307.07 Equipment

- 110 The equipment shall be capable of pulverizing the existing asphalt pavement, base and subgrade materials. The equipment used for mixing the pulverized materials with cement, water, additives, and corrective aggregate, when required, shall be capable of producing a homogenous and uniformly blended RBC. The equipment used for placement of the RBC shall be capable of placement in accordance with 105.03.

The equipment shall consist of the following major components:

(a) Spreaders and Distributors

- 120 Spreaders or distributors used to apply dry powder additives shall be non-pressurized mechanical vane-feed, cyclone or screw type capable of providing a consistent, accurate and uniform distribution of material while minimizing dust during construction. Corrective aggregate, when required, may be placed by a mechanical spreader, a conventional paver or by tailgating with end dump trucks and spread to a uniform thickness with a motor grader.

(b) Additive Slurry Storage and Supply Equipment

- 130 Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

(c) Mixing and Reclaiming Equipment

- 140 Only self-propelled, high powered, minimum 500 hp rotary mixers or reclaimers capable of mixing in-place to the depth specified shall be used. The minimum cutting drum width shall be 7 ft and fitted with cutting teeth capable of trimming earth, aggregate and HMA and be so designed that they may be accurately adjusted vertically and held in-place. The machine shall not weigh less than 25,000 lb and shall have the strength and rigidity so that it shall not develop a center deflection of more than 1/8 in.

The mixer or reclaimer shall be fitted with an integrated water injection system capable of introducing the water into the cutting drum during the mixing process. The

metering device shall be capable of automatically adjusting the flow of material to compensate for any variation in the amount of reclaimed material introduced into the mixing chamber. The water shall be calculated on a volumetric basis tied to a speed gauge, ft/min, using a calibrated meter that is capable of accurately measuring the amount of material to within 0.5% of the rate required. Automatic digital readings shall be displayed for both the flow rate and total amount of reclaimed material in appropriate units of weight and time.

150

(d) Motor Grader

A motor grader for pre-shaping, aerating, spreading and final shaping of the material shall be utilized. The motor grader shall have a cross slope indicator.

(e) Compaction Equipment

The RBC shall be compacted using self-propelled rollers. The number, weight and types of rollers shall be as necessary to obtain the required compaction throughout the entire RBC thickness. The rollers may be used in any combination and may include a pneumatic tire roller, an 84 in. wide drum vibratory pad-foot roller equipped with a knockdown blade or a 10 t minimum single or double drum vibratory steel roller.

160

(f) Water Trucks

A water truck shall be used for supplying water to the reclaimer or roadway for the addition of moisture during the reclaiming operation. The water truck shall be capable of providing a controlled and consistent spray without eroding or otherwise damaging the compacted RBC.

307.08 Weather Limitations

FDR operations shall be performed when the ambient temperature is 40°F or above. The FDR shall not be performed when the soil, aggregate, or subgrade is frozen or when freezing temperatures are anticipated within seven days of the end of RBC placement. The Engineer may restrict work when the heat index is greater than 100°F. The FDR shall not be performed before May 1 or after October 1.

170

307.09 Pulverization

The existing pavement shall be pulverized and stabilized in separate operations. Corrective aggregate, when required, shall be spread onto the existing surface in accordance with 307.07(a). The pre-determined full depth of asphalt pavement, base and subgrade materials shall be pulverized, along with the corrective aggregate, to a homogenous mixture. The mixture may be brought to the desired moisture content during this process by means of surface application or through the mixing or reclaiming equipment's integrated fluid injection system for dust control. The base course shall not contain roots, sod, topsoil, weeds, wood or any material deleterious to its reaction with the cement stabilizer.

180

For cement stabilized RBC, the pulverization shall produce a gradation that has 100% passing the 2 in. (50 mm) sieve and $\geq 55\%$ passing the No. 4 (4.75 mm) sieve.

When a paving fabric is encountered during the pulverization operation, the Contractor shall make the necessary changes in equipment or operations so that incorporation of shredded fabric into the RBC does not affect the performance parameters or inhibit placement or compaction of the RBC. The Contractor shall remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled material is no more than 5 sq in. No fabric piece shall have a dimension exceeding a length of 4 in.

Rubberized crack filler, durable pavement markings, loop wires, and other non-pavement materials shall be removed from the roadway during the pulverization process. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

Any such materials retained in the mixture shall be appropriately sized and blended so as to not adversely affect the strength of the RBC.

307.10 Stabilization

The cement used to stabilize the RBC may be dry powder or slurry. The Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used. The pulverized surface shall be scarified or knifed prior to applying materials in slurry form to prevent runoff or ponding. Any dry additives used shall be spread onto the pulverized surface using a mechanical spreader. The pulverized material shall be mixed with the stabilizer and additives as required by the mix design to create a homogeneous RBC.

The in-place moisture content of the material shall be within -1% to +2% of the design moisture content as determined by the mix design.

Cement stabilizing materials shall have an application tolerance determined by adding $\pm 0.5\%$ to the percent total cement content.

The cement shall be incorporated into the pulverized material at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of cement at various portions of the project.

The Contractor can request the cement percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

307.11 Control Strip and Compaction

A minimum 500 ft long control strip shall be constructed on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

- (a) demonstrate the equipment, materials and processes proposed can produce an RBC layer in accordance with specification requirements;
- 240 (b) determine the optimal rates for the cement, water, and any additives recommended for the reclaimed material;
- (c) determine the sequence and manner of rolling necessary to obtain strength requirements in one uniformly compacted layer.

The RBC density shall be achieved with the same equipment, materials, construction methods, and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside the tolerances of the original mix design, equipment, or construction methods.

- 250 The processed material shall be uniformly compacted in one layer to a minimum of 95% of the maximum density. Maximum density shall be determined in accordance with AASHTO T 180 at the required QC frequency from a representative sample collected after the cement has been added and mixed into the pulverized material but prior to compaction.

Compaction shall be monitored in accordance with AASHTO T 310 in the direct transmission mode and continue to reach a minimum of 95% of the established maximum density during the control strip and for the remainder of the compaction operation.

- 260 Compaction equipment shall be in accordance with 307.07(e). Initial compaction shall be within 500 ft of the reclaiming unit using either a vibratory pad-foot roller, a pneumatic tire roller or a combination of the two. The pass counts shall continue to increase until the cleat indentations from the pad-foot roller are no more than 3/16 in. in depth and light can be seen between the pad-foot and RBC interface or there are no wheel impressions from the pneumatic tire roller remaining in the RBC.

- 270 The cement stabilized material shall be bladed and shaped by a motor grader in accordance with 307.07(d) to remove any remaining roller marks or indentations then leveled in accordance with 301.07. The profile grade and cross section of the RBC shall be finished within a tolerance of $\pm 1/2$ in. from the plan RBC elevation prior to profile milling.

Intermediate and final compaction shall be applied to the bladed and shaped RBC using either a pneumatic tire roller, a single or double drum vibratory steel roller or a combination of the two. Finish rolling shall not be performed in vibratory mode. The compaction operation shall be performed while the RBC remains in a workable condition and continued until roller marks no longer appear.

- 280 Any type of rolling effort that causes cracking, displacement or other type of

307.12

pavement distress shall be discontinued until such time as the problem can be resolved as approved by the Engineer.

The QC technician shall be on site, observing all compaction efforts and approving areas as they reach minimum relative compaction. Care shall be taken to not over compact the mat.

All tests shall be conducted at the stated QC testing frequencies throughout FDR operations.

290

307.12 Opening to Traffic

Opening to traffic shall occur after sufficient cure time has been applied to the RBC so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.

After opening to traffic, the surface of the RBC shall be maintained in a condition suitable for the safe movement of traffic.

300

307.13 Maintenance

The Contractor shall maintain the RBC until the surface course has been constructed.

Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new HMA or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or RBC material as directed by the Engineer. No direct payment will be made for damage or repair unless approved by the Engineer.

310

307.14 Curing

The planned method and duration of curing for cement stabilized RBC shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the RBC final cure, but no later than November 1.

Before placing the final surfacing, the cement stabilized RBC shall remain in-place for a minimum of three days.

Cement stabilized RBC shall be cured to minimize moisture loss from the surface for a time period that achieves the minimum required 7-day unconfined strength.

320

307.15 Proofrolling

The cement stabilized RBC shall be proofrolled in accordance with 203.26 using a tandem or tri-axle dump truck loaded to the legal limit. The Engineer will determine the corrective remediation limits for any area that has deflection or rutting greater than 1/2 in.

The Contractor shall rework the areas failed in proofrolling by re-pulverizing and re-stabilizing the RBC in-place at no additional cost or by removing the RBC and stabilizing the subgrade with subgrade treatment Type IC in accordance with 207.

330

In locations of failing subgrade, the RBC shall be removed and subgrade treatment Type IC shall be placed in accordance with 207. HMA patching, type B shall be placed in accordance with 304 in place of the RBC.

307.16 Milling

The entire surface of the cement stabilized RBC shall be scarified in accordance with 306.04 in preparation for the overlay, except liquidated damages will not apply. Construction engineering in accordance with 105.08(b) shall be provided.

307.17 Underdrain Installation

Underdrain installation in accordance with 718, when required, shall begin after having completed the proofrolling.

340

307.18 RBC Overlay

The overlay atop the RBC shall be as shown on the plans. The overlay shall be placed after having completed the proofrolling.

The RBC shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the surface. The RBC shall be swept lightly to avoid damage to the RBC.

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A tack coat shall be required only for the HMA overlay and shall be applied to the RBC, in accordance with 406, immediately following sweeping operations.

Monuments shall be reestablished in accordance with 615.10.

307.19 Method of Measurement

The RBC will be measured by the square yard complete in place. Cement, used as stabilizing material, will be measured by the ton. Subgrade treatment will be measured in accordance with 207.05. Corrective aggregate to adjust the RBC gradation will be measured by the ton of material used. HMA patching, type B will be measured in accordance with 304.06. Milling will be measured in accordance with 306.10. Re-established monuments will be measured in accordance with 615.13. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12.

360

307.20 Basis of Payment

The RBC will be paid for as full depth reclamation at the contract unit price per square yard, complete in place. Cement, used as stabilizing material, will be paid for at the contract unit price per ton, complete in place. Subgrade treatment will be paid for in accordance with 207.06. Corrective aggregate used to adjust the RBC gradation will be paid for at the contract unit price per ton, complete in place. HMA patching,

370

type B will be paid for in accordance with 304.07, of the thickness specified on the plans. Milling will be paid for in accordance with 306.11. Re-established monuments will be paid for in accordance with 615.14. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.

Payment will be made under:

380	Pay Item	Pay Unit Symbol
	Corrective Aggregate, FDR.....	TON
	Full Depth Reclamation.....	SYS
	Stabilizing Material, Portland Cement	TON

The costs of the FDR mix design and QC testing shall be included in the cost of the full depth reclamation.

390 The costs associated with removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the full depth reclamation.

The costs associated with pulverizing, stabilizing, compacting curing and maintenance of the RBC shall be included in the cost of the full depth reclamation.

The cost associated with mixing water shall be included in the cost of the full depth reclamation.

400 The cost associated with aggregate when used to supplement material volume shall be included in the cost of the corrective aggregate pay item.

The cost associated with aggregate when used to adjust the RBC gradation shall be included in the cost of the corrective aggregate pay item.

In the locations of failing subgrade, removal of the RBC shall be included in the cost of subgrade treatment.

SECTION 308 – ASPHALT EMULSION STABILIZED FULL DEPTH RECLAMATION, FDR

308.01 Description

This work shall consist of pulverizing and stabilizing an existing asphalt pavement and base material, excluding subgrade, to construct a reclaimed base course, RBC, to the approved design properties in accordance with 105.03.

308.02 Just-in-Time Training, JITT

10 The Engineer and Contractor are required to attend a JITT course regarding FDR and both shall mutually agree on the course instructor, course content and training site.

The training class shall be conducted at a project field location convenient for all project construction personnel responsible for FDR operations and inspection to attend.

The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of FDR operations.

- 20 The Contractor shall provide a JITT instructor experienced in the construction methods, materials and test methods associated with asphalt emulsion stabilized FDR. A copy of the course syllabus, handouts and presentation materials shall be submitted to the Engineer at least five business days before the course is to be taught.

308.03 Quality Control

A quality control plan, QCP, shall be submitted to the Engineer a minimum of five calendar days prior to the JITT.

- 30 The QCP shall include the proposed FDR mix design, a start to finish process description including discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, the curing methods applied to the asphalt emulsion stabilized RBC and the stabilization process applied to the RBC and subgrade after a failed proofroll.

All QC test results and responses to test results shall be maintained during the duration of the contract and made available to the Engineer upon request.

The following table provides the type and minimum frequency for tests.

QC Testing	
Test	Frequency ^{1,2}
Depth of Pulverization	1 per 500 ft
Pulverized Material Gradation	1 per 0.5 day of production
In-place Moisture of Pulverized Material	1 per 0.5 day of production
Asphalt Emulsion Content	1 per 500 ft
Maximum Density and Moisture Content of Injected Material	1 per 0.5 day of production
Compacted In-Place Field Density ³	1 per 1,000 ft
Field Moisture Content for Curing	1 per each day of production
Proofrolling	proofroll the entire RBC
Notes:	
1. The Contractor shall perform all QC tests within the first 500 ft after startup and after any change in the mix design.	
2. Testing frequency is based upon linear feet of FDR laydown.	
3. The density probe shall be no more than 2.0 in. above the bottom of the FDR treatment.	

MATERIALS

308.04 Materials

RBC shall consist of a homogenous blend of reclaimed asphalt pavement, RAP, and base materials that are combined with asphalt emulsion, water, and when required, recycling additives such as corrective aggregate or cement. Cement recycling additives used in asphalt emulsion stabilized RBC may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the FDR mix design and project requirements.

50

Materials for use in RBC shall be in accordance with the following:

Asphalt Emulsion	902.1(b)3
Corrective aggregate to adjust gradation or supplement material volume:	
1. Coarse or Dense Graded Aggregate,	
Class C or Higher	904.03
2. Fine Aggregate	904.02
3. RAP, shall be the product resulting from the cold	
milling or crushing of an existing asphalt	
pavement. The RAP coarse aggregate shall be	
processed so that 100% passes the 1 1/2 in. (37.5	
mm) sieve.	
Portland Cement, Type I.....	901.01(b)
Water	913.01

60

A type D certification in accordance with 916 shall be provided for the RBC.

308.05 Mix Design

The FDR mix design shall be in accordance with ITM 594 and comprised of existing RAP, existing base material, asphalt emulsion and if necessary, recycling additives. The mix design and all associated testing shall be performed using samples of the existing pavement and base material from the project site representing the reclaiming depth. Sampling, testing, and the mix design shall be performed by a design laboratory that is AASHTO Material Reference Laboratory, AMRL, accredited for soil, aggregates, HMA and asphalt emulsion.

70

Additional mix designs shall be performed when the in-place material changes significantly in order to establish representative mixes for the entire job. The Contractor shall obtain all samples required to develop the mix design. One sample per lane mile of planned RBC shall be the minimum sampling frequency for mix design preparation.

80

The mix design, or designs, shall be submitted for approval at least five calendar days prior to the JITT and shall include all test results performed. If new materials are added, a new mix design, including the revised test results, shall be submitted at least one day prior to implementation.

CONSTRUCTION REQUIREMENTS

90 **308.06 Roadway Preparation**

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to FDR operations.

Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the RBC during milling operation.

Grade adjustments of existing structures shall be made in accordance with 720.04 except existing structures shall be lowered prior to FDR operations, properly covered and filled with material compatible with the FDR mix design to maintain traffic.

100

All areas of soft or yielding subgrade, as shown on the plans, shall be corrected prior to pulverization operations.

308.07 Equipment

The equipment shall be capable of pulverizing the existing asphalt pavement and base materials. The equipment used for mixing the pulverized materials with asphalt emulsion, water, additives, and corrective aggregate, when required, shall be capable of producing a homogenous and uniformly blended RBC. The equipment used for placement of the RBC shall be capable of placement in accordance with 105.03.

110

The equipment shall consist of the following major components:

(a) Spreaders and Distributors

Spreaders or distributors used to apply dry powder additives shall be non-pressurized mechanical vane-feed, cyclone or screw type capable of providing a consistent, accurate and uniform distribution of material while minimizing dust during construction. Corrective aggregate, when required, may be placed by a mechanical spreader, a conventional paver or by tailgating with end dump trucks and spread to a uniform thickness with a motor grader.

120

(b) Additive Slurry Storage and Supply Equipment

Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

(c) Mixing and Reclaiming Equipment

130

Only self-propelled, high powered, minimum 500 hp rotary mixers or reclaimers capable of mixing in-place to the depth specified shall be used. The minimum cutting drum width shall be 7 ft and fitted with cutting teeth capable of trimming earth,

aggregate and HMA and be so designed that they may be accurately adjusted vertically and held in-place. The machine shall not weigh less than 25,000 lb and shall have the strength and rigidity so that it shall not develop a center deflection of more than 1/8 in.

140 The mixer or reclaimer shall be fitted with an integrated water and asphalt emulsion injection system capable of introducing both materials into the cutting drum during the mixing process. The metering device shall be capable of automatically adjusting the flow of material to compensate for any variation in the amount of reclaimed material introduced into the mixing chamber. The water or asphalt emulsion shall be calculated on a volumetric basis tied to a speed gauge, ft/min, using a calibrated meter that is capable of accurately measuring the amount of material to within 0.5% of the rate required. Automatic digital readings shall be displayed for both the flow rate and total amount of reclaimed material in appropriate units of weight and time.

(d) Motor Grader

150 A motor grader for pre-shaping, aerating, spreading and final shaping of the material shall be utilized. The motor grader shall have a cross slope indicator.

(e) Compaction Equipment

The RBC shall be compacted using self-propelled rollers. The number, weight and types of rollers shall be as necessary to obtain the required compaction throughout the entire RBC thickness. The rollers may be used in any combination and may include a pneumatic tire roller, an 84 in. wide drum vibratory pad-foot roller equipped with a knockdown blade or a 10 t minimum single or double drum vibratory steel roller.

160 **(f) Water Trucks**

A water truck shall be used for supplying water to the reclaimer or roadway for the addition of moisture during the reclaiming operation. The water truck shall be capable of providing a controlled and consistent spray without eroding or otherwise damaging the compacted RBC.

308.08 Weather Limitations

170 FDR operations shall be performed when the ambient temperature is 50°F or above. The FDR shall not be performed when the soil, aggregate, or subgrade is frozen or when freezing temperatures are anticipated within seven days of the end of RBC placement. The Engineer may restrict work when the heat index is greater than 100°F. The FDR shall not be performed before May 1 or after October 1.

308.09 Pulverization

The existing pavement shall be pulverized and stabilized in separate operations. Corrective aggregate, when required, shall be spread onto the existing surface in accordance with 308.07(a). The pre-determined full depth of asphalt pavement and base materials shall be pulverized, along with the corrective aggregate, to a homogenous mixture. The mixture may be brought to the desired moisture content

180 during this process by means of surface application or through the mixing or reclaiming equipment's integrated fluid injection system for dust control. The base course shall not contain subgrade, roots, sod, topsoil, weeds, wood or any material deleterious to its reaction with the asphalt emulsion.

For asphalt emulsion stabilized RBC, the pulverization shall produce a gradation that has 100% passing the 2 in. (50 mm) sieve and $\geq 35\%$ passing the No.4 (4.75 mm) sieve.

190 When a paving fabric is encountered during the pulverization operation, the Contractor shall make the necessary changes in equipment or operations so that incorporation of shredded fabric into the RBC does not affect the performance parameters or inhibit placement or compaction of the RBC. The Contractor shall be required to remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled material is no more than 5 sq in. No fabric piece shall have a dimension exceeding a length of 4 in.

200 Rubberized crack filler, durable pavement markings, loop wires, and other non-pavement materials shall be removed from the roadway during the pulverization process. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

Any such materials retained in the mixture shall be appropriately sized and blended so as to not adversely affect the strength of the RBC.

308.10 Injection

210 An additive used in asphalt emulsion stabilized RBC may be dry powder or slurry and the Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used. The pulverized surface shall be scarified or knifed prior to applying materials in slurry form to prevent runoff or ponding. Any dry additives used shall be spread onto the pulverized surface using a mechanical spreader. The pulverized material shall be mixed with the stabilizer and additives as required by the mix design to create a homogeneous RBC.

The in-place moisture content of the material shall be within -1% to +2% of the design moisture content as determined by the mix design.

220 Asphalt stabilizing materials shall have an application tolerance determined by adding $\pm 0.25\%$ to the percent total asphalt emulsion content.

The asphalt emulsion shall be incorporated into the pulverized material at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of asphalt emulsion at various portions of the project.

The Contractor can request the asphalt emulsion percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

230 **308.11 Control Strip and Compaction**

A minimum 500 ft long control strip shall be constructed on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

- (a) demonstrate the equipment, materials and processes proposed can produce an RBC layer in accordance with specification requirements;
- 240 (b) determine the optimal rates for the asphalt emulsion, water and any additives recommended for the reclaimed material;
- (c) determine the sequence and manner of rolling necessary to obtain specified density requirements in one uniformly compacted layer.

The RBC density shall be achieved with the same equipment, materials, construction methods and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside the tolerances of the original mix design, equipment or construction methods.

- 250 The processed material shall be uniformly compacted in one layer to a minimum of 95% of the maximum density. Maximum density shall be determined in accordance with AASHTO T 180 at the required QC frequency from a representative sample collected after injection but prior to compaction.

Compaction shall be monitored in accordance with AASHTO T 310 in the direct transmission mode and continue to reach a minimum of 95% of the established maximum density during the control strip and for the remainder of the compaction operation.

- 260 Compaction equipment shall be in accordance with 308.07(e). Initial compaction shall be within 500 ft of the reclaiming unit using either a vibratory pad-foot roller, a pneumatic tire roller or a combination of the two. The pass counts shall continue to increase until the cleat indentations from the pad-foot roller are no more than 3/16 in. in depth and light can be seen between the pad-foot and RBC interface or there are no wheel impressions from the pneumatic tire roller remaining in the RBC.

The asphalt emulsion stabilized material shall be bladed and shaped by a motor grader in accordance with 308.07(d) to remove any remaining roller marks or indentations then leveled in accordance with 301.07. The profile grade and cross

- 270 section of the RBC shall be finished within a tolerance of $\pm 1/2$ in. from the plan RBC elevation prior to profile milling.

Intermediate and final compaction shall be applied to the bladed and shaped RBC using either a pneumatic tire roller, a single or double drum vibratory steel roller or a combination of the two. Finish rolling shall not be performed in vibratory mode. The compaction operation shall be performed while the RBC remains in a workable condition and continued until roller marks no longer appear.

- 280 Any type of rolling effort that causes cracking, displacement or other type of pavement distress shall be discontinued until such time as the problem can be resolved and approved by the Engineer.

The QC technician shall be on site, observing all compaction efforts and approving areas as they reach minimum relative compaction. Care shall be taken to not over compact the mat.

All tests shall be conducted at the stated QC testing frequencies throughout FDR operations.

290 **308.12 Opening to Traffic**

Opening to traffic shall occur after sufficient cure time has been applied to the RBC so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.

After opening to traffic, the surface of the RBC shall be maintained in a condition suitable for the safe movement of traffic.

308.13 Maintenance

- 300 The Contractor shall maintain the RBC in a satisfactory manner until the surface course has been constructed.

Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new asphalt concrete or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or RBC material as directed by the Engineer. No direct payment will be made for damage or repair unless approved by the Engineer.

308.14 Curing

- 310 Before placing the final surfacing, the asphalt emulsion stabilized RBC shall remain in-place for a minimum of three days and meet one of the following conditions:

- (a) there is less than 3.0% moisture remaining in the mixture, or
- (b) the in-place moisture contents have remained constant at 50% or less

308.15

of the design optimum moisture content for a continuous time period of five days.

320 The planned method and duration of curing for asphalt emulsion stabilized RBC shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the RBC final cure, but no later than November 1.

308.15 Proofrolling

The asphalt emulsion stabilized RBC shall be proofrolled in accordance with 203.26 using a tandem or tri-axle dump truck loaded to the legal limit. The Engineer will determine the corrective remediation limits for any area that has deflection or rutting greater than 1/2 in.

330 The Contractor shall rework the areas failed in proofrolling by re-pulverizing and re-stabilizing the RBC in-place at no additional cost or by removing the RBC and stabilizing the subgrade with subgrade treatment Type IC in accordance with 207.

The reworked areas shall be proofrolled for final acceptance.

In locations of failing subgrade the RBC shall be removed and subgrade treatment Type IC shall be placed in accordance with 207. HMA patching, type B shall be placed in accordance with 304 in place of the RBC.

308.16 Milling

340 The entire surface of the asphalt emulsion stabilized RBC shall be scarified in accordance with 306.04 in preparation for the overlay, except liquidated damages will not apply. Construction engineering in accordance with 105.08(b) shall be provided.

308.17 Underdrain Installation

Underdrain installation in accordance with 718, when required, shall begin after having completed the proofrolling.

308.18 RBC Overlay

350 The overlay atop the RBC shall be as shown on the plans. The overlay shall be placed after having completed the proofrolling.

The RBC shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the surface. The RBC shall be swept lightly to avoid damage to the RBC.

A tack coat shall be required only for the HMA overlay and shall be applied to the RBC in accordance with 406 immediately following sweeping operations.

Monuments shall be reestablished in accordance with 615.10.

360

308.19 Method of Measurement

The RBC will be measured by the square yard complete in place. Asphalt emulsion will be measured by the ton. Subgrade treatment will be measured in accordance with 207.05.

Corrective aggregate to adjust the RBC gradation will be measured by the ton of material used. HMA patching, type B will be measured in accordance with 304.06.

370 Milling will be measured in accordance with 306.10. Re-established monuments will be measured in accordance with 615.13. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12.

Portland cement will be measured by the ton.

308.20 Basis of Payment

The RBC will be paid for as full depth reclamation at the contract unit price per square yard, complete in place. Asphalt emulsion will be paid for at the contract unit price per ton, complete in place. Subgrade treatment will be paid for in accordance with 207.06.

380

Corrective aggregate used to adjust the RBC gradation will be paid for at the contract unit price per ton, complete in place. HMA patching, type B will be paid for in accordance with 304.07, of the thickness specified on the plans.

Milling will be paid for in accordance with 306.11. Re-established monuments will be paid for in accordance with 615.14. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.

390 Portland cement will be paid for in accordance with 104.03. The change order will include direct material costs, delivery costs, and shall not include any other markups.

Payment will be made under:

Pay Item	Pay Unit Symbol
Corrective Aggregate, FDR.....	TON
Full Depth Reclamation.....	SYS
Stabilizing Material, Asphalt Emulsion.....	TON
Stabilizing Material, Portland Cement	TON

400

The costs of the RBC mix design and QC testing shall be included in the cost of the full depth reclamation.

The costs associated with removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the full depth reclamation.

308.20

The costs associated with pulverizing, stabilizing, compacting, curing and maintenance of the RBC shall be included in the cost of the full depth reclamation.

410

The cost associated with mixing water shall be included in the cost of the full depth reclamation.

The cost associated with aggregate when used to supplement material volume shall be included in the cost of the corrective aggregate pay item.

When portland cement is a required stabilizing material, costs associated with mixing, installation, compaction, curing, and maintenance shall be included in the cost of the full depth reclamation.

420

The cost associated with aggregate when used to adjust the RBC gradation shall be included in the cost of the corrective aggregate pay item.

In the locations of failing subgrade, removal of the RBC shall be included in the cost of the subgrade treatment.

DIVISION 400 – ASPHALT PAVEMENTS

SECTION 401 – QC/QA HMA PAVEMENT

401.01 Description

This work shall consist of one or more courses of QC/QA HMA base, intermediate, or surface mixtures constructed on prepared foundations in accordance with 105.03.

401.02 Quality Control

10 The HMA shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Hot Mix Asphalt Producer Program.

The HMA shall be transported and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803; Contractor Quality Control Plans for Hot Mix Asphalt Pavements. The QCP shall be submitted to the Engineer at least 15 days prior to commencing HMA paving operations.

When a safety edge is required for a project, the QCP shall identify the device or devices in accordance with 409.03(c) to be used for constructing the safety edge.

20

MATERIALS

401.03 Materials

Materials shall be in accordance with the following:

	Asphalt Materials	
	PG Binder	902.01(a)
	Coarse Aggregates.....	904.03
	Base Mixtures – Class D or Higher	
30	Intermediate Mixtures – Class C or Higher	
	Surface Mixtures* – Class B or Higher	
	Fine Aggregates.....	904.02
	Stabilizing Additives	AASHTO M 325
	* Surface aggregate requirements are listed in 904.03(d).	

401.04 Design Mix Formula

40 A design mix formula, DMF, shall be prepared in accordance with 401.05 and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall be based on the ESAL category identified in the pay item and shall state the mixture designation and maximum particle size in the mixture. No mixture will be accepted for use until the DMF has been assigned a mixture number by the Engineer.

401.05

The DMF shall state the binder content, the ΔPb determined in accordance with ITM 591 and a Mixture Adjustment Factor, MAF. The DMF shall state the source, type, and dosage rate of any stabilizing additives.

The ESAL category identified in the pay item correlates to the following ESAL ranges.

50

ESAL Category	ESAL
2*	< 3,000,000
3	3,000,000 to < 10,000,000
4*	≥ 10,000,000
* A category 2 mixture shall replace a category 1 mixture and a category 4 mixture shall replace a category 5 mixture.	

The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 64-22 or PG 70-22 binders are used or not more than 325°F whenever PG 76-22 binder is used. QC/QA HMA may be produced using a water-injection foaming device. The DMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture.

401.05 Volumetric Mix Design

60 The DMF shall be determined for each mixture from a volumetric mix design by a design laboratory selected from the Department’s list of Qualified Mix Design Laboratories. A volumetric mixture shall be designed in accordance with AASHTO R 35 and the respective AASHTO reference as listed below.

All loose mixtures shall be conditioned for 4 h in accordance with AASHTO R 30 prior to testing. Steel furnace slag coarse aggregate, when used in an intermediate or base mixture application, shall have a deleterious content less than 4.0% as determined in accordance with ITM 219.

70 Bulk Specific Gravity and Density of
Compacted Asphalt Mixtures using
Automatic Vacuum Sealing.....AASHTO T 331

The single percentage of aggregate passing each required sieve shall be within the limits of the following gradation tables:

Sieve Size	Dense Graded, Mixture Designation – Control Point (Percent Passing)				
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm**
2 in. (50.0 mm)					
1 1/2 in. (37.5 mm)	100.0				
1 in. (25.0 mm)	90.0 - 100.0	100.0			
3/4 in. (19.0 mm)	< 90.0	90.0 - 100.0	100.0		
1/2 in. (12.5 mm)		< 90.0	90.0 - 100.0	100.0	100.0
3/8 in. (9.5 mm)			< 90.0	90.0 - 100.0	95.0 - 100.0
No. 4 (4.75 mm)				< 90.0	90.0 - 100.0
No. 8 (2.36 mm)	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0*	
No. 16 (1.18 mm)					30.0 - 55.0
No. 30 (600 µm)					
No. 50 (300 µm)					
No. 200 (75 µm)	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	3.0 - 8.0
<p>* The mix design gradation shall be less than or equal to 58.0% passing the No. 8 (2.36 mm) sieve for all 9.5 mm surface mixtures. The mix design gradation can be greater than 58.0% passing the No. 8 (2.36 mm) sieve when used on non-Department maintained facilities.</p> <p>** The total blended aggregate gradation for the 4.75 mm mixture shall have a fineness modulus greater than or equal to 3.30 as determined in accordance with AASHTO T 27.</p>					

Primary Control Sieve, PCS, Control Point for Mixture Designation (Percent Passing)					
Mixture Designation	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm
PCS	4.75 mm	4.75 mm	2.36 mm	2.36 mm	n/a
PCS Control Point	40	47	39	47	n/a

Sieve Size	Open Graded, Mixture Designation – Control Point (Percent Passing)		
	OG9.5 mm	OG19.0 mm	OG25.0 mm
1 1/2 in. (37.5 mm)			100.0
1 in. (25.0 mm)		100.0	70.0 – 98.0
3/4 in. (19.0 mm)		70.0 – 98.0	50.0 – 85.0
1/2 in. (12.5 mm)	100.0	40.0 – 68.0	28.0 – 62.0
3/8 in. (9.5 mm)	75.0 – 100.0	20.0 – 52.0	15.0 – 50.0
No. 4 (4.75 mm)	10.0 – 35.0	10.0 – 30.0	6.0 – 30.0
No. 8 (2.36 mm)	0.0 – 20.0	7.0 – 23.0	7.0 – 23.0
No. 16 (1.18 mm)		2.0 – 18.0	2.0 – 18.0
No. 30 (600 μm)		1.0 – 13.0	1.0 – 13.0
No. 50 (300 μm)		0.0 – 10.0	0.0 – 10.0
No. 100 (150 μm)		0.0 – 9.0	0.0 – 9.0
No. 200 (75 μm)	0 – 6.0	0.0 – 8.0	0.0 – 8.0
% Binder	> 3.0	> 3.0	> 3.0

Dust/Calculated Effective Binder Ratio shall be 0.6 to 1.4. The Dust/Calculated Effective Binder Ratio for 4.75 mm mixtures shall be 1.0 to 2.0.

The optimum binder content shall produce a $\Delta P_b \leq 0.20$ as determined in accordance with ITM 591 and the following air voids at N_{des} :

Air Voids at Optimum Binder Content								
Mixture Designation	Dense Graded					Open Graded		
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	25.0 mm	19.0 mm	9.5 mm
Air Voids	5.0%	5.0%	5.0%	5.0%	5.0%	15.0% - 20.0%	12.0% - 17.0%	

90 The design for dense graded mixtures shall have at least four points, including a minimum of two points above and one point below the optimum. A one point design may be used for open graded mixtures. The maximum specific gravity shall be mass determined in water in accordance with AASHTO T 209. The bulk specific gravity of the gyratory specimens shall be determined in accordance with AASHTO T 166, Method A or AASHTO T 331, if required, for dense graded and open graded mixtures.

The percent draindown of open graded mixtures shall not exceed 0.30% in accordance with AASHTO T 305. Open graded mixtures may incorporate recycled materials and fibers. The recycled materials shall be in accordance with 401.06, and the fiber type and minimum dosage rate shall be in accordance with AASHTO M 325.

100 The binder for open graded mixtures may have the upper temperature classification reduced by 6°C from the specified binder grade if fibers are incorporated into the mixture or if 3.0% reclaimed asphalt shingles by weight of the total mixture is used.

110 The percent draindown of dense graded mixtures shall not exceed 0.30% in accordance with AASHTO T 305. Dense graded mixture shall be tested for moisture susceptibility in accordance with AASHTO T 283 except that the loose mixture curing shall be replaced by mixture conditioning for 4 h in accordance with AASHTO R 30. The minimum tensile strength ratio, TSR, shall be 80%. The 6 in. mixture specimens shall be compacted in accordance with AASHTO T 312. If anti-stripping additives are added to the mixture to be in accordance with the minimum TSR requirements, the dosage rate shall be submitted with the DMF.

A PG binder grade or source change will not require a new mix design. If the upper temperature classification of the PG binder is lower than the original PG grade, a new TSR value is required.

120 The MAF equals the Gmm from the mixture design divided by the following: 2.465 for 9.5 mm mixtures and 2.500 for 12.5 mm, 19.0 mm, and 25.0 mm mixtures. If the MAF calculation results in a value where $0.980 \leq \text{MAF} \leq 1.020$, then the MAF shall be considered to be 1.000. If the MAF is greater than 1.020, the calculated MAF value shall have 0.020 subtracted from the value. If the MAF is less than 0.980, the calculated MAF value shall have 0.020 added to the value. The MAF does not apply to OG mixtures.

Changes in the source or types of aggregates shall require a new DMF.

The mixture design compaction temperature for the specimens shall be $300 \pm 9^\circ\text{F}$ for dense graded mixtures and 260°F for open graded mixtures.

130 Design criteria for each mixture shall be based on the ESAL shown in the contract documents and shall be as follows:

Gyratory Compaction Effort					
ESAL	N_{ini}^*	N_{des}^*	N_{max}^*	Max. %Gmm @ N_{ini}	Max. %Gmm @ N_{max}
Dense Graded 4.75 mm					
< 3,000,000	7	75	115	90.5	98.0
3,000,000 to < 10,000,000	8	100	160	89.0	98.0
$\geq 10,000,000$	8	100	160	89.0	98.0
Dense Graded 9.5 mm, 12.5 mm, 19.0 mm, and 25.0 mm					
< 3,000,000	5	30	40	91.5	97.0
3,000,000 to < 10,000,000	6	50	75	91.5	97.0
$\geq 10,000,000$	6	50	75	91.5	97.0
Open Graded					
All ESAL	n/a	20	n/a	n/a	n/a
* N_{ini} , N_{des} , N_{max} - definitions are included in AASHTO R 35.					

Voids in Mineral Aggregate, VMA, Criteria @ N _{des}	
Mixture Designation	Minimum VMA, %
4.75 mm	17.0
9.5 mm	16.0
12.5 mm	15.0
19.0 mm	14.0
25.0 mm	13.0
OG	n/a

Volume of Effective Binder, Vbe, Criteria @ N _{des}	
Mixture Designation	Minimum Vbe, %
4.75 mm	12.0
9.5 mm	11.0
12.5 mm	10.0
19.0 mm	9.0
25.0 mm	8.0
OG	n/a

Voids Filled with Asphalt, VFA, Criteria @ N _{des}	
ESAL	VFA, %
< 3,000,000	60 – 73
3,000,000 to < 10,000,000	60 – 70
≥ 10,000,000	60 – 70
Notes:	
1. For 4.75 mm mixtures, the specified VFA range shall be 67% to 79%.	
2. For 9.5 mm mixtures, the specified VFA range shall be 69% to 72% for design traffic levels ≥ 3,000,000 ESALs.	
3. For 25.0 mm mixtures, the specified lower limit of the VFA shall be 62% for design traffic levels < 300,000 ESALs.	
4. For OG mixtures, VFA is not applicable.	

140 401.06 Recycled Materials

Recycled materials may consist of reclaimed asphalt pavement, RAP, or reclaimed asphalt shingles, RAS, or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. Before entering the plant, RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve and RAS shall be processed so that 100% will pass the 3/8 in. (9.5 mm) sieve. The RAP coarse aggregate shall pass the maximum size sieve for the mixture being produced.

150 RAP for the ESAL category 3 and 4 surface mixtures shall be a fine RAP with 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve. The Contractor may request the use of coarse RAP in a category 4 surface mixture up to a maximum 20.0% by volume of material retained on the No. 4 (4.75 mm) sieve. The election to use coarse RAP in a category 4 surface mixture will void the allowed use of crushed stone and gravel coarse aggregate materials in accordance with 904.03(d). SMA RAP as defined in 410.06 shall not be used in any HMA mixture.

Recycled materials may be used as a substitute for a portion of the new materials required to produce HMA mixtures. The amount of total binder replaced by binder in the recycled material shall be computed as follows:

160
$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E}$$

where:

- A = RAP, % Binder Content by Mass of RAP
- B = RAP, % by Total Mass of Mixture
- C = RAS, % Binder Content by Mass of RAS
- D = RAS, % by Total Mass of Mixture
- E = Total, % Binder Content by Total Mass of Mixture.

170 RAS may be obtained from either pre-consumer or post-consumer asphalt shingles but the two RAS types shall not be blended together for use in HMA mixtures.

Post-consumer asphalt shingles shall be in accordance with the following:

- (a) post-consumer asphalt shingles shall be essentially nail-free
- (b) extraneous metallic materials retained on or above the No. 4 (4.75 mm) sieve shall not exceed 0.5% by mass
- 180 (c) extraneous non-metallic materials such as glass, rubber, soil, brick, paper, wood and plastic retained on or above the No. 4 (4.75 mm) sieve shall not exceed 1.5% by mass
- (d) post-consumer shingles shall be prepared by a processing company with an IDEM Legitimate Use Approval letter. The approval letter shall be submitted with the DMF to the Engineer.

The recycled material percentages shall be as specified on the DMF. HMA mixtures utilizing recycled materials shall be limited to the binder replacement percentages in the following table:

190

HMA mixtures utilizing RAP or RAS or a blend of RAP and RAS

Maximum Binder Replacement, %										
Mixture Category	Base and Intermediate							Surface		
	Dense Graded				Open Graded			Dense Graded		
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	25.0 mm	19.0 mm	9.5 mm	12.5 mm	9.5 mm	4.75 mm
2	25.0*				25.0*			25.0*		
3	25.0*				25.0*			25.0*		
4	25.0*				25.0*			25.0*		
* The contribution of RAS to any HMA mixture shall be $\leq 3.0\%$ by total mass of mixture and $\leq 15.0\%$ binder replacement.										

The combined aggregate properties shall be in accordance with 904. The combined aggregate bulk specific gravity shall be determined in accordance with ITM 584 and the combined aggregate gradation shall be in accordance with 401.05 for the HMA mixture specified.

401.07 Lots and Sublots

200 Lots will be defined as 5,000 t of base or intermediate mixtures or 3,000 t of surface mixture. Lots will be further sub-divided into sublots not to exceed 1,000 t of base or intermediate mixtures or 600 t of surface mixture. Partial sublots of 100 t or less will be added to the previous subplot. Partial sublots greater than 100 t constitute a full subplot. Partial lots of four sublots or less will be added to the previous lot to create an extended lot.

401.08 Blank**401.09 Acceptance of Mixtures**

210 Acceptance of mixtures for V_{be} at N_{des} , and air voids at N_{des} for each lot will be based on tests performed by the Engineer for dense graded 9.5 mm, 12.5 mm, 19.0 mm and 25.0 mm mixtures with original contract pay item quantities greater than or equal to 300 t.

Acceptance of mixtures for binder content and air voids at N_{des} will be based on a type D certification in accordance with 402.09 for dense graded mixtures with original contract pay item quantities less than 300 t. Acceptance of mixtures for binder content and air voids at N_{des} for each lot will be based on a type D certification in accordance with 402.09 for dense graded 4.75 mm mixtures.

220 Acceptance of mixtures for binder content and air voids at N_{des} for each lot will be based on tests performed by the Engineer for open graded mixtures with original contract pay item quantities greater than or equal to 300 t. Acceptance of mixtures for binder content and air voids at N_{des} will be based on a type D certification in accordance with 402.09 for open graded mixtures with original pay item quantities less than 300 t, except the air voids tolerance shall be $\pm 3.5\%$ from the DMF.

230 The Engineer will randomly select the location within each subplot for sampling in accordance with ITM 802. The first 300 t of the first subplot of the first lot for each mixture pay item will not be sampled. An acceptance sample will consist of plate samples obtained in accordance with ITM 802 and ITM 580. The Engineer will take immediate possession of the samples.

Acceptance samples will be reduced to the appropriate size for testing in accordance with ITM 587. The binder content and gradation will be determined in accordance with ITM 571. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209.

240 The effective specific gravity, G_{se} , of the mixture will be determined in each subplot and reported from the acceptance sample testing.

The total aggregate bulk specific gravity, G_{sb} , value will be determined in accordance with ITM 597.

250 The air voids will be determined in accordance with AASHTO R 35 based on the average bulk specific gravity from two gyratory specimens and the MSG for the subplot. The VMA will be determined in accordance with AASHTO R 35 based on the average bulk specific gravity from two gyratory specimens, the percent aggregate in the mixture from the subplot and the BSG of the aggregate blend from the DMF as applicable. The gyratory pills will be prepared in accordance with AASHTO T 312.

250 The dust/calculated effective binder ratio and the volume of effective binder in the mixture will be determined and reported from the acceptance sample testing conducted in each subplot. The volume of effective binder will be the difference between VMA and air voids. The Contractor shall take action in accordance with ITM 583 to address a dust/calculated effective binder ratio not in accordance with 401.05, a volume of effective binder in the mixture below design minimums, or a volume of effective binder in the mixture greater than 2.0% above design minimums.

260 The bulk specific gravity of gyratory specimens for dense graded mixtures will be determined in accordance with AASHTO T 166, Method A or AASHTO T 331, if required, except samples are not required to be dried overnight. The bulk specific gravity of gyratory specimens for open graded mixtures will be determined in accordance with AASHTO T 331.

A binder draindown test in accordance with AASHTO T 305 for open graded mixtures shall be completed once per lot in accordance with 401.07 and shall not exceed 0.50%.

270 The Contractor shall make available the subplot quality control results within seven calendar days from the date the acceptance sample was taken.

401.09

The Engineer will make available the subplot acceptance test results after receiving the subplot quality control results from the Contractor.

Air voids, binder content and Vbe values will be reported to the nearest 0.01%. Draindown test results will be rounded to the nearest 0.01%. Rounding will be in accordance with 109.01(a).

280 Pay factors for dense graded mixtures with original contract pay item quantities greater than or equal to one lot will be determined in accordance with 401.19(a). Partial lots of four sublots or less will have pay factors determined in accordance with 401.19(b) if the previous lot is not available.

Pay factors for dense graded mixtures with original contract pay item quantities greater than or equal to 300 t and less than one lot and open graded mixtures will be determined in accordance with 401.19(b).

290 The Contractor may request an appeal of the Engineer's test results in accordance with 401.20.

A type C certification in accordance with 916 shall be provided for the stabilizing additives for each shipment. Stabilizing additives from different manufacturers and different types of stabilizing additives shall not be intermixed.

In the event that an acceptance sample is not available to represent a subplot, all test results of the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

300 Samples shall not be obtained from the following areas:

- (a) Mixture placed on an approach, taper, gore area, crossover that is not placed simultaneously with the mainline.
 - (b) Mixture placed on a shoulder less than 8 ft in width that is not placed simultaneously with the mainline.
 - (c) Within 25 ft of a transverse construction joint.
 - (d) Areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3.
- 310

If a random location falls within this area, the Engineer will randomly select another location within the subplot for sampling. If an entire subplot falls within this area, test results from the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance. If previous or subsequent subplot results for a mixture accepted by 401.19(a) will be replicated for an entire lot, each subplot in that lot will be accepted by 401.19(b).

CONSTRUCTION REQUIREMENTS

320

401.10 General

Equipment for HMA operations shall be in accordance with 409. The Contractor shall submit to the Engineer written documentation that includes the manufacturer's make, model, serial number, manufactured year, and the manufacturer's literature with pictures. The documentation shall be submitted prior to use and shall certify that the paving equipment proposed for the project is new and includes the modifications or has been modified in accordance with the following.

330

The paver shall be equipped with means of preventing the segregation of the coarse aggregate particles when moving the mixture from the paver hopper to the paver augers. The means and methods used shall be in accordance with the paver manufacturer's instructions and may consist of chain curtains, deflector plates, or other such devices, or any combination of these.

The following specific requirements shall also apply to identified HMA pavers:

340

1. Blaw-Knox HMA pavers shall be equipped with the Blaw-Knox Materials Management Kit, MMK.
2. Cedarapids HMA pavers shall be those that were manufactured in 1989 or later.
3. Barber-Green/Caterpillar HMA pavers shall be equipped with deflector plates as identified in the December, 2000 Service Magazine entitled "New Asphalt Deflector Kit {6630-DFL, 6631-DFL, or 6640-DFL}".

350

The Contractor is also required to demonstrate to the Engineer prior to use, that the modifications to the paving equipment have been implemented on all pavers to be used on the project.

Fuel oil, kerosene, or solvents shall not be transported in open containers on equipment. Cleaning of equipment and small tools shall not be performed on the pavement or shoulder areas.

360

HMA mixtures shall not exhibit segregation, flushing, or bleeding. Corrective action shall immediately be taken to prevent continuation of these conditions. Segregated, flushed, or bleeding HMA mixtures will be referred to the Department's Division of Materials and Tests for adjudication as a failed material in accordance with 105.03.

401.11

All mixtures that become loose and broken, mixed with dirt, or are defective in any way shall be removed and replaced in accordance with 105.03.

401.11 Preparation of Surfaces to be Overlaid

The subgrade shall be shaped to the required grade and sections, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Milling of an existing pavement surface shall be in accordance with 306. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

Prior to placing an open graded mixture, the underlying HMA course shall have a full width base seal applied in accordance with 415. The base seal materials shall be applied within three calendar days after all density cores in accordance with 401.16 have been obtained.

Rubblized concrete pavements shall be primed in accordance with 405. PCCP, milled asphalt surfaces, and new and existing asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

All partially completed sections of roadway that are 8 in. or less in thickness shall be proofrolled prior to the placement of additional materials unless otherwise directed by the Engineer. Proofrolling shall be accomplished in accordance with 203.26. The contact pressure shall be 70 to 80 psi. Soft yielding areas shall be removed and replaced.

401.12 Process Control

The Engineer and Contractor will jointly review the operations to ensure compliance with the QCP. Continuous violations of compliance with the QCP will result in suspension of paving operations.

401.13 Weather Limitations

HMA courses of less than 138 lb/sq yd shall be placed when the ambient temperature and the temperature of the surface on which it is to be placed is 45°F or above. No mixture shall be placed on a frozen subgrade.

401.14 Spreading and Finishing

The mixture shall be placed upon an approved surface by means of laydown equipment in accordance with 409.03(c). Prior to paving, both the planned quantity and lay rate shall be adjusted by multiplying by the MAF. When mixture is produced from more than one DMF for a given pay item, the MAF will be applied to the applicable portion of the mixture for each. The temperature of each mixture at the time of spreading shall be less than 315°F whenever PG 64-22 or PG 70-22 binders are used or not more than 325°F whenever PG 76-22 binder is used. No mixture shall be placed on a previously paved course that has not cooled to below 175°F. For mixtures

compacted in accordance with 402.15, the temperature of each mixture at the time of spreading shall not be less than 245°F.

410

Planned HMA courses greater than 220 lb/sq yd placed under traffic, shall be brought up even with each adjacent lane at the end of each work day. Planned HMA courses less than or equal to 220 lb/sq yd shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane. Traffic shall not be allowed on open graded mixtures.

420

Hydraulic extensions on the paver will not be allowed for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving width varies. Hydraulic extensions may be used in tapers and added lanes less than 250 ft in length.

Automatic slope and grade controls shall be used as outlined in the QCP.

HMA mainline and HMA shoulders which are 8 ft or more in width shall be placed with paving equipment in accordance with 409.03(c)1.

430

When laying mixtures with density not controlled by cores, the speed of the paver shall not exceed 50 ft per minute. Rollers shall be operated to avoid shoving of the HMA and at speeds not to exceed 3 mph. However, vibratory rollers will be limited to 2.5 mph.

The finished thickness of any course shall be at least two times but not more than five times the maximum particle size as shown on the DMF, except 4.75 mm mixtures shall be at least 1.5 times but not more than 3 times the maximum particle size shown on the DMF.

440

A safety edge shall be constructed at locations where a dense graded intermediate mixture or a surface mixture is constructed adjacent to an aggregate or earth shoulder.

Vibratory rollers in accordance with 409.03(d)4 shall not be operated in the vibratory mode at locations indicated on the plans. Oscillatory rollers in accordance with 409.03(d)5 will be allowed for use but the vertical impact force capability shall not be used. Density acceptance shall be in accordance with 401.16.

401.15 Joints

450

Longitudinal joints in the surface shall be at the lane lines of the pavement. Longitudinal joints below the surface shall be offset from previously constructed joints by approximately 6 in. and be located within 12 in. of the lane line.

Hot poured joint adhesive in accordance with 906 shall be applied to longitudinal joints constructed between two adjacent HMA courses in the top course of dense graded intermediate mixtures and all 4.75 mm, 9.5 mm and 12.5 mm surface mixture

401.15

courses. This includes joints within the traveled way as well as between any of the following: traveled way and an auxiliary lane; traveled way and a paved shoulder; and auxiliary lane and a paved shoulder.

The material shall be heated in a jacketed, double boiler melting kettle. The kettle shall have an attached pressure feed wand system with applicator shoe.

460

The joint adhesive shall be applied to the face of the previously constructed edge at the joint using a wand applicator. Prior to application of the joint adhesive, the joint face shall be dry and free of loose material and foreign objects. The adhesive shall be applied on the joint face 1/8 in. thick at the temperature recommended by the manufacturer. Excess joint adhesive shall not be allowed to pool on the top of the previously constructed pavement course or the pavement to be overlaid. The application of the adhesive shall be made within the same day, but at least 30 minutes prior to construction of the longitudinal joint.

470

All 9.5 mm and 12.5 mm surface mixture longitudinal joints that have the joint adhesive applied shall be sealed using SS-1h or AE-NT asphalt emulsion in accordance with 902.01(b). The sealing operation shall not begin until all density cores in accordance with 401.16 and 401.20 have been obtained and the installation of pavement corrugations, when specified in accordance with 606, has been completed.

480

The liquid asphalt sealant shall be a minimum width of 24 in., centered on the joint line, and shall be extended, when necessary, to provide coverage beyond the edge of the pavement corrugation. The sealant shall be applied at an application rate of 0.03 ±0.01 gal./sq yd onto a dry surface, free of any foreign or loose material, using a distributor in accordance with 409.03(a). Areas receiving greater than 0.04 gal./sq yd shall be lightly broomed to reduce the effects of excess sealant on the pavement surface. The sealant temperature at the time of application shall be at least 135°F and shall not exceed 180°F. The ambient air and pavement temperatures at the time of application shall be greater than 32°F.

490

Temporary pavement markings in accordance with 801.12 shall be offset a sufficient distance from the longitudinal joint so as not to obstruct the installation of the pavement corrugations or the application of the liquid asphalt sealant. The sealant shall be cured a minimum of five days prior to applying the permanent pavement traffic markings in accordance with 808. Where pavement markings are to be grooved in accordance with 808.07(b)1, the minimum cure of five days for the sealant shall not apply.

Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course. For areas inaccessible to rollers, other mechanical devices shall be used to achieve the required density.

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

500

401.16 Density

Acceptance will be based on lots and sublots in accordance with 401.07.

Density of the compacted dense graded mixture will be determined from cores except where:

- (a) the total planned lay rate to be placed over a shoulder existing prior to the contract award is less than 385 lb/sq yd; or
- 510 (b) the first lift of material placed at less than 385 lb/sq yd over a shoulder existing prior to the contract award.

Density of any random core location in these areas will be assigned a value of 94.0% MSG and compaction shall be in accordance with 402.15.

Open graded mixtures shall be compacted with six passes of a static tandem roller and will be assigned a value of 84.0% MSG. Vibratory rollers shall not be used on open graded mixtures.

- 520 Compaction of 4.75 mm mixtures shall be in accordance with 402.15, except vibratory rollers shall be operated in static mode and the vertical impact force capability of oscillatory rollers shall not be used.

Compaction of mixtures with original contract pay item quantities less than 300 t shall be in accordance with 402.15.

- 530 Density acceptance by cores will be based on samples obtained from two random locations selected by the Engineer within each subplot in accordance with ITM 802. One core shall be cut at each random location in accordance with ITM 580. The transverse core location will be located so that the edge of the core will be no closer than 3 in. from a confined edge or 6 in. from a non-confined edge of the course being placed. The maximum specific gravity will be determined from the samples obtained in 401.09.

The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6.00 ± 0.25 in. diameter pavement sample. Coring shall be completed prior to the random location being covered by the next course.

- 540 All core locations will be marked and shall be cored within two work days of placement. A damaged core shall be discarded and replaced with a core from a location selected by adding 1 ft to the longitudinal location of the damaged core using the same transverse offset.

The Contractor and the Engineer shall mark the core to define the course to be tested. If the core indicates a course thickness of less than two times the maximum

401.17

particle size, the core will be discarded and a core from a new random location will be selected for testing.

Cores shall not be obtained from the following areas:

550

- (a) Mixture placed on an approach, taper, gore area, crossover that is not placed simultaneously with the mainline.
- (b) Mixture placed on a shoulder less than 8 ft in width that is not placed simultaneously with the mainline.
- (c) Within 25 ft of a transverse construction joint.
- (d) Within 25 ft of an acceptance sample taken in accordance with 401.09.

560

- (e) Areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3.

If a random location falls within this area, the Engineer will randomly select another location within the subplot for coring. If an entire subplot falls within this area, test results from the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

570

The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 1 ft from the random location using the same transverse offset.

580

The density for the mixture will be expressed as the percentage of maximum specific gravity, %MSG, obtained by dividing the average bulk specific gravity by the maximum specific gravity for the subplot, times 100. Samples for the bulk specific gravity and maximum specific gravity will be dried in accordance with ITM 572. The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166, Method A or AASHTO T 331, if required. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209.

Within one work day of coring operations the Contractor shall clean, dry, and refill the core holes with HMA of similar or smaller size particles.

The Engineer's acceptance test results for each subplot will be available when the subplot testing is complete. Acceptance of the pavement for density, %MSG, will be reported to the nearest 0.01%. Rounding will be in accordance with 109.01(a).

590

401.17 Pavement Corrugations

Pavement corrugations shall be in accordance with 606.

401.18 Pavement Smoothness

Pavement smoothness will be accepted by means of a profilograph, a 16 ft long straightedge, or a 10 ft long straightedge as described below.

(a) Profilograph

When a pay item for Profilograph, HMA is included in the contract, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 600 912 on the mainline traveled way and ramps, including adjacent acceleration or deceleration lane, where all of the following conditions are met:

1. The design speed is greater than 45 mph.
2. The traveled way or ramp lane width is constant and is 0.1 mi in length or longer.
- 610 3. The HMA is placed on a milled surface or the total combined planned lay rate of surface, intermediate, and base courses is 385 lb/sq yd or greater.

The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor.

The project area, less paving exceptions and areas exempt from profilograph operation in accordance with ITM 912, will be divided into individual smoothness sections measuring 0.1 mi in length for each lane. Partial length smoothness sections adjacent to project limits, paving exceptions, or areas exempt from profilograph operation will be considered in accordance with ITM 912.

620 If the original contract pay item quantity for a surface mixture is less than or equal to one subplot, the item will be exempt from profilograph operation and the smoothness will be accepted in accordance with 401.18(b).

If the posted speed limit for an entire smoothness section is less than or equal to 45 mph, the section will be exempt from profilograph operation and the smoothness within the section will be accepted in accordance with 401.18(b).

630 If the posted speed limit is greater than 45 mph for a portion of a smoothness section and is less than or equal to 45 mph for the remainder, the section smoothness acceptance will be as follows:

1. By profilograph for the portion of the section with a posted speed limit greater than 45 mph.
2. In accordance with 401.18(b) for the portion of the section with a posted speed limit less than or equal to 45 mph.

640 At locations where the profilograph is required, it shall be used on the surface course and on any dense graded intermediate course immediately below the surface course.

(b) 16 ft Straightedge and 10 ft Straightedge

The Department will furnish and operate 16 ft and 10 ft straightedges as described below. The 16 ft straightedge is used to accept smoothness along the direction of mainline traffic and the 10 ft straightedge is used to accept smoothness transverse to the direction of mainline traffic. This includes longitudinal smoothness on public road approaches and median crossovers.

650

For contracts which include the Profilograph, HMA pay item, the 16 ft long straightedge will be used to accept longitudinal smoothness on surface courses at the following locations:

1. All mainline traveled way lanes shorter than 0.1 mi.
2. All mainline traveled way lanes within smoothness sections with posted speed limits less than or equal to 45 mph throughout the entire section length.
- 660 3. All mainline traveled way lanes at locations exempted from profilograph operation in accordance with ITM 912.
4. All tapers.
5. All turn lanes, including bi-directional left turn lanes.
6. All ramps with design speeds of 45 mph or less.
- 670 7. All acceleration and deceleration lanes associated with ramps with design speeds of 45 mph or less.
8. All shoulders.

670

For contracts where the profilograph is not used for smoothness acceptance, the 16 ft straightedge will be used to accept longitudinal smoothness on all dense graded courses at the above locations as well as all mainline travel way lanes and ramps with design speeds of greater than 45 mph. Smoothness acceptance on ramp acceleration or deceleration lanes will also be based on operation of the 16 ft straightedge.

680

The 10 ft long straightedge shall be used to check transverse slopes, across travel lanes and shoulders, approaches, and crossovers.

(c) Smoothness Correction

At locations where the profilograph is being used on an intermediate course, all areas having a high or low point deviation in excess of 0.30 in. shall be corrected. After corrective action is taken on an intermediate course, a 16 ft straightedge may be used to verify the adequacy of the corrective action.

690

At locations where the profilograph is being used on a surface course, all areas having a high or low point deviation in excess of 0.30 in. shall be corrected. All smoothness sections with a deficient profile index in accordance with 401.19(c) shall be corrected. Underlying courses that are exposed by corrective action shall be milled to a depth of 1 1/2 in. and replaced with surface course. After the corrective action is taken on a surface course, the profilograph shall be operated throughout the entire affected smoothness section to verify the adequacy of the corrective action.

700 At locations where the 16 ft straightedge is used, the pavement variations shall be corrected to 1/4 in. or less. When the 10 ft straightedge is used, the pavement variations shall be corrected to 1/8 in. or less.

If grinding of an intermediate course is used for pavement smoothness corrections, the grinding shall not precede the surface placement by more than 30 calendar days if open to traffic.

401.19 Pay Factors**(a) Dense Graded Mixture \geq One Lot**

710 Pay factors, PF, are calculated for the air voids at N_{des} , V_{be} at N_{des} and in-place density, %Gmm. The Percent Within Limits, PWL, for each lot will be determined in accordance with ITM 588.

The appropriate pay factor for each property is calculated as follows:

Estimated PWL greater than 90:

$$PF = ((0.50 \times PWL) + 55.00)/100$$

720 Estimated PWL greater than 70 and equal to or less than 90:

$$PF = ((0.40 \times PWL) + 64.00)/100$$

Estimated PWL greater than or equal to 50 and equal to or less than 70:

$$PF = ((0.85 \times PWL) + 32.5)/100$$

730 If the Lot PWL for any one of the properties is less than 50, a subplot has an air void content less than 1.0% or greater than 8.0%, or a subplot has a volume of effective binder greater than 3.0% above design minimums, the lot will be referred to the

Department’s Division of Materials and Tests for adjudication as a failed material in accordance with normal Department practice as listed in 105.03.

Air voids, Vbe, and in-place density, %Gmm, PF values will be reported to the nearest 0.01. Rounding will be in accordance with 109.01(a).

A composite pay factor for each lot based on test results for mixture properties and density is determined by a weighted formula as follows:

740
$$\text{Lot PF} = 0.30(\text{PF}_{\text{VOIDS}}) + 0.35(\text{PF}_{\text{Vbe}}) + 0.35(\text{PF}_{\text{DENSITY}})$$

where:

- Lot PF = Lot Composite Pay Factor for Mixture and Density
- PF_{VOIDS} = Lot Pay Factor for Air Voids at N_{des}
- PF_{Vbe} = Lot Pay Factor for Vbe at N_{des}
- PF_{DENSITY} = Lot Pay Factor for In-Place Density, % Gmm

The lot quality assurance adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (\text{Lot PF} - 1.00) / \text{MAF}$$

where:

- q = quality assurance adjustment for mixture properties and density of the lot
- L = Lot quantity
- U = Unit price for the material, \$/ton
- Lot PF = Lot Pay Factor

750

Lot test results for the air voids at N_{des}, Vbe at N_{des}, and density will be used to determine the Lot Pay Factors.

The specification limits for the air voids at N_{des}, Vbe at N_{des}, and density will be as follows:

Specification Limits		
Mixture		
	LSL*	USL**
Air Voids at N _{des} , %	3.60	6.40
Volume of Effective Binder at N _{des} , %	Spec	Spec +2.50
Density		
	LSL*	USL**
Roadway Core Density (%Gmm), %	93.00	n/a
* LSL, Lower Specification Limit		
** USL, Upper Specification Limit		

(b) Dense Graded Mixture < One Lot and Open Graded Mixture

760 A composite pay factor for each subplot based on test results for mixture properties and density is determined in a weighted formula as follows:

Dense Graded Mixture:

$$\text{SCPF} = 0.30(\text{PF}_{\text{VOIDS}}) + 0.35(\text{PF}_{\text{Vbe}}) + 0.35(\text{PF}_{\text{DENSITY}})$$

Open Graded Mixture:

$$\text{SCPF} = 0.20(\text{PF}_{\text{BINDER}}) + 0.35(\text{PF}_{\text{VOIDS}}) + 0.45$$

770

where:

SCPF = Sublot Composite Pay Factor for Mixture and Density
 PF_{BINDER} = Sublot Pay Factor for Binder Content
 PF_{VOIDS} = Sublot Pay Factor for Air Voids at N_{des}
 PF_{Vbe} = Sublot Pay Factor for Vbe at N_{des}
 PF_{DENSITY} = Sublot Pay Factor for Density

If the SCPF for an open graded subplot is less than 0.85 or the volume of effective binder is greater than 3.0% above design minimums, the subplot will be referred to the Division of Materials and Tests for adjudication as a failed material in accordance with 105.03.

780 The subplot quality assurance adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (\text{SCPF} - 1.00) / \text{MAF}$$

where:

q = quality assurance adjustment for the subplot
 L = subplot quantity
 U = unit price for the material \$/ton
 SCPF = subplot composite pay factor

Sublot test results for mixture properties will be assigned pay factors in accordance with the following:

Binder Content	
Open Graded Deviation from DMF ($\pm\%$)	Pay Factor
≤ 0.2	1.05
0.3	1.04
0.4	1.02
0.5	1.00
0.6	0.90
0.7	0.80
0.8	0.60
0.9	0.30
1.0	0.00
>1.0	Submitted to the Division of Materials and Tests*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.	

790

Volume of Effective Binder, Vbe	
Dense Graded Deviation from Spec Minimum	Pay Factors
$> +3.0$	Submitted to the Division of Materials and Tests*
$\geq +2.5$ and $\leq +3.0$	1.00 - 0.05 for each 0.1% above +2.5%
$\geq +2.0$ and $< +2.5$	1.05 - 0.01 for each 0.1% above +2.0%
$> +0.5$ and $< +2.0$	1.05
≥ 0.0 and $\leq +0.5$	1.05 - 0.01 for each 0.1% below +0.5%
≥ -0.5 and < 0.0	1.00 - 0.02 for each 0.1% below 0.0%
≥ -2.0 and < -0.5	0.90 - 0.06 for each 0.1% below -0.5%
< -2.0	Submitted to the Division of Materials and Tests*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.	

Air Voids		
Dense Graded	Open Graded	Pay Factor
Deviation from Spec ($\pm\%$)	Deviation** ($\pm\%$)	
≤ 0.5	≤ 3.0	1.05
> 0.5 and ≤ 1.7	> 3.0 and ≤ 4.0	1.00
	4.1	0.98
1.8	4.2	0.96
	4.3	0.94
	4.4	0.92
1.9	4.5	0.90
2.0	4.6	0.84
	4.7	0.78
	4.8	0.72
	4.9	0.66
	5.0	0.60
> 2.0	> 5.0	Submitted to the Division of Materials and Tests*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.		
** Deviation shall be from 17.5% for OG25.0 mm and OG19.0 mm mixtures and shall be from 14.5% for OG9.5 mm mixtures.		

For mixtures produced during a plant's adjustment period, pay factors based on the DMF with the above tolerances will be used to compute quality assurance adjustments.

Sublot test results for density will be assigned pay factors in accordance with the 800 following:

Density	
Percentages are based on %MSG	Pay Factors, %
Dense Graded	
≥ 98.0	Submitted to the Division of Materials and Tests*
97.0 - 97.9	1.00
96.6 - 96.9	1.05 - 0.01 for each 0.1% above 96.5
95.0 - 96.5	1.05
94.1 - 94.9	1.00 + 0.005 for each 0.1% above 94.0
93.0 - 94.0	1.00
92.0 - 92.9	1.00 - 0.005 for each 0.1% below 93.0
91.0 - 91.9	0.95 - 0.010 for each 0.1% below 92.0
90.0 - 90.9	0.85 - 0.030 for each 0.1% below 91.0
≤ 89.9	Submitted to the Division of Materials and Tests*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.	

The pay factors will be rounded to the nearest 0.01.

(c) Smoothness

Smoothness pay adjustments will only be applied when the smoothness is measured by a profilograph. The pay adjustment will be based on the profile index generated on the surface course only.

- 810 At locations where a profilograph is used to accept smoothness, a quality assurance adjustment will be determined for each 0.1 mile section of each lane. This adjustment will be applied to all QC/QA HMA pay items within the pavement section. The adjustment for each section will be calculated using the following formula:

$$q_s = (PF_s - 1.00) \sum_{i=1}^n \left(A \times \frac{S}{T} \times U \right)$$

where:

- q_s = quality assurance adjustment for smoothness for one section
- PF_s = pay factor for smoothness
- n = number of layers
- A = area of the section, sq yd
- S = planned spread rate for material, lb/sq yd
- T = conversion factor: 2,000 lb/ton
- U = unit price for the material, \$/ton.

- 820 For smoothness sections that are less than 0.1 mile in length or require profilograph operation along both lane edges, the profile index used to obtain the smoothness pay factor used in the above formula will be determined in accordance with ITM 912.

The quality assurance adjustment for smoothness, Q_s , for the contract will be the total of the quality assurance adjustments for smoothness, q_s , on each section by the following formula:

$$Q_s = \sum q_s$$

- 830

When smoothness is measured by a profilograph, payment adjustments will be made based on a zero blanking band on the final profile index in accordance with the following table. Regardless of the tabulated value, the maximum pay factor for a smoothness section where corrective action has been performed will be 1.00.

Pay Factors for Smoothness (PI _{0.0}) Zero Blanking Band	
Design Speed greater than 45 mph	
Profile Index in./0.1 mi.	Pay Factor, PFs
Over 0.00 to 1.20	1.06
Over 1.20 to 1.40	1.05
Over 1.40 to 1.60	1.04
Over 1.60 to 1.80	1.03
Over 1.80 to 2.00	1.02
Over 2.00 to 2.40	1.01
Over 2.40 to 3.20	1.00
Over 3.20 to 3.40	0.96
All pavement with a profile index (PI _{0.0}) greater than 3.40 in. shall be corrected to a profile index less than or equal to 3.40 in.	

The total quality assurance adjustment is calculated as follows:

840

$$Q = Q_s + (\sum q)$$

where:

Q = total quality assurance adjustment

Q_s = quality assurance adjustment for smoothness

q = lot or subplot quality assurance adjustment

401.20 Appeals

If the QC test results do not agree with the acceptance test results in a subplot, a request, along with a comparison of the QC and acceptance test results, may be made in writing for additional testing of that subplot. The appeal sample will be analyzed in a lab different than the lab that analyzed the original sample at the discretion of the Engineer.

850

The Contractor may appeal an individual subplot for the binder content, the MSG, the BSG of the gyratory specimens or the BSG of the density cores when the QC results are greater than one standard deviation from the acceptance test results as follows: 0.25 for binder content, 0.010 for the MSG and 0.010 for the BSG of the gyratory specimens and 0.020 for the BSG of the density cores.

Upon request from the Contractor, the BSG of the density core may be exempted from the individual subplot appeal if both the QC and QA results show a %MSG for the density greater than or equal to 93.0%.

860

A \$500.00 credit adjustment will be included in a quality adjustment pay item in accordance with 109.05.1(d) for each appealed subplot that did not result in an improvement to the SCPF or Lot PF.

A written request for an appeal shall be submitted within seven calendar days of receipt of the Department's written results for the lot accepted under 401.19(a) or the subplot accepted under 401.19(b). The conditions for an extended lot appeal are as follows:

- 870
1. One appeal will be allowed for the entire extended lot if the Contractor informs the Department of the anticipated extended lot condition within seven calendar days of receipt of the lot results, or;
 2. One appeal will be allowed only for the extended sublots if the Contractor did not inform the Department of the anticipated extended lot condition within seven calendar days of receipt of the lot results.

880 The backup sample will be tested in accordance with the applicable test method for the subplot requested for all tests exceeding the subplot standard deviation criteria.

(a) MSG

The backup MSG will be dried in accordance with ITM 572 and mass determined in water in accordance with AASHTO T 209.

(b) BSG of the Gyrotory Specimen

New gyrotory specimens will be prepared and tested in accordance with AASHTO T 312 from the backup sample.

890

(c) Binder Content

The backup binder content sample will be prepared and tested in accordance with ITM 571.

(d) BSG of the Density Core

Additional cores shall be taken within seven calendar days unless otherwise directed. Additional core locations will be determined by adding 1 ft longitudinally of the cores tested using the same transverse offset. The appeal density cores will be dried in accordance with ITM 572 and tested in accordance with AASHTO T 166, Method
900 A or AASHTO T 331, if required.

The appeal results will replace all previous test result for acceptance of mixture in accordance with 401.09 and density in accordance with 401.16. The results will be furnished to the Contractor.

401.21 Method of Measurement

HMA mixtures will be measured by the ton of the type specified, in accordance with 109.01(b). The measured quantity will be divided by the MAF to determine the pay quantity.

910

Milled shoulder corrugations will be measured in accordance with 606.02.

Joint adhesive will be measured by the linear foot in accordance with 109.01(a). Liquid asphalt sealant will be measured by the linear foot.

401.22 Basis of Payment

The accepted quantities for this work will be paid for at the contract unit price per ton for QC/QA-HMA, of the type specified, complete in place.

920

Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made at the contract lump sum price for profilograph, HMA.

Adjustments to the contract payment with respect to mixture, density, and smoothness for mixture produced will be included in a quality adjustment pay item in accordance with 109.05.1.

Milled shoulder corrugations will be paid for in accordance with 606.03.

930

Joint adhesive will be paid for at the contract unit price per linear foot, complete in place. Liquid asphalt sealant will be paid for at the contract unit price per linear foot.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Joint Adhesive, _____ course type	LFT
	Liquid Asphalt Sealant	LFT
940	Profilograph, HMA.....	LS
	QC/QA-HMA, _____, _____, _____, _____ mm	TON
	(ESAL ⁽¹⁾) (PG ⁽²⁾) (Course ⁽³⁾) (Mix ⁽⁴⁾)	

(1) ESAL Category as defined in 401.04

(2) Number represents the high temperature binder grade. Low temperature grades are - 22

(3) Surface, Intermediate, or Base

(4) Mixture Designation

950 Preparation of surfaces to be overlaid shall be included in the cost of other pay items.

402.01

Coring and refilling of the core holes shall be included in the cost of other pay items within this section.

No payment will be made for additional anti-stripping additives, appeal coring or traffic control expenditures related to coring operations.

The cost of removing and replacing soft and yielding areas shall be included in the cost of other pay items in this section.

960

Corrections for pavement smoothness shall be included in the cost of other pay items within this section.

The price for Profilograph, HMA will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

970

If QC/QA-HMA 19.0 mm over QC/QA-HMA 25.0 mm mixtures are specified, QC/QA-HMA 19.0 mm mixture may be considered as a substitute for the QC/QA-HMA 19.0 mm and QC/QA-HMA 25.0 mm mixtures upon a written request by the Contractor. The request for the substitution shall be prepared in advance of the work. A computation will be made in order to obtain a unit price for the QC/QA-HMA 19.0 mm mixture. The quantity and amount for QC/QA-HMA 19.0 mm mixture shall equal the sum of the contract quantities and amounts shown for QC/QA-HMA 19.0 mm and QC/QA-HMA 25.0 mm mixtures. The unit price for QC/QA-HMA 19.0 mm mixture shall be equal to the sum of contract amounts divided by the sum of contract quantities. Payment for the QC/QA-HMA 19.0 mm mixture will be made at the unit price per ton for QC/QA-HMA 19.0 mm mixture. No payment will be made for additional work or costs which may result due to this change.

SECTION 402 – HMA PAVEMENT

402.01 Description

This work shall consist of one or more courses of miscellaneous mixtures constructed in accordance with 105.03.

402.02 Quality Control

10 The HMA shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Hot Mix Asphalt Producer Program. The HMA shall be transported and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803; Contractor Quality Control Plans for Hot Mix Asphalt Pavements. The QCP shall be submitted to the Engineer at least 15 days prior to commencing HMA paving operations.

When a safety edge is required for a project, the QCP shall identify the device or devices in accordance with 409.03(c) to be used for constructing the safety edge.

MATERIALS

20 402.03 Materials

Materials shall be in accordance with the following:

Asphalt Materials	
PG Binder	902.01(a)
Coarse Aggregates.....	904
Base Mixtures – Class D or Higher	
Intermediate Mixtures – Class C or Higher	
Surface Mixtures* – Class B or Higher	
Fine Aggregates.....	904
* Surface aggregate requirements are listed in 904.03(d).	

30

402.04 Design Mix Formula

A DMF shall be prepared in accordance with 401.04 and submitted in a format acceptable to the Engineer one week prior to use.

The DMF will be based on the ESAL and mixture designation as follows:

Mixture Type	Type B*	Type C	Type D
Design ESAL	< 3,000,000	3,000,000 to < 10,000,000	≥ 10,000,000
Surface	4.75 mm	4.75 mm	4.75 mm
	9.5 mm	9.5 mm	9.5 mm
	12.5 mm	12.5 mm	12.5 mm
Surface – PG Binder	64-22	70-22	70-22
Intermediate	9.5 mm	9.5 mm	9.5 mm
	12.5 mm	12.5 mm	12.5 mm
	19.0 mm	19.0 mm	19.0 mm
	25.0 mm	25.0 mm	25.0 mm
Intermediate – PG Binder	64-22	64-22	70-22
Base	19.0 mm	19.0 mm	19.0 mm
	25.0 mm	25.0 mm	25.0 mm
Base – PG Binder	64-22	64-22	64-22
*A type B mixture shall replace a type A mixture.			

40 A Type D mixture may be used in lieu of a Type C or a Type B mixture and a Type C mixture may be used in lieu of a Type B mixture.

Surface 4.75 mm mixtures shall not be used when the required lay rate shown on the plans is greater than 100 lb/sq yd. Surface 12.5 mm mixtures shall not be used when the required lay rate shown on the plans is less than 195 lb/sq yd.

402.05

The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 64-22 or PG 70-22 binders are used. HMA may be produced using a water-injection foaming device. The DMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture.

No mixture will be accepted for use until the DMF has been assigned a mixture number by the Engineer.

402.05 Volumetric Mix Design

The DMF shall be determined for each mixture from a volumetric mix design in accordance with 401.05.

A DMF developed for a QC/QA HMA mixture may be used and the source or grade of the binder may be changed; however, the high temperature grade shall meet the minimum requirements of 402.04.

The MAF equals the G_{mm} from the mixture design divided by the following: 2.465 for 9.5 mm mixtures and 2.500 for 12.5 mm, 19.0 mm, and 25.0 mm mixtures. If the MAF calculation results in a value where $0.980 \leq \text{MAF} \leq 1.020$, then the MAF shall be considered to be 1.000. If the MAF is greater than 1.020, the calculated MAF value shall have 0.020 subtracted from the value. If the MAF is less than 0.980, the calculated MAF value shall have 0.020 added to the value.

70 **402.06 Blank**

402.07 Mix Criteria

(a) Composition Limits for HMA Transverse Rumble Strip Mixtures

Transverse rumble strip mixtures shall be type B surface in accordance with 402.04. A MAF in accordance with 402.05 will not apply. Aggregate requirements of 904.03(d) do not apply.

(b) Composition Limits for HMA Wedge and Leveling Mixtures

80 The mixture shall consist of surface or intermediate mixtures in accordance with 402.04. Aggregate requirements of 904.03(d) do not apply when the wedge and leveling mixture is covered by a surface or intermediate mixture.

(c) Composition Limits for Temporary HMA Mixtures

Temporary HMA mixtures shall be the type specified in accordance with 402.04. A MAF in accordance with 402.05 will not apply.

(d) Composition Limits for HMA Curbing Mixes

90 The mixture shall be HMA surface type B in accordance with 402 except 402.05 shall not apply and RAP shall not be used. The binder content shall be 7.0% and the gradations shall meet the following.

HMA Curbing Gradations	
Sieve Size	Percent Passing
1/2 in. (12.5 mm)	100.0
3/8 in. (9.5 mm)	80.0 - 100.0
No. 4 (4.75 mm)	73.0 ±5.0
No. 30 (600 µm)	20.0 - 50.0
No. 200 (75 µm)	6.0 - 12.0

A DMF shall be prepared in accordance with the above table and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall state the binder content.

402.08 Recycled Materials

100 Recycled materials shall be in accordance with 401.06 except type B mixtures shall correspond to category 2 mixtures, type C mixtures shall correspond to category 3 mixtures and type D mixtures shall correspond to category 4 mixtures.

402.09 Acceptance of Mixtures

A type D certification in accordance with 916 and the Frequency Manual shall be provided for the HMA pavement. The test results shown on the certification shall be the quality control tests representing the material supplied and include air voids and binder content. Air voids tolerance shall be ±2.0% and binder content tolerance shall be ±0.7% from DMF.

110

Single test values and averages will be reported to the nearest 0.1%. Rounding will be in accordance with 109.01(a).

Test results exceeding the tolerance limits will be considered as a failed material and adjudicated in accordance with 105.03.

CONSTRUCTION REQUIREMENTS

402.10 General

120 Equipment for HMA operations shall be in accordance with 409. The Contractor shall submit to the Engineer prior to use a written Certificate of Compliance that the proposed paving equipment has been modified in accordance with 401.10 or is new and includes the modifications.

Fuel oil, kerosene, or solvents shall not be transported in open containers on any equipment at any time. Cleaning of equipment and tools shall not be performed on the pavement or shoulder areas.

130 Segregation, flushing, or bleeding of HMA mixtures will not be allowed. Corrective action shall be taken to prevent continuation of these conditions. Areas of

402.11

segregation, flushing, or bleeding shall be corrected, if directed. All areas showing an excess or deficiency of asphalt materials shall be removed and replaced.

All mixtures that become loose and broken, mixed with dirt, or defective in any way shall be removed and replaced.

Mixture shall not be dispatched from the plant that cannot be spread and compacted before sundown of that day, unless otherwise specified.

140 **402.11 Preparation of Surfaces to be Overlaid**

The subgrade shall be shaped to the required grade and sections, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Milling of an existing surface shall be in accordance with 306. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

150 Prior to placing an open graded mixture, the underlying HMA course shall have a full width base seal applied in accordance with 415. The base seal materials shall be applied within three calendar days upon completion of paving the underlying HMA course.

Rubblized concrete pavements shall be primed in accordance with 405. PCCP, milled asphalt surfaces, and asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

402.12 Weather Limitations

160 HMA courses less than 110 lb/sq yd are to be placed when the ambient and surface temperatures are 60°F or above. HMA courses equal to or greater than 110 lb/sq yd but less than 220 lb/sq yd are to be placed when the ambient and surface temperatures are 45°F or above. HMA courses equal to or greater than 220 lb/sq yd and HMA curbing are to be placed when the ambient and surface temperatures are 32°F or above. Mixture shall not be placed on a frozen subgrade. However, HMA courses may be placed at lower temperatures, provided the density of the HMA course is in accordance with 402.16.

170 All partially completed sections of roadway that are 8 in. or less in thickness shall be proofrolled prior to the placement of additional materials unless otherwise directed by the Engineer. Proofrolling shall be accomplished in accordance with 203.26. The contact pressure shall be 70 to 80 psi. Soft yielding areas shall be removed and replaced.

402.13 Spreading and Finishing

The mixture shall be placed upon an approved surface by means of laydown equipment in accordance with 409.03(c). Prior to paving, both the planned quantity and lay rate shall be adjusted by multiplying by the MAF. When a mixture is produced

from more than one DMF for a given pay item, the MAF will be applied to the applicable portion of the mixture for each. Mixtures in areas inaccessible to laydown equipment or mechanical devices may be placed by other methods.

180

The temperature of each mixture at the time of spreading shall be less than 315°F whenever PG 64-22 or PG 70-22 binders are used. The temperature of each mixture at the time of spreading shall not be less than 245°F. No mixture shall be placed on a previously paved course that has not cooled to less than 175°F.

190

Planned HMA courses greater than 220 lb/sq yd placed under traffic shall be brought up even with each adjacent lane at the end of each work day. Planned HMA courses less than or equal to 220 lb/sq yd shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane. Traffic shall not be allowed on open graded mixtures.

Hydraulic extensions on the paver will not be allowed for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving widths vary. Hydraulic extensions may be used on approaches, tapers, and added lanes less than 250 ft in length.

200

HMA shoulders which are 8 ft or more in width shall be placed with automatic paving equipment.

HMA mixtures in hauling equipment shall be protected by tarps from adverse weather conditions or foreign materials. Adverse weather conditions include, but will not be limited to, precipitation or temperatures below 45°F.

The speed of the paver shall not exceed 50 ft per minute when spreading mixtures.

210

Automatic slope and grade controls shall be required except when placing mixtures on roadway approaches which are less than 200 ft in length or on miscellaneous work. The use of automatic controls on other courses where use is impractical due to project conditions may be waived by the Engineer.

The finished thickness of each course shall be at least two times but not more than five times the maximum particle size as shown on the DMF. The finished thickness of wedge and level mixtures shall be at least 1 1/2 times but not more than six times the maximum particle size as shown on the DMF. Feathering may be less than the minimum thickness requirements.

220

Transverse rumble strips shall be placed to ensure uniformity of height, width, texture, and the required spacing between strips. A tack coat in accordance with 406 shall be applied on the pavement surface prior to placing the mixture. The tack coat may be applied with a paint brush or other approved methods.

A safety edge shall be constructed at locations where an intermediate mixture or a surface mixture is constructed adjacent to an aggregate or earth shoulder.

Vibratory rollers in accordance with 409.03(d)4 shall not be operated in vibratory mode at locations indicated on the plans. Oscillatory rollers in accordance with 409.03(d)5 will be allowed for use but the vertical impact force capability shall not be used. Density acceptance shall be in accordance with 402.15.

402.14 Joints

Longitudinal joints in the surface shall be at the lane lines of the pavement. Longitudinal joints below the surface shall be offset from previously constructed joints by approximately 6 in. and be located within 12 in. of the lane line.

Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course.

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

402.15 Compaction

The HMA mixture shall be compacted with equipment in accordance with 409.03(d) immediately after the mixture has been spread and finished. Rollers shall not cause undue displacement, cracking, or shoving.

A roller application is defined as one pass of the roller over the entire mat. Compaction operations shall be completed in accordance with one of the following options.

Number of Roller Applications							
Rollers	Courses						
	≤ 440 lb/sq yd					> 440 lb/sq yd	
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 1	Option 2
Three Wheel	2		4			4	
Pneumatic Tire	2	4				4	
Tandem	2	2	2			4	
Vibratory				6			8
Oscillatory					6	-	-

A reduced number of applications on a course may be approved if detrimental results are being observed.

260 Compaction equipment shall be operated with the drive roll or wheels nearest the paver and at speeds not to exceed 3 mph. However, vibratory rollers will be limited to 2.5 mph. Rolling shall be continued until applications are completed and all roller marks are eliminated.

Compaction operations shall begin at the low side and proceed to the high side of the mat. The heaviest roller wheel shall overlap its previous pass by a minimum of 6 in.

Longitudinal joints shall be compacted in accordance with the following:

- 270 (a) For confined edges, the first pass adjacent to the confined edge, the compaction equipment shall be entirely on the hot mat 6 in. from the confined edge.
- (b) For unconfined edges, the compaction equipment shall extend 6 in. beyond the edge of the hot mat.

All displacement of the HMA mixture shall be corrected at once by the use of lutes or the addition of fresh mixture as required. The line and grade of the edges of the HMA mixture shall not be displaced during rolling.

280 The wheels shall be kept properly moistened with water or water with detergent to prevent adhesion of the materials to the wheels.

Areas inaccessible to rollers shall be compacted thoroughly with hand tampers or other mechanical devices in accordance with 409.03(d)7 to achieve the required compaction. A trench roller, in accordance with 409.03(d)6, may be used to obtain compaction in depressed areas.

The final two roller applications shall be completed at the highest temperature where the mixture does not exhibit any tenderness.

290 Vehicular traffic will not be allowed on a course until the mixture has cooled sufficiently to prevent distortions.

Transverse rumble strips shall be compacted with vibratory compacting equipment in accordance with 409.03(d)7 unless otherwise stated.

402.16 Low Temperature Compaction Requirements

300 Compaction for mixtures placed below the temperatures listed in 402.12 shall be controlled by density determined from MSG of the plate samples and cores cut from the compacted pavement placed during a low temperature period. Samples shall be obtained in accordance with ITM 580. Acceptance will be based on a plate sample and two cores. The Engineer will randomly select the locations in accordance with ITM 802. The transverse core location will be located so that the edge of the core will be

402.17

no closer than 3 in. from a confined edge or 6 in. from a non-confined edge of the course being placed.

For compaction of HMA during low temperature periods with quantities less than 100 t per day, acceptance may be visual.

310 The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6.00 ±0.25 in. diameter pavement sample. Coring shall be completed prior to the random location being covered. The final HMA course shall be cored within one work day of placement. Damaged cores shall be discarded and replaced with a core from a location selected by adding 1 ft to the longitudinal location of the damaged core using the same transverse offset.

The Contractor and the Engineer shall mark the core to define the course to be tested. If the core indicates a course thickness of less than two times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing.

320

The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific section will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 1 ft from the random location using the same transverse offset.

The density for the mixture shall be expressed as:

$$\text{Density} = 100 \times \text{BSG}/\text{MSG}$$

330 where:

BSG = average bulk specific gravity
MSG = maximum specific gravity

The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166 Method A or AASHTO T 331, if required. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. Density shall not be less than 93.0%.

Within one work day of coring operations, the Contractor shall clean, dry, refill, and compact the core holes with suitable HMA of similar or smaller size particles.

340

402.17 Pavement Corrugations

Pavement corrugations shall be in accordance with 606.

402.18 Pavement Smoothness

Pavement smoothness will be in accordance with 401.18 except profilograph requirements will not apply.

402.19 Method of Measurement

350 HMA mixtures will be measured by the ton of the type specified, in accordance with 109.01(b). The measured quantity will be divided by the MAF to determine the pay quantity.

HMA rumble strips will be measured by the linear foot of each transverse strip, complete in place.

Milled pavement corrugations will be measured in accordance with 606.02.

402.20 Basis of Payment

360 The accepted quantities for this work will be paid for at the contract unit price per ton for HMA, of the type specified complete in place.

HMA transverse rumble strips will be paid for at the contract unit price per linear foot, complete in place.

Milled pavement corrugations will be paid for in accordance with 606.03.

Payment will be made under:

Pay Item	Pay Unit Symbol
HMA Transverse Rumble Strips	LFT
HMA for Temporary Pavement, Type <u> *</u>	TON
HMA Wedge and Level, Type <u> *</u>	TON
* Mixture type	

Preparation of surfaces to be overlaid shall be included in the cost of other pay items in this section.

380 No payment will be made for additional anti-stripping additives.

The cost of removing and replacing soft yielding areas shall be included in the cost of other pay items in this section.

No payment will be made for coring operations and related traffic control expenditures required in 402.16.

Corrections for pavement smoothness including removal and replacement of pavement, shall be included in the cost of other pay items in this section.

390 The cost of removal of HMA for temporary pavement including the subgrade and subbase materials shall be included in the cost of HMA for temporary pavement.

SECTION 403 – CMA PAVEMENT

403.01 Description

This work shall consist of the construction of one or more courses of CMA base, intermediate, or surface for immediate use or stockpiled in accordance with 105.03.

MATERIALS

403.02 Materials

10 Materials shall be in accordance with the following:

	Asphalt Materials	
	For Immediate Use,	
	Asphalt Emulsion AE-150, AE-90	902.01(b)
	For Stockpiling,	
	Asphalt Emulsion AE-150	902.01(b)
	Coarse Aggregates.....	904.03
	Base, Class D or Higher	
20	Intermediate, Class C or Higher	
	Surface, Class B or Higher	
	Fine Aggregates.....	904.02

A type D certification in accordance with 916 and the Frequency Manual shall be provided for the CMA pavement.

CONSTRUCTION REQUIREMENTS

30 **403.03 Weather Limitations**

CMA pavements shall not be placed on a wet surface, when the ambient temperature is below 40°F, or when other unsuitable conditions exist, unless approved by the Engineer.

403.04 Equipment

Mixing plant, hauling trucks, pavers, and rollers shall be in accordance with 409.

403.05 Preparation of Mixtures

The size of the aggregate and the grade of asphalt materials shall be as specified.

40 The gradations and percent of asphalt shall be as follows.

Composition Limits for CMA Mixtures						
Sieve Size	Total % of Aggregates Passing Sieves Based on Total Weight of Aggregates					
	Size 2	Size 5	Size 8	Size 9	Size 11	Size 5D
2 1/2 in. (63.0 mm)	100					
2 in. (50.0 mm)	95 - 100					
1 1/2 in. (37.5 mm)		100				100
1 in. (25.0 mm)	0 - 25	85 - 100	100			80 - 99
3/4 in. (19.0 mm)	0 - 10	60 - 90	75 - 100	100		68 - 90
1/2 in. (12.5 mm)	0 - 7	30 - 65	40 - 75	65 - 90	100	54 - 76
3/8 in. (9.5 mm)		15 - 50	20 - 55	30 - 65	75 - 100	45 - 67
No. 4 (4.75 mm)		0 - 20	0 - 20	0 - 20	10 - 35	30 - 50
No. 8 (2.36 mm)		0 - 15	0 - 15	0 - 15	0 - 15	20 - 45
No. 30 (600 µm)						7 - 28
No. 200 (75 µm)	0 - 5	0 - 5	0 - 5	0 - 6	0 - 6	0 - 6
Minimum % Crushed	95	95	95	95	95	95
% of Asphalt*	2.0 - 3.5	2.5 - 4.0	3.0 - 4.5	3.5 - 5.0	4.0 - 6.0	3.5 - 5.0
* Percent of asphalt shall be calculated on the basis of the total weight of the mixture, exclusive of water or solvent. When slag is used, the asphalt content will be adjusted to compensate for the specific gravity and surface area.						

The moisture condition of the aggregate shall be such that the aggregate is uniformly coated and satisfactorily retains the required amount of asphalt during the stockpiling, hauling, and spreading operations. Mixtures shall not be produced at temperatures exceeding 180°F.

403.06 Preparation of Subgrade or Base

- 50 Mixtures for CMA base may be placed on an earth subgrade, on an existing pavement surface to be used as a base, or on a previously prepared base or subbase as specified. If such material is to be laid on a newly prepared subgrade, then all applicable requirements of 207 shall apply.

403.07 Spreading Mixture

The CMA mixture shall be spread in accordance with 402.13.

A safety edge shall be constructed at locations where an intermediate mixture or a surface mixture is constructed adjacent to an aggregate or earth shoulder.

60

403.08 Curing

All CMA mixtures shall be allowed to cure sufficiently to prevent undue distortions under the roller wheels.

When a CMA mixture is allowed to cure under traffic, the surface shall be maintained and all damaged areas shall be satisfactorily repaired.

MATERIALS

404.03 Asphalt Material

The type and grade of asphalt material shall be in accordance with the following:

- 20 Asphalt Emulsion, RS-2, AE-90,
AE-90S, or HFRS-2..... 902.01(b)

404.04 Cover Aggregate

Aggregate shall be in accordance with the following requirements. When slag is used as an alternate to natural aggregate, adjustments will be made in accordance with 904.01, to compensate for differences in specific gravity.

- Coarse Aggregates*, Class B or Higher
Size No. 8, 9, 11, 12, SC 11, SC 12, or SC 16..... 904.03
 - 30 Fine Aggregate, Size No. 23 or 24 904.02
- * Coarse aggregate type required shall be in accordance with 904.03(d)1 for ESAL categories 2 or 3.

The types of seal coats shall be as follows:

Type (see Note 1)	Application	Cover Aggregate Size No. and Course	Rates of Application per sq yd	
			Aggregate, lb	Asphalt Material, Gal. at 60°F
1 or 1P (see Note 2)	Single	23, 24	12 - 15	0.12 - 0.16
2 or 2P	Single	12, SC 12	14 - 17	0.29 - 0.33
3 or 3P	Single	11, SC 11, SC 16	16 - 20	0.36 - 0.40
4 or 4P	Single	9	28 - 32	0.63 - 0.68
5 or 5P	Double	Top: 12, SC 12	16 - 19	0.41 - 0.46
		Bottom: 11, SC 11, SC 16	16 - 20	0.28 - 0.31
6 or 6P	Double	Top: 11, SC 11, SC 16	18 - 22	0.62 - 0.68
		Bottom: 9	28 - 32	0.42 - 0.46
7 or 7P	Double	Top: 11, SC 11, SC 16	18 - 22	0.62 - 0.68
		Bottom: 8	28 - 32	0.42 - 0.46

Note 1 – AE-90S and SC aggregates shall be used for type P seal coats, except SC aggregate requirement will not apply to seal coat used on shoulders.
 Note 2 – HFRS-2 shall not be used with type 1 seal coat.

- 40 Seal coat, SC, aggregates shall be 85% one face and 80% two face crushed. The Flakiness Index in accordance with ITM 224 shall be a maximum of 25%. Non SC aggregates shall have a minimum crushed particle percentage of 70%. Determination

of crushed particles shall be made from the mass weight of material retained on the No. 4 (4.75 mm) sieve in accordance with ASTM D5821.

CONSTRUCTION REQUIREMENTS

404.05 Weather Limitations

Asphalt material shall not be applied on a wet surface, or when other weather conditions would adversely affect the seal coat. Seal coat shall not be placed when the ambient or pavement temperature is below 60°F. Seal coat shall not be applied to travel lanes or auxiliary lanes before May 1 or after October 1, but may be applied to shoulders within the above temperature range.

404.06 Equipment

A distributor, rotary power broom, pneumatic tire roller, and aggregate spreader in accordance with 409.03 shall be used.

404.07 Preparation of Surface

Surfaces to be sealed shall be patched as shown on the plans or as directed, brought to proper section and grade, and compacted.

The surface shall be cleaned of all loose material prior to seal coat application. Sealing operations may not commence until the surface is approved.

All castings, detector housings, and snowplowable raised pavement markers shall be covered prior to applying the asphalt material to prevent coating with seal coat. These coverings shall be removed prior to opening to unrestricted traffic.

404.08 Applying Asphalt Material

Asphalt material shall be applied in a uniform continuous spread over the section to be treated. The quantity of asphalt material to be applied per square yard shall be in accordance with the QCP. During application, minor adjustments to the application rate shall be made in accordance with the QCP.

The asphalt material shall not be spread over a greater area than that which can be covered with the cover aggregate that is in trucks at the site.

The spread of the asphalt material shall be no wider than the width covered by the cover aggregate from the spreading device. Operations shall not proceed such that asphalt material is allowed to chill, set up, dry, or otherwise impair retention of the cover coat.

404.09 Application of Cover Aggregate

Within 1 minute of the application of the asphalt material, cover aggregate shall be spread in quantities as required. Spreading shall be accomplished such that the tires of the trucks or aggregate spreader do not contact the uncovered and newly applied asphalt material.

405.01

The cost of determination of asphalt material and cover aggregate application rates, sweeping and rolling operations, blotting material, and other incidentals shall be included in the cost of the pay items.

The Contractor shall adjust application rates as required by the Engineer within the limits set out herein. No additional payment will be made for additional materials necessary to meet the required application rates within the specified limits.

SECTION 405 – PRIME COAT

405.01 Description

This work shall consist of preparing and treating a rubblized PCCP with asphalt material in accordance with 105.03.

MATERIALS

405.02 Asphalt Materials

10 The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-PL 902.01(b)

405.03 Cover Aggregate

Aggregate shall be in accordance with the following:

Coarse Aggregate, Class B or Higher, Size No. 12 904.03

Fine Aggregate, Size No. 23 or 24 904.02

20

CONSTRUCTION REQUIREMENTS

405.04 Weather Limitations

Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 50°F, or when other unsuitable conditions exist, unless approved by the Engineer.

405.05 Equipment

A distributor and aggregate spreader in accordance with 409.03 shall be used.

30

405.06 Preparation of Surface

The existing surface to be treated shall be shaped to the required grade and section, free from all ruts, corrugations, or other irregularities; uniformly compacted; and approved.

405.07 Application of Asphalt Material

AE-PL shall be uniformly applied at the rate of 0.50 to 0.75 gal./sq yd placed in a single application. When placing material on a rubblized base, a carpet drag shall be utilized behind the distributor.

- 40 When traffic is to be maintained within the limits of the section, approximately one half of the width of the section shall be treated in one application. Complete coverage of the section shall be ensured. Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

405.08 Cover Aggregate

If the asphalt material fails to penetrate and the primed surface must be used by traffic, cover aggregate shall be spread to provide a dry surface.

405.09 Method of Measurement

- 50 Asphalt for prime coat will be measured by the ton, or by the square yard. Cover aggregate will be measured by the ton.

405.10 Basis of Payment

The accepted quantities of prime coat will be paid for at the contract unit price per ton, or per square yard for asphalt for prime coat. The accepted quantities of cover aggregate will be paid for at the contract unit price per ton, complete in place.

Payment will be made under:

60	Pay Item	Pay Unit Symbol
	Asphalt for Prime Coat.....	TON
		SYS
	Cover Aggregate, Prime Coat.....	TON

SECTION 406 – TACK COAT

406.01 Description

This work shall consist of preparing and treating an existing pavement or concrete surface with asphalt material in accordance with 105.03.

MATERIALS

406.02 Materials

- 10 The type and grade of asphalt material shall be in accordance with the following:
 - Asphalt Emulsion, SS-1h, AE-NT..... 902.01(b)
 - PG Asphalt Binder, PG 64-22 902.01(a)

CONSTRUCTION REQUIREMENTS

406.03 Equipment

A distributor in accordance with 409.03(a) shall be used.

20 **406.04 Preparation of Surface**

The existing surface to be treated shall be free of foreign materials deemed detrimental by the Engineer. The surface to which the asphalt material is applied shall not have standing water and shall be cleaned of dust, debris and any substances that will prevent adherence.

406.05 Application of Asphalt Material

30 The asphalt material shall be uniformly applied across the entire width of pavement to be overlaid and shall cover a minimum of 95% of the surface. The asphalt material shall be given sufficient time to break and set to minimize tracking from hauling and laydown equipment. Areas of inadequate coverage that create streaking or areas of excessive coverage that create ponding shall be corrected to obtain an even distribution.

The asphalt material application rate shall be based on the existing surface type and shall be as follows:

Surface Type	Application Rate*(gal./sg yd)
New Asphalt	0.05 to 0.08
Existing Asphalt	0.06 to 0.11
Milled Asphalt	0.06 to 0.12
PCCP	0.05 to 0.08
* The asphalt material shall not be diluted.	

406.06 Method of Measurement

40 Asphalt for tack coat will be measured by the ton or by the square yard.

406.07 Basis of Payment

The accepted quantities of tack coat will be paid for at the contract unit price per ton, or per square yard for asphalt for tack coat, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
50	Asphalt for Tack Coat	TON SYS

SECTION 407 – DUST PALLIATIVE

407.01 Description

This work shall consist of preparing and treating an existing aggregate surface with asphalt material in accordance with 105.03.

MATERIALS

407.02 Asphalt Material

10 The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-PL 902.01(b)

CONSTRUCTION REQUIREMENTS

407.03 Weather Limitations

Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 50°F, or when other unsuitable conditions exist, unless approved by the Engineer.

20

407.04 Equipment

A distributor in accordance with 409.03(a) shall be used.

407.05 Preparation of Surface

The surface to be treated shall be shaped to the required section and be free from all ruts, corrugations, or other irregularities.

407.06 Application of Asphalt Material

30 The asphalt material shall be uniformly applied at the rate of 0.25 to 1 gal./sq yd in a uniform continuous spread over the section to be treated or as directed.

When traffic is to be maintained within the limits of the section, approximately one half of the width of the section shall be treated in one application. Complete coverage of the section shall be ensured.

Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

407.07 Method of Measurement

40 Asphalt for dust palliative will be measured by the ton.

407.08 Basis of Payment

The accepted quantities of this work will be paid for at the contract unit price per ton for asphalt for dust palliative, complete in place.

Payment will be under:

408.01

	Pay Item	Pay Unit Symbol
50	Asphalt for Dust Palliative	TON

SECTION 408 – SEALING OR FILLING CRACKS AND JOINTS

408.01 Description

This work shall consist of sealing or filling longitudinal and transverse cracks and joints in existing asphalt pavement in accordance with 105.03.

Full lane width transverse cracks and longitudinal joints shall be routed and sealed. All other cracks shall be filled.

10 **MATERIALS**

408.02 Materials

Materials shall be in accordance with the following:

Asphalt Binder, PG 64-22*	902.01(a)
Asphalt Emulsion for Crack Filling, AE-90S.....	902.01(b)
Fine Aggregates, No. 23 or 24.....	904.02
Joint Sealing Materials	906.02(a)2

20 * A PG 64-22 asphalt binder shall be used to fill cracks on a surface that is milled in accordance with 306, and polypropylene fibers shall be used only in conjunction with warranted micro-surfacing.

CONSTRUCTION REQUIREMENTS

408.03 Equipment

30 A distributor in accordance with 409.03 shall be used when crack filling with asphalt emulsion or an indirect-heat double boiler kettle with mechanical agitator shall be used when filling with hot poured material. An indirect-heat double boiler kettle with mechanical agitator shall be used when routing and sealing. Air compressors shall be capable of producing a minimum air pressure of 100 psi.

408.04 Weather Limitations

Sealing or filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F, or when other unsuitable conditions exist, unless approved by the Engineer.

408.05 Routing and Sealing Cracks and Joints

40 Cracks and joints, 1/2 in. or less in width, shall be routed with a routing machine capable of cutting a uniform shape to form a reservoir not exceeding 3/4 in. wide with a minimum depth of 3/4 in. Cracks and joints shall be cleaned by blowing with compressed air or by other suitable means. The operation shall be coordinated such

that routed materials do not encroach on pavement lanes carrying traffic and all routed materials are disposed of in accordance with 104.07. Cracks and joints shall be sealed with hot poured joint sealant to within 1/4 in. below the surface in accordance with the manufacturer’s recommendations.

408.06 Filling Cracks

Cracks shall be cleaned by blowing with compressed air or by other suitable means. Asphalt material shall be placed utilizing a “V” shaped wand tip, to allow the penetration of the materials into the cracks. The cracks shall be completely filled or overbanded not to exceed 5 in., or as required. All excess asphalt material shall be removed from the pavement. The filled cracks shall be covered with sufficient fine aggregate or other suitable material to prevent tracking of the asphalt materials. All excess cover material shall be removed from the pavement within 24 h, when directed.

Application of asphalt materials shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section, temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

408.07 Method of Measurement

Sealing and filling of cracks and joints in asphalt pavements will be measured by the ton of material used. Routing of cracks and joints will not be measured.

Temporary traffic control measures will be measured in accordance with 801.17.

408.08 Basis of Payment

Sealing and filling of cracks and joints in asphalt pavements will be paid for by the ton of material used for the type specified.

Temporary traffic control measures will be paid for in accordance with 801.18.

Payment will be made under:

Pay Item	Pay Unit Symbol
Cracks in Asphalt Pavement, Fill	TON
Cracks and Joints in Asphalt Pavement, Rout and Seal	TON

The cost of all materials, cover aggregate, cleaning, and all necessary incidentals shall be included in the cost of the pay items in this section.

SECTION 409 – EQUIPMENT

409.01 Production, Transportation, and Laydown of Asphalt Mixtures

For production of asphalt mixtures, the Contractor shall provide all equipment necessary for the production, transportation, and laydown operations.

409.02 Mixing Plant

The mixing plant shall be capable of producing a uniform mixture.

10 **(a) Certified HMA Plant**

A certified HMA plant shall be in accordance with ITM 583.

(b) CMA Mixing Plant

The mixing plant shall be of sufficient capacity and coordination to adequately handle the proposed CMA construction. The mixing unit shall be a twin shaft pugmill or other approved mixer, including the drum type capable of producing a consistent uniform mixture. The outlet of the mixer shall be such that it prevents segregation of the material when discharged.

- 20 A certified HMA plant in accordance with 409.02(a) may be utilized as a CMA mixing plant.

409.03 HMA Laydown Operations

(a) Distributor

The distributor shall be equipped, maintained, and operated to provide uniform heating and application rates as specified. The distributor shall have a volume measuring device and a thermometer to monitor the asphalt material.

- 30 Distributors shall also be equipped with a power unit for the pump and with a full circulation spray bar with vertical controls.

(b) Hauling Equipment

The mixtures shall be transported to the laydown operation in trucks that have tight, clean, and smooth beds.

- 40 Truck beds may be treated with anti-adhesive agents from the QPL. The truck beds shall be raised after application of non-foaming anti-adhesive agents to drain liquids from the bed prior to HMA being loaded into the truck. The Department will maintain a QPL of Anti-Adhesive Materials.

Hauling equipment shall be equipped with a watertight cover to protect the mixture.

(c) Laydown Equipment

1. Paver

The paver shall be self-propelled, and equipped with a material receiving system, and equipped with heated and vibrating screeds. The paver may also include automatic slope and grade controls, extendable screeds and extendable augers.

Automatic control devices shall be separated from the paver screeds, paver tracks or wheels and be capable of adjusting both sides of the screeds automatically to maintain a constant angle of attack in relation to the grade leveler device or grade line.

A grade leveling system may be used to activate the control devices on each HMA course, including matching lays. The leveling system shall be attached to the paver and operated parallel to the paver's line of travel.

Extendable screeds shall be rigid, heated, and vibrating, and be capable of maintaining the cross slope, and line and grade of the pavement, to produce uniform placement of the materials.

Auger extensions shall be used when required to distribute the HMA uniformly in front of the screed.

When a dense graded intermediate or a surface mixture is placed adjacent to an aggregate or earth shoulder, the side of the paver adjacent to the aggregate or earth shoulder shall be equipped with a device capable of constructing a safety edge. The following devices are approved for this application:

- (a) Advant-Edge™, Advant-Edge Paving Equipment LLC
- (b) Safety Edge End Gate, Carlson Paving Products, Inc.
- (c) TransTech Shoulder Wedge Maker™, TransTech Systems, Inc.
- (d) SafeTSlope Edge Smoother™, Troxler Electronic Laboratories, Inc.

2. Widener

A device capable of receiving, transferring, spreading, and striking off materials to the proper grade and slope.

3. Other Mechanical Devices

Inaccessible or short sections of HMA may be placed with specialty equipment approved by the Engineer.

(d) Compaction Equipment

Compaction equipment shall be self-propelled, steel wheel or pneumatic tire types, in good condition, and capable of reversing direction without backlash. All roller wheels shall be equipped with scrapers to keep the wheels clean, have water spraying devices on the wheels, and steering devices capable of accurately guiding the roller.

1. Tandem Roller

A roller having two axles and a minimum weight of 10 t.

2. Three Wheel Roller

A roller having three wheels with a minimum bearing of 300 lb/in. on the rear wheels. The crown of the wheels shall not exceed 2.5 in. in 18 ft.

100 A tandem roller which has a drive wheel bearing of no less than 300 lb/in. may be used in lieu of the three wheel roller.

3. Pneumatic Tire Roller

A pneumatic tire roller shall have a minimum rolling width of 5.5 ft. The roller shall be equipped with compaction tires, minimum size 7:50 by 15, exerting a uniform, average contact pressure from 50 to 90 psi uniformly over the pavement by adjusting ballast and tire inflation pressures.

110 The wheels on at least one axle shall be fully oscillating vertically, and mounted as to prevent scuffing of the pavements during rolling or turning operations. Charts or tabulations showing the contact areas and pressures for the full range of tire inflation pressures and for the full range of tire loadings for each compactor shall be furnished to the Engineer.

4. Vibratory Roller

A vibratory roller shall have both drums equipped for vertical impact forces, a variable amplitude system, a speed control device, and have a minimum vibration frequency of 2,000 vibrations per minute. A reed tachometer shall be provided for verifying the frequency of vibrations.

5. Oscillatory Roller

120 An oscillatory roller shall have both drums equipped for horizontal and vertical shear forces or one drum equipped for horizontal and vertical shear force and the other drum equipped for a vertical impact force.

6. Trench Roller

A trench roller shall have a compaction wheel bearing of no less than 300 lb/in.

7. Specialty Roller/Compactor

130 Inaccessible or short sections of HMA may be compacted with specialty equipment approved by the Engineer.

(e) Miscellaneous Equipment**1. Aggregate Spreader**

A spreader shall be a self-propelled, pneumatic tired, motorized unit with a front loading hopper and a transportation system for distributing the aggregates uniformly across the pavement.

2. Rotary Power Broom

140 A motorized, pneumatic tired unit with rotary bristle broom head.

(f) Smoothness Equipment

1. Profilograph

The profilograph shall be in accordance with ITM 912.

2. Straightedge – 16 ft

150 A 16 ft straightedge shall be a rigid beam mounted on two solid wheels on axles 16 ft apart. The straightedge has a mounted push bar to facilitate propelling the device along or across the pavement. Tolerance points are located at the 1/4, 1/2, and 3/4 points and may be composed of threaded bolts capable of being adjusted to the tolerance required.

3. Straightedge – 10 ft

A 10 ft straightedge is the same as a 16 ft straightedge except that the wheels are mounted 10 ft apart. A handheld rigid beam may be substituted.

SECTION 410 – QC/QA HMA – SMA PAVEMENT

410.01 Description

This work shall consist of one course of QC/QA HMA – SMA mixture constructed on prepared foundations in accordance with 105.03.

410.02 Quality Control

10 The SMA mixture shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Hot Mix Asphalt Producer Program. The QCP shall be modified to include the requirements for the SMA mixtures. The SMA shall be transported and placed according to the QCP prepared and submitted by the Contractor in accordance with ITM 803; Contractor Quality Control Plans for Hot Mix Asphalt Pavements. The QCP shall be submitted to the Engineer at least 15 days prior to commencing SMA paving operations.

When a safety edge is required for a project, the QCP shall identify the device or devices in accordance with 409.03(c) to be used for constructing the safety edge.

MATERIALS

20

410.03 Materials

Materials shall be in accordance with the following:

Asphalt Materials

PG Binder, PG 76-22, PG 70-22902.01(a)

Coarse Aggregates, Class AS 904.03
 Fine Aggregates (sand, mineral filler) 904.02
 Stabilizing Additives AASHTO M 325

30 **410.04 Design Mix Formula**

A design mix formula, DMF, shall be prepared in accordance with 410.05 and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall state the maximum particle size in the mixture. The DMF shall state the calibration factor, test temperature and absorption factors to be used for the determination of binder content using the ignition oven in accordance with ITM 586, the binder content by extraction in accordance with ITM 571, ΔP_b , determined in accordance with ITM 591, the aggregate degradation loss value in accordance with ITM 220 and a Mixture Adjustment Factor, MAF. The DMF shall state the source, type dosage rate of any stabilizing additives. The DMF will be based on the ESAL and mixture designation.

40 No mixture will be accepted for use until the DMF has been assigned a mixture number by the Engineer.

The ESAL category identified in the pay item correlates to the following ESAL ranges:

ESAL Category	ESAL
2*	< 3,000,000
3	3,000,000 to < 10,000,000
4*	\geq 10,000,000
* A category 2 mixture shall replace a category 1 mixture and a category 4 mixture shall replace a category 5 mixture.	

50 The plant discharge temperature for any mixture shall not be more than 315°F whenever PG 70-22 binder is used or not more than 325°F whenever PG 76-22 binder is used. SMA may be produced using a water-injection foaming device. The DMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture.

410.05 SMA Mix Design

60 The DMF shall be determined for each mixture from a SMA mix design by a design laboratory selected from the Department’s list of Qualified Mix Design Laboratories. A SMA mixture shall be designed in accordance with ITM 220, AASHTO M 325 and R 46 except the design gyrations shall be 75 for all ESAL categories. All loose mixture shall be conditioned for 4 h in accordance with AASHTO R 30 prior to testing. Steel furnace slag coarse aggregate, when used in an intermediate mixture application, shall have a deleterious content less than 4.0% as determined in accordance with ITM 219.

The single percentage of aggregate passing each required sieve shall be within the limits of the following gradation table.

SMA Gradation Control Limits						
	Mixture Designation					
	9.5 mm		12.5 mm		19.0 mm	
Sieve Size	Lower	Upper	Lower	Upper	Lower	Upper
1 1/2 in. (37.5 mm)					100.0	100.0
1 in. (25.0 mm)			100.0	100.0	99.0*	100.0
3/4 in. (19.0 mm)	100.0	100.0	99.0*	100.0	90.0	99.0
1/2 in. (12.5 mm)	99.0*	100.0	90.0	99.0	50.0	88.0
3/8 in. (9.5 mm)	70.0	95.0	50.0	80.0	25.0	60.0
No. 4 (4.75 mm)	30.0	50.0	20.0	35.0	20.0	28.0
No. 8 (2.36 mm)	20.0	30.0	16.0	24.0	16.0	24.0
No. 16 (1.18 mm)	---	21.0	---	---	---	---
No. 30 (600 μ m)	---	18.0	---	---	---	---
No. 50 (300 μ m)	---	15.0	---	---	---	---
No. 200 (75 μ m)	8.0	12.0	8.0	11.0	8.0	11.0

* The lower % passing gradation may be 98.0% when SMA RAP material in accordance with 410.06 is used in the SMA mixture.

70 The optimum binder and aggregate gradation content shall produce a $\Delta P_b \leq 0.20$ as determined in accordance with ITM 591 and 4.0% air voids. The maximum specific gravity shall be mass determined in water in accordance with AASHTO T 209. The percent draindown for SMA mixture shall not exceed 0.30% in accordance with AASHTO T 305.

80 The MAF equals the Gmm from the mixture design divided by the following: 2.465 for 9.5 mm mixtures and 2.500 for 12.5 mm and 19.0 mm mixtures. If the MAF calculation results in a value where $0.980 \leq \text{MAF} \leq 1.020$, then the MAF shall be considered to be 1.000. If the MAF is greater than 1.020, the calculated MAF value shall have 0.020 subtracted from the value. If the MAF is less than 0.980, the calculated MAF value shall have 0.020 added to the value. The MAF does not apply to OG mixtures.

90 The mixture shall be tested for moisture susceptibility in accordance with AASHTO T 283 except that the loose mixture curing shall be replaced by mixture conditioning for 4 h in accordance with AASHTO R 30. The minimum tensile strength ratio, TSR, shall be 70%. The 6 in. mixture specimens shall be compacted to $6.0 \pm 1.0\%$ air voids in accordance with AASHTO T 312. Specimens shall be prepared using freeze-thaw preconditioning. If anti-stripping additives are added to the mixture to be in accordance with the minimum TSR requirements, the dosage rate shall be submitted with the DMF.

The fine aggregate portion of the aggregate blend shall be non-plastic as determined in accordance with AASHTO T 90.

A change in the source or types of aggregates, a change in source or type of stabilizing additives, or a change in the source of the specified binder shall require a new DMF.

The specific gravity of SF and the Gsb of the aggregate blend containing SF may be adjusted once per contract upon notification by the SF source and approval by the District Testing Engineer. A new DMF is not required for this adjustment.

The mixture design compaction temperature for the specimens shall be $300 \pm 9^\circ\text{F}$.

Mixture Designation	Minimum VMA, %
19.0 mm	15.0
12.5 mm	16.0
9.5 mm	17.0

410.06 Recycled Materials

Recycled materials shall be in accordance with 401.06 for dense graded mixtures except non-SMA RAP material for use in the SMA mixture shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

SMA RAP material shall be the product derived by exclusively milling an existing SMA mixture. The SMA RAP material shall pass the maximum size sieve for the mixture being produced as follows:

Sieve Size	Mixture Designation					
	9.5 mm		12.5 mm		19.0 mm	
	Lower	Upper	Lower	Upper	Lower	Upper
1 1/2 in. (37.5 mm)					100.0	100.0
1 in. (25.0 mm)			100.0	100.0	95.0	100.0
3/4 in. (19.0 mm)	100.0	100.0	95.0	100.0	---	---
1/2 in. (12.5 mm)	95.0	100.0	---	---	---	---

The Contractor may request the use of SMA RAP material in the SMA mixture provided the material is stockpiled separately at the plant and the material properties were determined in accordance with ITM 584 during stockpile construction. The request shall include all QC test results describing the stockpile composition. The Engineer will obtain a representative sample of the SMA RAP material in accordance with ITM 207 for testing in accordance with ITM 590 to verify the proposed design value.

410.07 Lots and Sublots

Lots will be defined as 4,000 t of SMA intermediate mixture or 2,400 t of SMA surface mixture. Lots will be further sub-divided into sublots not to exceed 1,000 t of SMA intermediate mixture or 600 t of SMA surface mixture. Partial sublots of 100 t or less will be added to the previous subplot. Partial sublots greater than 100 t constitute a full subplot.

130 **410.08 Job Mix Formula**

A job mix formula, JMF, shall be developed by a certified HMA producer in accordance with ITM 583. A JMF used for SMA mixture in the current calendar year will be allowed.

The aggregate and recycled materials blend percentage and the amount passing all sieves on the DMF may be adjusted provided the gradation limits do not exceed the requirements of 410.05. Adjustments to the aggregate and recycled materials blend percentage, gradation and the new combined aggregate bulk specific gravity shall be included on the JMF.

140

The total binder content on the JMF may be determined by adjusting the DMF a maximum of $\pm 0.3\%$. The recycled materials binder content may be adjusted as part of the total binder content provided the binder replacement percentage is in accordance with 410.06.

The mixture compaction temperature shall be $300 \pm 9^\circ\text{F}$. The JMF shall list the minimum and maximum plant discharge temperatures as applicable to the mixture. The JMF for each mixture shall be submitted to the Engineer.

150 **410.09 Acceptance of Mixtures**

Acceptance of mixtures for binder content and gradation for each lot will be based on tests performed by the Engineer. The Engineer will randomly select the location within each subplot for sampling in accordance with ITM 802. An acceptance sample will consist of one plate sample at the random location. A backup sample will consist of one plate sample located 2 ft towards the center of the mat from the acceptance sample.

160 Samples from each location shall be obtained from each subplot from the pavement in accordance with ITM 580. The Engineer will take immediate possession of the samples.

A maximum specific gravity sample and a binder content and gradation sample will be obtained from the plate sample in accordance with ITM 587. The binder content will be determined in accordance with ITM 586 or ITM 571 as directed by the Engineer and the gradation will be determined in accordance with AASHTO T 30. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. The test results of the sublots will be averaged and shall meet the requirements for tolerances from the JMF for each sieve and binder content.

- 170 The Engineer will make available the subplot acceptance test results after receiving the subplot quality control results from the Contractor.

Acceptance Tolerance for Mixtures (Percent Mass)									
Mixture	Number of Tests	Sieve Size							
		*25.0 mm	*19.0 mm	*12.5 mm	*9.5 mm	*4.75 mm	2.36 mm	600 μm	75 μm
Surface	1	---	---	---	---	---	8.0	4.0	2.5
	2	---	---	---	---	---	5.7	2.8	2.1
	3	---	---	---	---	---	4.6	2.3	1.8
	4	---	---	---	---	---	4.0	2.0	1.5
Intermediate	1	---	---	---	---	---	10.0	6.0	2.0
	2	---	---	---	---	---	7.0	4.2	1.4
	3	---	---	---	---	---	5.8	3.5	1.2
	4	---	---	---	---	---	5.0	3.0	1.0
* The acceptance tolerance for this sieve shall be the applicable composition limits specified in 410.05.									

Acceptance Tolerance for Binder				
Binder Content	Number of Tests			
	1	2	3	4
%Binder	0.7	0.5	0.4	0.3

Acceptance of mixtures for range will be determined using the results of subplot tests performed by the Engineer from each lot. If the range is not in accordance with the requirements, adjustment points will be assessed in accordance with 410.19(a).

Acceptance Tolerance for Range (\pm Percent Mass)		
Sieve Size and Binder Content	Percentage Points	
	Surface	Intermediate
No. 8 (2.36 mm)	12.0	15.0
No. 30 (600 μm)	6.0	9.0
No. 200 (75 μm)	2.0	3.0
%Binder	1.0	1.0

- 180 Acceptance tolerances for binder content and gradation will be as set out above for the number of tests performed. The acceptance tolerance for range will be as set out above for lots of more than one subplot. The range of binder shall be the difference between the highest subplot binder content and the lowest subplot binder content in one lot. The range of gradation shall be the difference between the highest subplot percent passing and the lowest subplot percent passing each required sieve in one lot.

Single test values and averages will be reported to the nearest 0.1%. Rounding will be in accordance with 109.01(a).

190 Lot adjustment points will be assessed in accordance with 410.19(a) when the average or range for binder content or gradation are not met.

The Contractor may request an appeal of the Engineer's test results in accordance with 410.20.

A binder draindown test in accordance with AASHTO T 305 shall be completed once per lot in accordance with 410.07 and shall not exceed 0.30%.

200 A type C certification in accordance with 916 shall be provided for the stabilizing additives for each shipment. Stabilizing additives from different manufacturers and different types of additives shall not be intermixed.

In the event than an acceptance sample is not available to represent subplot, all test results of the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

210 Samples shall not be obtained from areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3. If a random location falls within this area, the Engineer will randomly select another location within the subplot for sampling. If an entire subplot falls within this area, test results from the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

CONSTRUCTION REQUIREMENTS

410.10 General

220 Equipment for SMA operations shall be in accordance with 409. The Contractor shall submit to the Engineer, prior to use, a written Certificate of Compliance that the proposed paving equipment has been modified in accordance with 401.10 or is new and includes the modifications.

Fuel oil, kerosene, or solvents shall not be transported in open containers on equipment. Cleaning of equipment and small tools shall not be performed on the pavement or shoulder areas.

230 SMA mixtures shall not exhibit segregation, flushing, or bleeding. Corrective action shall immediately be taken to prevent continuation of these conditions. Segregated, flushed, or bleeding of SMA mixtures will be referred to the Department's Division of Materials and Tests for adjudication as a failed material in accordance with 105.03.

410.11

All mixtures that become loose and broken, mixed with dirt, or are in any way defective shall be removed and replaced in accordance with 105.03.

410.11 Preparation of Surfaces to be Overlaid

Milling of an existing pavement surface shall be in accordance with 306. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

240 Milled asphalt surfaces and asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

410.12 Process Control

The Engineer and Contractor will jointly review the operations to ensure compliance with the QCP. Continuous violations of compliance with the QCP will result in suspension of paving operations.

410.13 Weather Limitations

250 SMA courses shall be placed when the ambient temperature and the temperature of the surface on which it is to be placed is 45°F or above.

410.14 Spreading and Finishing

260 The mixture shall be placed upon an approved surface by means of a paver or other mechanical devices in accordance with 409.03. Mixtures in areas inaccessible to mechanical devices may be placed by other methods. The temperature of mixture at the time of spreading shall be no more than 315°F whenever PG 70-22 binder is used or no more than 325°F whenever PG 76-22 binder is used. The temperature of each mixture shall not be less than 245°F at the time of spreading when placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3. No mixture shall be placed on a previously paved course that has not cooled to less than 175°F.

Prior to paving, both the planned quantity and lay rate shall be adjusted by multiplying by the MAF. When mixture is produced from more than one DMF or JMF for a given pay item, the MAF will be applied to the applicable portion of the mixture for each.

270 Planned SMA courses greater than 220 lb/sq yd placed under traffic, shall be brought up even with each adjacent lane at the end of each work day. Planned SMA courses less than or equal to 220 lb/sq yd shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane.

Hydraulic extensions on the paver will not be allowed for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving widths vary. Hydraulic extensions may be used in tapers and added lanes less than 250 ft in length.

280 Automatic slope and grade controls will be required and shall be outlined in the QCP.

SMA mainline and SMA shoulders which are 8 ft or more in width shall be placed with automatic paving equipment.

290 The rollers shall be operated to avoid shoving of the SMA and at speeds not to exceed 3 mph. Rollers shall be in accordance with 409.03(d)1, 2, or 7. Vibratory rollers meeting the requirements of 409.03(d)4 may be used but shall not be operated in vibratory mode. Oscillatory rollers in accordance with 409.03(d)5 will be allowed for use but the vertical impact force capability shall not be used.

The finished thickness of any course shall be at least two times but not more than five times the maximum particle size as shown on the DMF.

A safety edge shall be constructed at locations where the surface mixture is constructed adjacent to an aggregate or earth shoulder.

410.15 Joints

Longitudinal joints in the surface shall be at the lane lines of the pavement.

300 Hot poured joint adhesive in accordance with 906 shall be applied to longitudinal joints constructed between two adjacent HMA courses in the top course of dense graded intermediate mixtures and all 9.5 mm and 12.5 mm SMA mixture courses. This includes joints within the traveled way as well as between any of the following: traveled way and an auxiliary lane; traveled way and a paved shoulder; and auxiliary lane and a paved shoulder.

The material shall be heated in a jacketed, double boiler melting kettle. The kettle shall have an attached pressure feed wand system with applicator shoe.

310 The joint adhesive shall be applied to the face of the previously constructed edge at the joint using a wand applicator. Prior to application of the joint adhesive, the joint face shall be dry and free of loose material and foreign objects. The adhesive shall be applied on the joint face 1/8 in. thick at the temperature recommended by the manufacturer. Excess joint adhesive shall not be allowed to pool on the top of the previously constructed pavement course or the pavement to be overlaid. The application of the adhesive shall be made within the same day, but at least 30 minutes prior to construction of the longitudinal joint.

320 Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course. For areas inaccessible to rollers, other mechanical devices shall be used to achieve the required density.

410.16

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

410.16 Density

Acceptance will be based on lots and sublots in accordance with 410.07.

330 The Engineer's acceptance test results for each subplot will be available after the subplot and testing are complete.

Sublot and lot density values will be reported to the nearest 0.1%. Rounding will be in accordance with 109.01(a).

340 Density acceptance for all SMA mixtures shall be based on cores cut from the compacted pavement and analysis of pavement samples obtained in accordance with ITM 580. Acceptance will be based on lots and sublots in accordance with 410.07. The Engineer will randomly select two locations in accordance with ITM 802, within each subplot for coring. The transverse core location will be located so that the edge of the core will be no closer than 3 in. from a confined edge or 6 in. from a non-confined edge of the course being placed. The maximum specific gravity will be determined from the sample obtained in 410.09.

The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6.00 ± 0.25 in. diameter pavement sample. Surface courses shall be cored within one work day of placement. Damaged core shall be discarded and replaced with a core from a location selected by adding 1 ft to the longitudinal location of the damaged core using the same transverse offset.

350 The Contractor and the Engineer shall mark the core to define the course to be tested. If the core indicates a course thickness of less than two times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing.

360 Cores shall not be obtained from areas placed with paving equipment in accordance with 409.03(c)2 or 409.03(c)3. If a random location falls within this area, the Engineer will randomly select another location within the subplot for coring. If an entire subplot falls within this area, test results from the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific subplot or sublots will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 1 ft from the random location using the same transverse offset.

The density of the mixture will be expressed as the percentage of maximum specific gravity, % MSG, obtained by dividing the average bulk specific gravity by

370 the maximum specific gravity for the subplot, times 100. Samples for the bulk specific gravity and maximum specific gravity will be dried in accordance with ITM 572. The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166, Method A or AASHTO T 331, if required. The maximum specific gravity will be mass determined in water in accordance with AASHTO T 209. The target value for density of SMA mixtures of each subplot shall be 93.0%.

The densities of the sublots will be averaged to determine the density of the lot.

380 Within one work day of coring operations the Contractor shall clean, dry, and refill the core holes with SMA of similar or smaller size particles or other approved materials. The Contractor's plan for refilling core holes shall be outlined in the QCP.

410.17 Pavement Corrugations

Pavement corrugations shall be in accordance with 606.

410.18 Pavement Smoothness

The pavement smoothness will be evaluated and determined in accordance with 401.18.

410.19 Adjusted Points

390 When test results for mixture properties or density exceed the allowable tolerances, adjustment points will be assessed. The adjustment points will be used to calculate a quality assurance adjustment quantity, q , for the lot. Quality assurance adjustment points for smoothness will be in accordance with 401.19(c).

The adjustment for mixture properties and density are calculated as follows:

$$q = 1.00 \times (L \times U \times P/100)/MAF$$

where:

q = quality assurance adjustment quantity

L = lot quantity

U = unit price for the material, \$/ton

P = total adjustment points

400

The total quality assurance adjustments is to be calculated as follows:

$$Q = Q_s + \sum (q_m + q_d)$$

where:

Q = total quality assurance adjustment quantity

Q_s = quality assurance adjustment for smoothness as calculated in 401.19(c)

q_m = lot adjustments for mixtures

q_d = lot adjustments for density

410.19

If the total adjustment points for a lot are greater than 15, the pavement will be evaluated by the Division of Materials and Tests. If the Contractor is not required to remove the mixture, quality assurance adjustments of the lot will be assessed or other corrective actions as determined by the Division of Materials and Tests.

(a) Mixture

When test results for the mixture furnished exceeded the allowable tolerances, adjustment points will be assessed as follows:

Adjustment Points for Gradation								
Adjustment Points	Sieve Size							
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	600 μm	75 μm
For each 0.1% up to 1.0% out of tolerance	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3
For each 0.1% above 1.0% out of tolerance	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.6

Gradation adjustment points for the lot shall be the sum of points calculated for up to 1% out of tolerance and the points calculated for greater than 1% out of tolerance in accordance with 410.09.

Binder content adjustment points for the lot shall be two points for each 0.1% above the tolerance or four points for each 0.1% below the tolerance in accordance with 410.09.

When test results for the mixture furnished exceed the allowable range in accordance with 410.09, adjustment points will be assessed as follows:

Adjustment Points for Range	
Sieve Size and Binder Content	Adjustment Points (For each 0.1% out of range)
No. 8 (2.36 mm)	0.1
No. 30 (600 μm)	0.1
No. 200 (75 μm)	0.1
%Binder	1.0

430

For mixtures produced during a certified HMA plant's adjustment period, adjustment points will not be assessed if the mixture produced is in accordance with the following:

1. The gradation complies with 410.05 with the allowable tolerance limits shown in 410.09.

440

2. The range for the binder content and gradation do not exceed the limits shown in 410.09.
3. The binder content is within the tolerance requirements of 410.09.

If the mixture is not in accordance with these requirements, adjustment points will be assessed in accordance with 410.09 for variations exceeding the requirements shown above.

(b) Density

450 When the density of the lot is outside the allowable tolerances, adjustment points will be assessed as follows:

Density	
Percentages are based on %MSG	Pay Adjustments, %
> 97.0	Submitted to the Division of Materials and Tests*
93.0 – 97.0	0.00
92.0 – 92.9	0.20 points for each 0.10% below 93.0
91.0 – 91.9	2.00 + 0.40 points for each 0.10% below 92.0
89.0 – 90.9	6.00 + 1.00 points for each 0.10% below 91.0
≤ 89.0	Submitted to the Division of Materials and Tests*
* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.	

410.20 Appeals

460 If the QC test results do not agree with the acceptance test results, a request, along with the QC test results, may be made in writing for additional testing. Additional testing may be requested for one or more of the following tests: binder content, gradation, or MSG of the mixture samples and bulk specific gravity of the density cores. The appeal request shall be submitted within seven calendar days of receipt of the Department's written results for that subplot. The request for the appeal for MSG, BSG of the density cores or binder content and gradation shall be submitted within seven calendar days of receipt of the Department's written results for that subplot. The subplot and specific tests shall be specified at the time of the appeal request. Only one appeal request per subplot is allowed. Upon approval of the appeal, the Engineer will perform additional testing.

470 The appeal results will replace all previous test results for acceptance of mixture in accordance with 410.09 and density in accordance with 410.16. The results will be furnished to the Contractor. The backup mixture samples or density cores will be tested in accordance with the following:

- QC/QA-HMA, _____, _____, _____, _____ mm, - SMA TON
 (ESAL⁽¹⁾)(PG⁽²⁾)(Course⁽³⁾)(Mix⁽⁴⁾)
- 520 Quality Assurance Adjustment..... DOL
- (1) ESAL Category as defined in 410.04
 - (2) Number represents the high temperature binder grade. Low temperature grades are - 22
 - (3) Surface or Intermediate
 - (4) Mixture Designation

Preparation of surfaces to be overlaid shall be included in the cost of other pay items within this section.

- 530 Coring and refilling of the pavement holes shall be included in the cost of other pay items within this section.

No payment will be made for additional anti-stripping additives, appeal coring or related traffic control expenditures for coring operations.

Corrections for pavement smoothness shall be included in the cost of other pay items within this section.

- 540 The price for profilograph, HMA will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

SECTION 411 – WARRANTED MICRO-SURFACING

411.01 Description

This work shall consist of furnishing materials and the placement of warranted micro-surfacing in accordance with 105.03.

Multiple course micro-surfacing shall consist of a surface course over a rut fill or leveling course. Single course micro-surfacing shall consist of a surface course.

- 10 The Contractor shall be responsible for the warranted micro-surfacing in accordance with 411.09.

MATERIALS

411.02 Materials

Materials shall be in accordance with the following:

- Asphalt Emulsion902.01(b)1
- Coarse Aggregates – Class B or Higher*904.03
- 20 Fine Aggregates**904.02
- Portland Cement, Type I.....901.01(b)
- Water913.01

* The coarse aggregate angularity shall be a minimum of 95% in accordance with ASTM D5821. The coarse aggregate for rut fill shall be limestone, dolomite, crushed gravel, sandstone, ACBF, or SF. The surface application aggregate type shall be based on the ESAL category in the Surface Aggregate Table below.

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** The fine aggregate for micro-surface shall be limestone, dolomite, crushed gravel, sandstone, ACBF, or SF. The fine aggregate angularity shall be a minimum of 45 in accordance with AASHTO T 304 Method A. The clay content of the blended aggregate material from the fine and coarse aggregates shall meet a minimum sand equivalency of 65 in accordance with AASHTO T 176. The surface leveling application aggregate type shall be based on the ESAL category as follows:

Surface Aggregate Table			
Coarse or Fine Aggregate Type	Traffic ESALs		
	< 3,000,000	< 10,000,000	≥ 10,000,000
Air-Cooled Blast Furnace Slag	Yes	Yes	Yes
Steel Furnace Slag	Yes	Yes	Yes
Sandstone	Yes	Yes	Yes
Crushed Dolomite	Yes	Yes	(Note 1)
Polish Resistant Aggregates	Yes	Yes	(Note 1)
Crushed Stone	No	No	No
Gravel	No	No	No
Note 1: Polish resistant aggregate or crushed dolomite may be used when blended with ACBF or sandstone but cannot exceed 50% of the coarse aggregate by weight, or cannot exceed 40% of the coarse aggregate by weight when blended with SF.			

411.03 Design Mix Formula

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The Contractor shall submit a design mix formula, DMF, for the specific materials to be used on the project to the District Testing Engineer one week prior to use.

The DMF shall state the following, where the percentages shown are based on the dry weight of the aggregate:

- (a) source of each individual material
- (b) the aggregation gradation shall be in accordance with the following:

50

Sieve Size	Surface/Leveling, %	Rut Fill, %*
3/8 in. (9.5 mm)	100	100
No. 4 (4.75 mm)	85 - 100	70 - 90
No. 8 (2.36 mm)	50 - 80	45 - 70
No. 16 (1.18 mm)	40 - 65	28 - 50
No. 30 (600 µm)	25 - 45	19 - 34
No. 50 (300 µm)	13 - 25	12 - 25
No. 100 (150 µm)	7 - 18	7 - 18
No. 200 (75 µm)	5 - 15	5 - 15
* If rut fill course is used as a surface application, the aggregates shall be in accordance with the Surface Aggregate Table above.		

- (c) percentage of aggregate
(d) percentage of mineral filler, minimum and maximum
(e) percentage of water, minimum and maximum
(f) percentage of mix set additives, if required
(g) percentage of polymer modified CSS-1h emulsified asphalt
(h) state the quantitative effects of moisture content on the unit weight of the aggregate
(i) results for the tests in the following:

60

Characteristic	Test Method ISSA*	Requirement
Wet Cohesion 30 minutes, min. (set time) 60 minutes, min. (traffic)	TB-139**	12 kg-cm 20 kg-cm
Wet Stripping, min.	TB-114	> 90%
Compatibility Classification	TB-144	11 pts min.
Wet Track Abrasion Loss 60 minutes soak, max. 6 day soak, max.	TB-100	538 g/sq m 807 g/sq m
Mix Time @ 77°F (25°C)	TB-113**	controllable to 120 s
Mix Time @ 104°F (40°C)	TB-113**	controllable to 35 s
Excess Binder	TB-109	538 g/sq m
Deformation, max.	TB-147	5%
* International Slurry Surfacing Association. ** The TB-139 (set time) and TB-113 (mix time) tests shall be checked at the highest temperature expected during construction. For the TB-113 test at 104°F (40°C), all ingredients and containers shall be preheated.		

411.04 Equipment

The Contractor shall use self-contained, self-propelled, continuous loading units designed for micro-surfacing.

411.05

Truck-mounted batch type machines will be allowed on projects with quantities less than or equal to 50,000 sq yds. The Contractor shall provide a minimum of two
70 truck-mounted units at all times.

411.05 Pre-Paving Coordination

A pre-paving meeting will be held on-site prior to beginning work. The Contractor shall furnish as a minimum:

- (a) the Contractor's detailed work schedule
- (b) traffic control plan
- 80 (c) calibration of equipment
- (d) design mix formula/job mix formula
- (e) inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials
- (f) Quality Control Plan in accordance with ITM 803.

CONSTRUCTION REQUIREMENTS

90

411.06 Preparation of Surfaces

The Contractor shall be responsible for all surface preparation necessary to meet the performance requirements for warranted micro-surfacing. All castings and detector housings shall be protected prior to the application of material in accordance with 404.07, except that raised pavement markers shall be removed.

Any existing durable pavement markings shall be removed in accordance with 808.10 prior to placement of warranted micro-surfacing.

100 Cracks in the pavement in excess of 1/4 in. shall be filled in accordance with 408 prior to placement of warranted micro-surfacing.

The pavement surface shall have tack coat applied in accordance with 406 prior to placement of warranted micro-surfacing.

411.07 Opening to Traffic

The micro-surface shall be capable of being opened to traffic within 1 h after application. If the micro-surface is not stable under traffic loading within 1 h of placement, the Contractor shall immediately cease operations. Prior to resuming
110 operations, the Contractor shall notify the Engineer of the cause and the corrective action to be taken.

The micro-surface shall be cured a minimum of five days prior to applying permanent pavement markings in accordance with 808.

411.08 Finished Pavement Properties

All finished surface irregularities in excess of 1/8 in. measured with a 10 ft straightedge shall be corrected.

- 120 The longitudinal construction joints and lane edges shall coincide with the proposed painted lane lines. Longitudinal joints shall be constructed with less than a 3 in. overlap on adjacent passes and no more than 1/4 in. overlap thickness measured with a 10 ft straightedge in accordance with 409.03(f). If applicable, overlapping passes shall be made to prevent ponding of water. Construct transverse joints with no more than a 1/8 in. difference in elevation across the joint as measured with a 10 ft straightedge. The lane edge shall have no more than 2 in. of horizontal variance in 100 ft.

411.09 Warranty

- 130 A warranty bond is to insure completion of required warranty work, including payments for all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract used to remediate any warranted distresses.

- 140 The Contractor shall furnish to the Engineer a warranty bond at the preconstruction conference or prior to beginning any work on the contract. The warranty bond shall be equal to 100% of the contract total for the warranted micro-surfacing pay items, and shall be properly executed by a surety satisfactory to the Department, and shall be payable to the State of Indiana. The warranty bond shall be in effect for three years from the date of substantial completion.

Upon the final acceptance of the project, the contractual obligations of the Contractor are satisfied as long as the micro-surfacing continues to meet or exceed the warranted values as defined herein.

All warranty work shall be accomplished in accordance with 411.11. At the end of the warranty period, the Contractor will be released from further warranty work or responsibility, provided all previous warranty work has been satisfactorily completed and approved by the Department.

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411.10 Conflict Resolution Team

The scope of work for the conflict resolution team includes all issues concerning the warranted pavement relative to the quality control plan, material selection, warranted pavement evaluations, distress indicators, remedial action, and remediation plans.

The team will consist of two Contractor representatives, two Department representatives, and an additional person mutually agreed upon by both the

411.11

Department and the Contractor. All costs for the additional person will be equally
160 shared by the Department and the Contractor.

The team members will be identified in writing when needed and will be knowledgeable in the terms and conditions of this warranty and the methods used in the measurement and calculation of pavement distress. The team will render a final recommendation to the Chief Engineer by a majority vote. Each member has an equal vote.

411.11 Warranty Work

Elective work is performed by the Contractor at its discretion to meet the
170 performance requirements of warranted micro-surfacing prior to direction from the Department for the Contractor to perform remedial work.

Remedial work is performed as a result of pavement distress surveys performed by the Department.

During the warranty period, elective work and remedial work shall be performed at no cost to the Department. Elective work shall be at the Contractor's option. The scope of all elective work or remedial work to be performed as well as materials to be used shall be proposed by the Contractor and shall be subject to approval by the
180 Department. Prior to proceeding with any warranty work or monitoring, all necessary permits shall be obtained from the Department.

Elective work during the warranty period will not be assessed a lane closure fee. For remedial work, costs for closure periods will be as shown in the contract.

During the warranty period, the Contractor may monitor the warranted micro-surfacing using non-destructive procedures.

Coring, milling or other destructive procedures may not be performed by the
190 Contractor, without prior consent of the Department. The Contractor will not be responsible for damages to the pavement as a result of coring, milling or other destructive procedures conducted by the Department.

The Contractor has the first option to perform the remedial work. If, the problem requires immediate attention, as determined by the Engineer, for safety of the traveling public and the Contractor cannot perform the remedial work within 24 h of notification, the Department will perform the remedial work. The Contractor shall be responsible for all costs incurred by the Department for remedial work performed by the Department. Remedial work performed by the Department will not alter the
200 requirements, responsibilities, or obligations of the warranty.

411.12 Pavement Distress Indicators, Thresholds, and Remedial Work

The Department will use the following pavement distress indicators throughout the warranty period:

- 210
- (a) Rutting – transverse displacement of the micro-surfacing.
 - (b) Delamination – physical separation of the micro-surfacing that exposes the underlying surface.
 - (c) Raveling – wearing away of the micro-surfacing.
 - (d) Skid Resistance – friction number as measured by ASTM E274 and E524.

The pavement threshold values for the pavement distress indicators will be evaluated for the entire length of the project for each lane. The threshold values for the pavement distress indicators are listed below:

220

Distress	Single Location	Multiple Locations
Delamination or Raveling	1/2 sq yd	1 sq yd/mi
Rut Depth	1/4 in.	average 1/4 in./mi
Friction Number*	no less than 30	average 35
* Individual friction tests will be performed in each lane every 1/2 mi for the length of the project.		

The Department may evaluate the warranted micro-surfacing during the warranty period. A final condition survey will be made by the Department and the Contractor will be notified in writing of all sections exceeding the warranty threshold at least 90 days in advance of the expiration of the warranty period.

- 230
- If the Department determines that any threshold level has been met or exceeded and remedial work is required, the Contractor shall submit a work plan and schedule to the Engineer for approval. The Contractor shall perform the remedial work within 30 calendar days of notification of approval by the Engineer.

If, anytime during the warranty period, 30% or more of the project requires, or has received remedial work, remedial work as determined by the Department shall be performed on the entire project.

If remedial or elective work performed by the Contractor necessitates repair or replacement of pavement markings, adjacent lanes or roadway shoulders, the required work shall be the responsibility of the Contractor.

- 240
- Warranty requirements for elective and remedial work will be limited to the life of the original contract warranty.

411.13 Department Maintenance

The Department may perform routine maintenance operations during the warranty period including, but not limited to, plowing, applying de-icing chemicals, repairs to

411.14

safety appurtenances, pavement markings, mowing and sign maintenance. The Department will perform no routine pavement surface maintenance activities during the warranty period.

250 **411.14 Method of Measurement**

Warranted micro-surfacing, of the type specified, will be measured by the square yard of surface course.

Only the surface course will be measured for payment.

411.15 Basis of Payment

Warranted micro-surfacing, of the type specified, will be paid for at the contract unit price per square yard of micro-surface, warranted, of the type specified, complete in place.

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Payment will be made under:

Pay Item	Pay Unit Symbol
Micro-Surfacing, Warranted, for Approaches, Multiple Course	SYS
Micro-Surfacing, Warranted, for Approaches, Single Course.....	SYS
Micro-Surfacing, Warranted, Multiple Course.....	SYS
270 Micro-Surfacing, Warranted, Single Course	SYS

The cost of all incidentals including, but not limited to, surface preparation, meeting smoothness requirements, and warranty bond shall be included in the cost of the pay items.

411.16 Final Warranty Acceptance

280 The Engineer will review the project in the field for any defects not addressed in the indicators and recommend a Final Warranty Acceptance. The Department will issue the Contractor a Final Warranty Acceptance letter upon completion of the warranty period and all remedial work.

SECTION 412 – FOG SEAL

412.01 Description

This work shall consist of applying asphalt emulsion to the pavement surface in accordance with 105.03.

MATERIALS

412.02 Materials

10 Materials shall be in accordance with the following:

Asphalt Emulsion, AE-F	902.01(b)
Fine Aggregate	904.02

CONSTRUCTION REQUIREMENTS

412.03 Equipment

A distributor in accordance with 409.03(a) shall be used.

20 **412.04 Weather Limitations**

Fog seal operations shall not be conducted on a wet pavement, when the ambient air or pavement temperature is below 60°F, or when other unsuitable conditions exist, unless approved by the Engineer. Fog seal shall not be applied to travel or auxiliary lanes before May 1 or after October 1.

412.05 Preparation of Surface

Surfaces shall be clean and free of any foreign or loose material.

30 All castings, detector housings, and snowplowable raised pavement markers shall be covered to prevent coating with fog seal prior to application of the fog seal. These coverings shall be removed prior to opening to traffic.

412.06 Application of Asphalt Material

The asphalt material shall be applied uniformly at the rate of 0.10 ±0.02 gal./sq yd. Asphalt material shall be applied in such a way as to ensure even and uniform coverage to the pavement surface.

412.07 Protection of Surface

40 Fine aggregate or other approved blotting material shall be applied to pedestrian crosswalks, driveways, or other areas as directed by the Engineer. Brooming of ponded areas shall be required prior to opening to traffic on treated surfaces, as directed.

Traffic shall not be allowed on the freshly sealed surface until the asphalt material has sufficiently cured to prevent tracking.

412.08 Application of Pavement Markings

The fog seal shall be cured a minimum of five days prior to applying permanent pavement markings in accordance with 808.

50 **412.09 Method of Measurement**

Fog seal will be measured by the square yard complete in place.

412.10 Basis of Payment

Fog seal will be paid for at the contract unit price per square yard.

Payment will be made under:

414.01

Pay Item **Pay Unit Symbol**

60 Fog Seal..... SYS

The costs of all asphalt materials, fine aggregate, surface preparation, and all other necessary incidentals shall be included in the cost of the pay item.

SECTION 413 – BLANK

**SECTION 414 - ULTRATHIN BONDED WEARING COURSE,
WARRANTED**

414.01 Description

This work shall consist of furnishing materials and the placement of warranted ultrathin bonded wearing course, UBWC, in accordance with 105.03. The UBWC shall consist of surface preparation, application of asphalt emulsion and asphalt mixture. Asphalt mixture shall be produced by a Certified Hot Mix Asphalt Producer.

10 The Contractor shall be responsible for the warranted UBWC in accordance with 414.14.

MATERIALS

414.02 Materials

Materials shall be in accordance with the following:

- Asphalt Emulsion 902.01(b)2
- Asphalt Materials
- 20 PG Binder, PG 64-22, PG 76-22 902.01(a)
- PG Binder Grade 414.02(b)
- Coarse Aggregates, Class A or Higher 904.03 and 414.02(c)
- Fine Aggregates 904.02
- Mineral Filler 904.02(f)

(a) Blank

(b) Asphalt Materials

The PG binder grade shall be selected based on the following requirements:

30

PG Binder	ESAL
64-22	< 10,000,000
76-22	≥ 10,000,000

Additional requirements for the PG 76-22 binder as follows:

Characteristic	Test Method	Min.	Max.
Separation, % prepared by ASTM D 7173	AASHTO T 53		6°C
Elastic Recovery, @ 39°F (4°C), %	AASHTO T 301	60	

(c) Coarse Aggregates

Additional requirements for coarse aggregate shall also be as follows:

Characteristic	Method	Min.	Max.
Coarse Aggregate Angularity	ASTM D5821	95/85*	
Micro-Deval Abrasion, % loss	AASHTO T 327		18
* Denotes two faced crush requirements.			

414.03 Design Mix Formula

- 40 The design mix formula, DMF, shall be determined for each mixture prepared by a Qualified Mix Design Laboratory selected from the Department's list of Qualified Mix Design Laboratories. The Contractor shall submit a DMF for each mixture to the Engineer one week prior to use. The DMF shall state the maximum particle size in the mixture, the mixture gradation, the total aggregate bulk specific gravity, the maximum and bulk specific gravity of the UBWC mixture and the application rate for any anti-stripping additives. No mixture will be accepted until the DMF is approved.

414.04 Mix Design

- 50 The binder content and the percentage of aggregate passing each sieve shall be in accordance with the following requirements:

Mixture Designation – Control Point (Percent Passing)			
Sieve Size	12.5 mm	9.5 mm	4.75 mm
3/4 in. (19.0 mm)	100.0		
1/2 in. (12.5 mm)	85.0 - 100.0	100.0	
3/8 in. (9.5 mm)	55.0 - 80.0	85.0 - 100.0	100.0
No. 4 (4.75 mm)	22.0 - 38.0	22.0 - 38.0	40.0 - 55.0
No. 8 (2.36 mm)	19.0 - 32.0	19.0 - 32.0	20.0 - 32.0
No. 16 (1.18 mm)	15.0 - 24.0	15.0 - 24.0	15.0 - 24.0
No. 30 (600 µm)	11.0 - 18.0	11.0 - 18.0	11.0 - 18.0
No. 50 (300 µm)	8.0 - 14.0	8.0 - 14.0	8.0 - 14.0
No. 100 (150 µm)	5.0 - 10.0	5.0 - 10.0	5.0 - 10.0
No. 200 (75 µm)	4.0 - 5.5	4.0 - 5.5	4.0 - 5.5
Binder Content, %,	4.6 - 6.1	4.8 - 6.1	5.0 - 6.3
Plan Lay Rate (lb/sq yd)*	90	75	65
* Plan lay rates are based on 100 lb/sq yd/in. using a mixture with a specific gravity of 2.5. Mixtures with different specific gravity will require an adjusted equivalent lay rate.			

The binder film thickness shall be a minimum of 0.4 mil. The binder content of the mix shall be determined by calculating the binder film thickness in accordance with ITM 589.

The maximum specific gravity of the UBWC mixture shall be mass determined in water in accordance with AASHTO T 209.

60 The bulk specific gravity of the UBWC mixture shall be determined in accordance with AASHTO T 331.

Draindown from the loose mixture shall not exceed 0.10% when tested in accordance with AASHTO T 305.

70 The tensile strength ratio, TSR, shall meet or exceed 80% when tested in accordance with AASHTO T 283(1). Specimens for AASHTO T 283 shall be 6 in. in diameter by $3\frac{3}{4} \pm 1/4$ in. height and compacted in accordance with AASHTO T 312, except the specimens shall be compacted to 100 gyrations and resultant air voids reported for information purposes only.

The compaction temperatures shall be $300 \pm 10^\circ\text{F}$.

(1) Follow AASHTO T 283 with the following exceptions:

- (a) Condition the mixture for 4 h in accordance with AASHTO R 30, Section 7.1.
- 80 (b) Compact the Superpave Gyrotory Compactor, SGC, specimens to 100 gyrations.
- (c) Extrude the samples as soon as possible without damage to the sample.
- (d) Use AASHTO T 269 to determine the void content.
- (e) Record the void content of the specimens.
- 90 (f) If less than 55% saturation is achieved, the procedure does not need to be repeated unless the difference in tensile strength between duplicate specimens is greater than 25 lb/sq in.

414.05 Use of Recycled Materials

Recycled materials shall be in accordance with 401.06 for dense graded surfaces except RAP for use in the UBWC mixture shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

414.06 Quality Control

100 The Contractor shall produce a mixture in compliance with the DMF within the limits of the quality control tolerances. The Contractor shall maintain all quality control documentation and make a copy available to the Engineer upon request or at completion of work.

The Contractor shall sample the mix a minimum once per day in accordance with ITM 580, section 8.6 Truck Samples, Dense Graded HMA Mixture. The sample shall be tested for binder content and gradation prior to the next day's production.

The Contractor shall take corrective action when the binder content exceeds $\pm 0.5\%$ from that stated in the DMF as tested in accordance with ITM 586.

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The Contractor shall take corrective action when the aggregate gradation exceeds the following values from that stated in the DMF as tested in accordance with AASHTO T 30.

Sieve Size	Quality Control Tolerances (\pm), %		
	Mixture Designation - Tolerances		
	12.5 mm	9.5 mm	4.75 mm
3/4 in. (19.0 mm)			
1/2 in. (12.5 mm)	5.0		
3/8 in. (9.5 mm)		5.0	
No. 4 (4.75 mm)	4.0	4.0	5.0
No. 8 (2.36 mm)	4.0	4.0	4.0
No. 16 (1.18 mm)			4.0
No. 200 (75 μ m)	1.0	1.0	1.0

CONSTRUCTION REQUIREMENTS

414.07 Equipment

120 The equipment shall be in accordance with 409.01, 409.02(a), 409.03(b) and 409.03(d)1 except as follows:

The paver shall be self-priming, designed and built for applying the UBWC. The paver shall have a receiving hopper, feed system, asphalt emulsion storage tank, a calibrated metering system for measuring the emulsion volume applied, spray bar and a heated, variable width, combination vibratory screed or a combination vibratory-tamping bar screed. The paver shall be capable of spraying the asphalt emulsion, applying the asphalt mix and leveling the surface of the mat in one pass. The screed shall have the ability to crown the pavement at the center.

130

414.08 Preparation of Surface

The Contractor shall be responsible for all surface preparation to meet the requirements for warranted UBWC. All castings and detector housings not identified on the plans as being reset shall be protected prior to the application of material in accordance with 404.07, except that raised pavement markers shall be removed.

414.09 Asphalt Emulsion

140 The asphalt emulsion shall be applied at a temperature recommended by the emulsion supplier. The asphalt emulsion shall be applied uniformly across the entire width of pavement to be overlaid. Equipment shall not operate on the applied asphalt emulsion before the asphalt mix is placed.

The recommended plan application rates of the asphalt emulsion are as shown in the table below. Determination of actual application rates shall be the responsibility of the Contractor.

Recommended Asphalt Emulsion Application Rate and Adjustment Factors for Surface Conditions			
Mixture Designation	12.5 mm	9.5 mm	4.75 mm
General application rate, gal./sq yd	0.20	0.17	0.14
Existing Surface Condition	Recommended adjustment to application rate, gal./sq yd		
PCCP, smooth or polished	-0.03	-0.03	-0.03
PCCP, broomed or textured	0	0	0
Flushed asphalt concrete surface	-0.02	-0.03	-0.03
Dense, unaged asphalt concrete surface	0	0	0
Open textured, dry, aged or oxidized asphalt concrete surface	+0.02	+0.01	+0.01
Milled asphalt concrete surface	+0.02	+0.01	+0.01

414.10 Pre-Paving Meeting

150 A pre-paving meeting between the Engineer and Contractor will be held on-site prior to beginning work. The following shall be reviewed:

- (a) work schedule
- (b) traffic control plan
- (c) equipment calibrations and adjustments
- (d) inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials
- (e) job mix formula
- (f) Contractor's proposed emulsion and mix application rates
- 160 (g) QCP in accordance with ITM 803
- (h) Contractor's authorized representative.

414.11 Mixture Placement

The UBWC shall be prepared and placed at temperatures recommended by the binder supplier. Fracturing of aggregates shall be avoided.

414.12 Mixture Finishing

Three passes of rollers capable of exerting at least 150 lb/in. and in conformance with 409.03(d)1 shall be applied to the UBWC before the material has cooled below
170 185°F. A release agent may be added to the water system of the rollers to prevent adhesion of the material to the roller drum. Rollers shall not operate in vibratory mode.

414.13 Smoothness

A straightedge in accordance with 409.03(f) will be used to determine smoothness. The 16 ft straightedge will be used to accept smoothness along the direction of mainline traffic and the 10 ft straightedge will be used to accept smoothness transverse to the direction of mainline traffic. Smoothness correction shall be in accordance with 401.18(c).

180 The lane edge shall have no more than 2 in. of horizontal variance in 100 ft.

414.14 Warranty

A warranty bond is to insure completion of required warranty work, including payments for all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract used to remediate any warranted distresses.

The Contractor shall furnish to the Engineer a warranty bond at the preconstruction conference or prior to beginning any work on the contract. The
190 warranty bond shall be equal to 100% of the contract total for the warranted UBWC pay items, and shall be properly executed by a surety satisfactory to the Department, and shall be payable to the State of Indiana. The warranty bond shall be in effect for three years from the date of substantial completion.

Upon the final acceptance of the project, the contractual obligations of the Contractor are satisfied as long as the UBWC continues to meet or exceed the warranted values as defined herein.

200 All warranty work shall be accomplished in accordance with 414.16. At the end of the warranty period, the Contractor will be released from further warranty work or responsibility, provided all previous warranty work has been satisfactorily completed and approved by the Department.

414.15 Conflict Resolution Team

The scope of work for the conflict resolution team includes all issues concerning the warranted pavement relative to the quality control plan, material selection, warranted pavement evaluations, distress indicators, remedial action, and remediation plans.

210 The team will consist of two Contractor representatives, two Department representatives, and an additional person mutually agreed upon by both the Department and the Contractor. All costs for the additional person will be equally shared by the Department and the Contractor.

The team members will be identified in writing when needed and will be knowledgeable in the terms and conditions of this warranty and the methods used in the measurement and calculation of pavement distress. The team will render a final recommendation to the Chief Engineer by a majority vote. Each member has an equal vote.

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414.16 Warranty Work

Elective work is performed by the Contractor at its discretion to meet the performance requirements of warranted UBWC prior to direction from the Department for the Contractor to perform remedial work.

Remedial work is performed as a result of pavement distress surveys performed by the Department.

230 During the warranty period, elective work and remedial work shall be performed at no cost to the Department. Elective work shall be at the Contractor's option. The scope of all elective work or remedial work to be performed as well as materials to be used shall be proposed by the Contractor and shall be subject to approval by the Department. Prior to proceeding with any warranty work or monitoring, all necessary permits shall be obtained from the Department.

Elective work during the warranty period will not be assessed a lane closure fee. For remedial work, costs for closure periods will be as shown in the contract.

240 During the warranty period, the Contractor may monitor the warranted UBWC using non-destructive procedures.

Coring, milling or other destructive procedures may not be performed by the Contractor, without prior consent of the Department. The Contractor will not be responsible for damages to the pavement as a result of coring, milling or other destructive procedures conducted by the Department.

250 The Contractor has the first option to perform the remedial work. If the problem requires immediate attention, as determined by the Engineer, for safety of the traveling public and the Contractor cannot perform the remedial work within 24 h of notification, the Department will perform the remedial work. The Contractor shall be responsible for all costs incurred by the Department for remedial work performed by the Department. Remedial work performed by the Department will not alter the requirements, responsibilities, or obligations of the warranty.

414.17 Pavement Distress Indicators, Thresholds and Remedial Action

The Department will use the following pavement distress indicators throughout the warranty period:

- 260
- (a) Delamination - physical separation of the UBWC that exposes the underlying surface.
 - (b) Rutting - transverse displacement of the UBWC.
 - (c) Raveling - wearing away of the UBWC.
 - (d) Skid Resistance - friction number as measured by ASTM E274 and E524.

The pavement threshold values for the pavement distress indicators will be evaluated for the entire length of the project for each lane. The threshold values for the pavement distress indicators are listed below:

270

Distress	Single Location	Multiple Locations
Delamination/Raveling	1/2 sq yd	1 sq yd/mi
Rut Depth	1/4 in.	average 1/4 in./mi
Friction Number*	no less than 30	average 35
* Individual friction tests will be performed in each lane every 1/2 mi for the length of the project.		

The Department may evaluate the warranted UBWC during the warranty period. A final condition survey will be made by the Department and the Contractor will be notified in writing of all sections exceeding the warranty threshold at least 90 days in advance of the expiration of the warranty period.

- 280
- If the Department determines that any threshold level has been met or exceeded and remedial work is required, the Contractor shall submit a work plan and schedule to the Engineer for approval. The Contractor shall perform the remedial work within 30 calendar days of notification of approval by the Engineer.

If, anytime during the warranty period, 30% or more of the project requires, or has received remedial work, remedial work as determined by the Department shall be performed on the entire project.

If remedial or elective work performed by the Contractor necessitates repair or replacement of pavement markings, adjacent lanes or roadway shoulders, the required work shall be the responsibility of the Contractor.

- 290
- Warranty requirements for all elective and remedial work will be limited to the life of the original contract warranty.

414.18

414.18 Department Maintenance

The Department may perform routine maintenance operations during the warranty period including, but not limited to, plowing, applying de-icing chemicals, repairs to safety appurtenances, pavement markings, mowing and sign maintenance.

The Department will perform no routine pavement surface maintenance activities during the warranty period.

300

414.19 Method of Measurement

Ultrathin bonded wearing course, of the type specified, will be measured by the square yard in accordance with 109.01.

414.20 Basis of Payment

Ultrathin bonded wearing course, of the type specified, will be paid for at the contract unit price per square yard.

Payment will be made under:

310

Pay Item	Pay Unit Symbol
Ultrathin Bonded Wearing Course for Approaches, _____	SYS
	size
Ultrathin Bonded Wearing Course, _____	SYS
	size

320

The cost of all incidentals including, but not limited to, surface preparation, asphalt emulsion, meeting smoothness requirements, and warranty bond shall be included in the cost of the pay items.

414.21 Final Warranty Acceptance

The Engineer will review the project in the field for any general defects not addressed in the indicators and recommend a Final Warranty Acceptance. The Department will issue the Contractor a Final Warranty Acceptance letter upon completion of the warranty period and all required remedial work.

SECTION 415 – BASE SEAL

415.01 Description

This work shall consist of applying asphalt emulsion to the pavement surface in accordance with 105.03.

MATERIALS

415.02 Materials

10

Base seal materials shall be in accordance with the following:

Asphalt Emulsion, SS-1h, AE-NT.....902.01(b)

CONSTRUCTION REQUIREMENTS

415.03 Equipment

A distributor in accordance with 409.03(a) shall be used.

415.04 Weather Limitations

20 Base sealing operations shall not be conducted on a wet pavement or when the ambient air or pavement temperature is below 32°F.

415.05 Preparation of Surface

Surfaces shall be clean and free of any foreign or loose material.

415.06 Application of Asphalt Material

The base seal materials shall be applied to the pavement surface uniformly with a distributor at an application rate of 0.22 ±0.02 gal./sq yd.

30 **415.07 Protection of Surface**

The base seal materials shall cure a minimum of two hours after application before resuming paving operations.

415.08 Method of Measurement

The base seal will be measured by the ton complete in place.

415.09 Basis of Payment

The base seal will be paid for at the contract unit price per ton.

40 Payment will be made under:

Pay Item	Pay Unit Symbol
Base Seal	TON

The costs of all asphalt materials, surface preparation and all other necessary incidentals shall be included in the cost of the pay item.

SECTION 416 - COLD IN-PLACE RECYCLING, CIR

416.01 Description

This work shall consist of milling and pulverizing a portion of the existing asphalt pavement to specified depth and maximum size, mixing asphalt emulsion, water and additives to produce a recycled asphalt layer. This material shall then be placed and compacted to the approved design properties in accordance with 105.03.

416.02 Just-in-Time Training, JITT

10 The Engineer and the Contractor are required to attend a JITT course regarding CIR and both shall mutually agree on the course instructor, course content and training site. The training class shall be conducted at a project field location convenient for all project construction personnel responsible for CIR operations and inspection to attend.

The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of CIR operations.

The Contractor shall provide a JITT instructor experienced in the construction methods, materials and test methods associated with asphalt emulsion stabilized CIR.

20 A copy of the course syllabus, handouts and presentation materials shall be submitted to the Engineer at least five business days before the course is to be taught.

416.03 Quality Control

A quality control plan, QCP, shall be submitted to the Engineer a minimum of five calendar days prior to the JITT. The QCP shall include the proposed CIR mix design, a start to finish process description to include discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, and the curing methods applied to the CIR. All QC test results and responses to test results shall be maintained during the duration of the contract and
30 made available to the Engineer upon request.

The following table provides the type and minimum frequency for tests.

QC Testing	
Test	Frequency ^{1,2}
Depth of Pulverization	1 per 500 ft
Pulverized Material Gradation	1 per 0.5 day of processing
Asphalt Emulsion Content	1 per 500 ft
Water Content	1 per 500 ft
Compacted In-Place Field Density	1 per 1,000 ft
Field Moisture Content for Curing	1 per each day of production
Optimum Field Density	1 per 2 days of production
1. The Contractor shall perform all QC tests within the first 500 ft after startup and after any change in the mix design. 2. Testing frequency is based upon linear feet of CIR processing.	

MATERIALS

416.04 Materials

40 CIR shall consist of a homogenous blend of reclaimed asphalt pavement, RAP, combined with asphalt emulsion, water, and when required, recycling additives such

as corrective aggregate or cement. Cement recycling additives used in asphalt emulsion stabilized CIR may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the CIR mix design and project requirements.

Materials for use in CIR shall be in accordance with the following:

	Asphalt Emulsion	902.01(b)3
50	Corrective aggregate to adjust gradation or supplement material volume:	
	1. Coarse or Dense Graded Aggregate, Class C or Higher	904.03
	2. Fine Aggregate	904.02
	3. RAP shall be the product resulting from the cold milling or crushing of an existing asphalt pavement. The RAP coarse aggregate shall be processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.	
	Portland Cement, Type I.....	901.01(b)
60	Water	913.01

A type D certification in accordance with 916 and the Frequency Manual shall be provided for the CIR.

416.05 Mix Design

The CIR mix design shall be in accordance with ITM 592 and shall be comprised of existing RAP, asphalt emulsion and if necessary, recycling additives. The mix design and all associated testing shall be performed, using samples of the existing pavement material from the project site representing the recycling depth, by a design laboratory that is AMRL accredited in HMA and asphalt emulsion. Additional mix designs shall be performed when the in-place material changes significantly in order to establish representative mixes for the entire job. The Contractor shall be responsible for obtaining all samples required to develop the mix design. One sample per lane mile of planned CIR shall be the minimum sampling frequency for mix design preparation.

The Contractor shall provide a mix design, or designs, for approval at least five calendar days prior to the JITT. The mix design shall include all test results performed. If new materials are added, a new mix design, including the updated test results, shall be submitted at least one day prior to implementation.

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CONSTRUCTION REQUIREMENTS

416.06 Roadway Preparation

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to CIR operations.

416.07

Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the pulverized material during milling operation.

90

Grade adjustments of existing structures shall be made in accordance with 720.04 prior to CIR operations, except existing structures shall be lowered, properly covered and filled with material compatible with the CIR mix design to maintain traffic.

All areas of soft or yielding subgrade, as shown on the plans, shall be corrected prior to CIR operations.

416.07 Equipment

100 The recycling equipment shall be capable of milling the existing asphalt pavement, sizing the resulting RAP and mixing the RAP with the materials stipulated in the mix design. The recycling equipment shall be capable of meeting the specified sizing requirement with either the milling process or with additional sizing equipment. The recycling equipment shall be capable of producing a homogenous and uniformly coated CIR mixture by mixing the RAP with the asphalt emulsion, water and any other additives, either in the cold planer housing or in an additional mixing chamber. The equipment used for placement of the CIR mixture shall be capable of the placement in accordance with 105.03.

110 The CIR equipment shall consist of the following major components:

(a) Cold In-Place Recycler Equipment

The cold in-place recycling equipment will include either a single unit recycler or a multi-unit recycler.

1. Single Unit Recycler

120 The single-unit recycler shall be a self-propelled cold milling machine/cold recycling machine with a down cutting cutter head capable of pulverizing and recycling the existing HMA pavement to the depth specified, incorporate the asphalt emulsion and water and mix the materials to produce a homogenous mixture. The machine shall have two systems for adding asphalt emulsion and water, with each system having a full width spray bar with a positive displacement pump interlocked to the machine's ground speed to ensure that the amount of asphalt emulsion and water being added is automatically adjusted with changes to the machine's ground speed. Each additive system shall have its own spray bar equipped with two nozzles per foot of spray bar and be capable of incorporating up to 7 gal./sq yd of asphalt emulsion or water. Individual valves on the spray bar shall be capable of being turned off as necessary to minimize asphalt emulsion and water overlap on subsequent passes.

2. Multi-Unit Recycler

130 A multi-unit recycler may be utilized instead of a single unit recycler. The multi-unit train shall contain the following:

- 140
- a. A self-propelled cold milling machine that is capable of pulverizing the existing asphalt material in a single pass to the depth shown on the plans and to a minimum width of not less than 12 1/2 ft. The machine shall have automatic depth controls to maintain the cutting depth to within $\pm 1/4$ in. of that shown on the plans, and shall have a positive means for controlling cross slope elevations. The use of a heating device to soften the pavement will not be allowed.
 - b. A material sizing unit having screening and crushing capabilities to reduce the cold pulverized material to the appropriate size. The screening and crushing unit shall have a closed circuit system capable of continuously returning oversized material to the crusher. All of the pulverized material shall be processed to the maximum size requirements specified.
- 150
- c. A mixing unit equipped with a belt scale for the continuous weighing of the pulverized and sized asphalt material and a coupled/interlocked computer controlled liquid metering device. The mixing unit shall be an on-board completely self-contained pugmill. The liquid metering device shall deliver the amount of asphalt emulsion to within $\pm 0.25\%$ of the required amount by weight of the pulverized asphalt material. The asphalt emulsion pump shall be sufficient capacity to allow emulsion contents up to 4.0% by weight of pulverized material. Also, automatic digital readings shall be displayed for both the flow rate and total amount of pulverized asphalt material and asphalt emulsion in appropriate units of weight and time.
- 160

(b) Spreaders for Dry Cement

170 Spreaders used to apply dry cement recycling additives shall be non-pressurized mechanical vane-feed, cyclone or screw type capable of providing a consistent, accurate and uniform distribution of material while minimizing dust during construction.

(c) Additive Slurry Storage and Supply Equipment

Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

416.08

180 **(d) Spreading of Corrective Aggregate**

Corrective aggregate, when required shall be placed with a mechanical spreader or a conventional paver.

(e) Water Truck

A water truck for supplying water to the milling equipment during CIR operation shall be provided. The water truck system shall be able to supply the mixing chamber, if necessary, so as to provide an independent source of water to properly disperse the asphalt emulsion.

190 **(f) Laydown Equipment**

The processed CIR mixture shall be spread uniformly across the recycling width using either a self-propelled paver in accordance with 409.03(c) or screed integral to the recycling equipment.

In either case, the screed shall be controlled by electronic grade and cross slope control. The equipment shall be of sufficient size and power to spread the recycled material in one continuous pass, without segregation, in accordance with 105.03. Heating of the screed will not be allowed.

200 In utilizing a self-propelled paver, material shall either be loaded directly into the paver hopper from the recycling equipment or loaded by a pickup device from a windrow.

If utilizing a pickup device, it shall be capable of removing and transferring the entire windrow of recycled mix in a single pass. The pick-up machine shall be within 150 ft of the mixing unit throughout the treatment process.

(g) Compaction Equipment

210 Compaction equipment shall be in accordance with 409.03(d). The number, weight, and types of rollers shall be as necessary to obtain required compaction. At a minimum, the following rollers shall be used:

1. At least one pneumatic tired roller in accordance with 409.03(d)3 with a minimum weight of not less than 20 t.
2. At least one double drum vibratory roller in accordance with 409.03(d)4 with a minimum weight of not less than 10 t.

220 **416.08 Weather Limitations**

CIR operations shall be performed when the RAP temperature, or pavement surface temperature, is above 50°F with ambient temperatures above 35°F for seven days. The Engineer may restrict work when the heat index is greater than 100°F. The CIR shall not be performed before May 1 or after October 1.

416.09 Processing and Mixing Operation

For CIR mixtures, the pulverization shall produce a gradation that has 100% passing the 1 1/2 in. (37.5 mm) sieve.

- 230 Corrective aggregate, when required, shall be spread onto the existing surface using a mechanical spreader or a conventional paver.

An additive used in asphalt emulsion stabilized CIR may be dry powder or slurry and the Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used.

- 240 The pulverized material shall be processed through a mixing unit capable of combining the pulverized material, asphalt emulsion, and any additives to produce a homogenous recycled mixture. The asphalt emulsion shall be injected into the pulverized asphalt material at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of asphalt emulsion at various portions of the project.

- 250 When a paving fabric is encountered during the pulverization operation, the Contractor shall make the necessary changes in equipment or operations so that incorporation of shredded fabric into the CIR does not affect the performance parameters or inhibit placement or compaction of the CIR. The Contractor shall be required to remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled material is no more than 5 sq in. No fabric piece shall have a dimension exceeding a length of 4 in.

Rubberized crack filler, durable pavement markings, loop wires, and other non-pavement materials shall be removed as observed from the roadway during the CIR process. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

- 260 Any such materials retained in the mixture shall be appropriately sized and blended so as to not adversely affect the strength of the CIR.

Asphalt emulsion shall have an application tolerance determined by adding $\pm 0.25\%$ to the percent total asphalt emulsion content recommended by the mix design.

The Contractor can request the asphalt emulsion percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

416.10 Control Strip and Compaction

270 A minimum 500 ft long control strip shall be conducted on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

- (a) demonstrate the proposed equipment, materials and processes can produce a CIR layer in accordance with specification requirements, and;
- (b) determine the optimal rates for the asphalt emulsion, water and any additives recommended for the reclaimed material, and;
- 280 (c) determine the sequence and manner of rolling necessary to obtain specified density requirements.

The CIR density shall be achieved with the same equipment, materials, construction methods and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside of the tolerances of the original mix design, equipment or construction methods.

290 A rolling pattern that produces the maximum obtainable density, or optimum field density, shall be determined during the control strip using a roller in accordance with 409.03(d)4. The Contractor shall provide a sequence and manner of rolling by establishing a roller pass versus density chart that shows the progress of densification from initial lay down through optimum field density using a properly calibrated nuclear gauge in accordance with AASHTO T 310. Production may continue after approval of the control strip.

300 The Contractor shall perform compaction testing in accordance with AASHTO T 310 during production to ensure compaction is between 97% and 102% of the optimum field density established during the control strip. If two successive tests indicate compaction is over 102% or below 97% of the optimum field density, a new rolling pattern and roller pass versus density chart shall be established.

The QC technician shall be on site, observing all compaction efforts and approving areas as they reach minimum relative compaction. Care shall be taken not to over compact the mat.

Any type of rolling effort that causes cracking, displacement or other type of pavement distress shall be discontinued until such time as the problem can be resolved as approved by the Engineer.

310

Rollers shall not be started or stopped on recycled material except when changing direction during the compaction process.

All tests shall be conducted at the stated QC testing frequencies throughout CIR operations.

416.11 Opening to Traffic

320 Opening to traffic shall occur after sufficient cure time has been applied to the CIR so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.

After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic.

416.12 Maintenance

The Contractor shall maintain the recycled pavement in a manner satisfactory to the Engineer until the surface course has been constructed.

330 Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new asphalt concrete or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or CIR material as directed by the Engineer. No direct payment will be made for damage or repair unless approved by the Engineer.

416.13 Curing

Before placing the final surfacing, the recycled surface shall remain in-place for a minimum of three days and meet one of the following conditions:

- 340 (a) there is less than 3.0% moisture remaining in the mixture, or
- (b) the material has cured for a minimum of 10 consecutive days without rainfall.

The planned method and duration of curing for CIR shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the CIR final cure, but no later than November 1.

416.14 Milling

350 The entire surface of the CIR shall be scarified in accordance with 306.04 in preparation for the overlay, except liquidated damages will not apply. Construction engineering in accordance with 105.08(b) shall be provided.

416.15 CIR Surface Course

The surface course atop the CIR shall be as shown on the plans.

The CIR shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the surface. The CIR shall be swept lightly to avoid damage to the CIR.

416.16

360

A tack coat shall be required only for the HMA overlay and shall be applied to the CIR in accordance with 406 immediately following sweeping operations.

Monuments shall be reestablished in accordance with 615.10.

416.16 Method of Measurement

370 The CIR will be measured by the square yard, complete in place. Asphalt emulsion will be measured by the ton. Aggregate to adjust the CIR gradation will be measured by the ton of material used. HMA Patching will be measured in accordance with 304.06. Milling will be measured in accordance with 306.10. Re-established monuments will be measured in accordance with 615.13. Grade adjustment of existing structures will be measured in accordance with 720.06. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12. Portland cement will be measured by the ton.

416.17 Basis of Payment

380 The CIR will be paid for at the contract unit price per square yard, complete in place. Asphalt emulsion will be paid for at the contract unit price per ton, complete in place. Aggregate used to adjust the CIR gradation will be paid for at the contract unit price per ton, complete in place. HMA patching will be paid for in accordance with 304.07, for the thickness shown on the plans. Milling will be paid for in accordance with 306.11. Re-established monuments will be paid for in accordance with 615.14. Grade adjustment of existing structures will be paid for in accordance with 720.07. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.

Portland cement will be paid for in accordance with 104.03. The change order will include direct material costs, delivery costs, and shall not include any other markups.

390 Payment will be made under:

Pay Item	Pay Unit Symbol
Cold In-Place Recycling.....	SYS
Corrective Aggregate, CIR.....	TON
Stabilizing Material, Asphalt Emulsion.....	TON
Stabilizing Material, Portland Cement	TON

400 The costs of the CIR mix design and QC testing shall be included in the cost of the CIR.

The costs associated with removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the CIR.

The costs associated with stabilizing, compacting, curing and maintenance of the CIR not related to failing subgrade shall be included in the cost of the CIR.

410 The cost associated with mixing water shall be included in the cost of the CIR.

The cost associated with aggregate when used to supplement material volume shall be included in the cost of the corrective aggregate pay item.

When portland cement is a required stabilizing material, costs associated with mixing, installation, compaction, curing, and maintenance shall be included in the cost of the CIR.

420 The cost associated with aggregate when used to adjust the CIR gradation shall be included in the cost of the corrective aggregate pay item.

The cost of milling the asphalt emulsion stabilized CIR to maintain profile shall be included in the cost of the milling.

In the locations of failing subgrade, removal of the CIR shall be included in the cost of subgrade treatment.

SECTION 417 - COLD CENTRAL PLANT RECYCLING, CCPR

417.01 Description

This work shall consist of a mixture of sized reclaimed asphalt pavement, RAP, millings from existing asphalt pavement or existing stockpiles, asphalt emulsion, water and other additives. The mixture shall be produced at a nearby location, then placed and compacted to produce a recycled asphalt layer to the approved design properties in accordance with 105.03.

10 **417.02 Just-in-Time Training, JITT**

The Engineer and the Contractor are required to attend a just-in-time training, JITT, course regarding CCPR and both shall mutually agree on the course instructor, course content and training site. The training class shall be conducted at a project field location convenient for all project construction personnel responsible for CCPR operations and inspection to attend.

The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of CCPR operations.

20 The Contractor shall provide a JITT instructor experienced in the construction methods, materials and test methods associated with asphalt emulsion stabilized CCPR. A copy of the course syllabus, handouts and presentation materials shall be submitted to the Engineer at least five business days before the course is to be taught.

417.03 Quality Control

30 A quality control plan, QCP, shall be submitted to the Engineer a minimum of five calendar days prior to the JITT. The QCP shall include the proposed CCPR mix design, a start to finish process description to include discussion on corrective action measures, a list of proposed equipment, a list of proposed QC tests and testing frequencies, and the curing methods and procedures applied to the CCPR. All QC test results and response to test results shall be maintained during the duration of the contract and made available to the Engineer upon request.

The following table provides the type and minimum frequency for tests:

QC testing	
Test	Frequency ^{1,2}
Depth of Laydown	1 per 500 ft
Pulverized Material Gradation	1 per 1,000 tons of production
Pulverized Material Moisture Content	1 per 500 tons of production
Asphalt Emulsion Content ³	1 per 500 tons of production
Water Content ³	1 per 500 tons of production
Compacted In-Place Field Density	1 per 1,000 ft
Field Moisture Content for Curing	1 per each day of production
Optimum Field Density	1 per 2 days of production
1. The Contractor shall perform all QC tests within the first 500 ft after startup and after any change in the mix design. 2. Testing frequency is based upon either linear feet of CCPR laydown or tons of CCPR mixture processing. 3. Asphalt emulsion content and water content shall be taken from the readings of the control settings of the mixing unit.	

MATERIALS

417.04 Materials

40 CCPR shall consist of a homogenous blend of RAP combined with asphalt emulsion, water, and when required, recycling additives such as corrective aggregate or cement. Cement recycling additives used in asphalt emulsion stabilized CCPR may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the CCPR mix design and project requirements.

Materials for use in CCPR shall be in accordance with the following:

- 50 Asphalt Emulsion 902.01(b)3
- Corrective Aggregate to adjust gradation or supplement material volume:
1. Coarse or Dense Graded Aggregate, Class C or Higher 904.03
 2. Fine Aggregate 904.02

- 3. RAP shall be the product resulting from the cold milling or crushing of existing asphalt pavement and processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.

Portland Cement, Type I.....	901.01(b)
Water	913.01

60

A type D certification in accordance with 916 and the Frequency Manual shall be provided for the CCPR.

417.05 Mix Design

CCPR mix designs shall be in accordance with ITM 592 and shall be comprised of existing RAP, asphalt emulsion and recycling additives, if necessary. The mix design and all associated testing shall be performed using samples of each proposed material. RAP samples shall either be collected from the existing pavement at the project site representing the milling depth or from the RAP stockpile to be used during construction. The mix design shall be completed by a design laboratory that is AMRL accredited in HMA and asphalt emulsion. Additional mix designs shall be performed when the proposed material changes significantly in order to establish representative mixes for the entire job. The Contractor shall be responsible for obtaining all samples required to develop the mix design. One sample per lane mile of planned CCPR shall be the minimum sampling frequency for mix design preparation.

70

The Contractor shall provide a mix design or designs for approval at least five calendar days prior to the JITT. The mix design shall include all test results performed. If new materials are added, a new mix design, including the updated test results, shall be submitted at least one day prior to implementation.

80

CONSTRUCTION REQUIREMENTS

417.06 Roadway Preparation

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to CCPR operations.

90

Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the pulverized asphalt material during milling operation.

All areas of soft or yielding subgrade shall be corrected prior to CCPR operations.

If the CCPR mix is to be placed on a prepared subgrade or aggregate base, the Contractor shall ensure the subgrade soils and base have been properly prepared, moisture treated and compacted to the minimum density according to plans or specifications, immediately prior to placement of the CCPR mix, so as to create an evenly graded, unyielding surface.

417.07

100 **417.07 Pavement Removal**

The existing asphalt pavement shall be milled in accordance with 306 to the length, depth and width as shown on the plans or specifications. The RAP shall be free of contamination of dirt, base, concrete or other deleterious materials such as silt and clay.

110 When a paving fabric is encountered during the pulverization operation, the Contractor shall make the necessary changes in equipment or operations so that incorporation of shredded fabric into the CCPR does not affect the performance parameters or inhibit placement or compaction of the CCPR. The Contractor shall be required to remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled material is no more than 5 sq in. No fabric piece shall have a dimension exceeding a length of 4 in.

Rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be removed as observed from the roadway. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

120

Any such materials retained in the mix shall be appropriately sized and blended so as not to adversely affect the strength of the recycled pavement.

417.08 Equipment

The equipment shall consist of the following major components:

(a) Milling Machine/Pavement Cold Planer

130 Milling equipment shall be in accordance with 306.03(a). The equipment shall be capable of pulverizing the existing asphalt material in a single pass to the depth shown on the plans. The machine shall have automatic depth controls to maintain the cutting depth to within $\pm 1/4$ in. of that shown on the plans. The milling operation shall not disturb or damage the underlying material. The use of a heating device to soften the pavement will not be allowed.

(b) Additive Slurry Storage and Supply Equipment

140 Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

(c) Sizing Equipment

A material sizing unit shall be capable of sizing using a scalping screen or crushing capabilities to reduce RAP to a maximum size of 1 1/2 in. (37.5 mm) or to

the maximum size requirements specified prior to mixing with the asphalt emulsion.

(d) Mixing and Proportioning Equipment

150 The equipment shall be capable of processing sized RAP, asphalt emulsion, water
and any additives stipulated in the mix design to a homogenous and uniformly coated
CCPR mixture. The equipment shall be in accordance with 409.02(b) and display
automatic digital readings shall be displayed for flow rate of both the RAP and asphalt
emulsion in appropriate units of weight and time.

160 The mixing apparatus shall have cold feed hopper equipped with vibrators on the
hopper's walls to assist the free flow of materials to a variable speed belt conveyor.
Control of the RAP shall be by mechanically adjustable gate valves at the point of
discharge or a RAP belt scale for the continuous weighing of the RAP. The variable
speed belt conveyor or RAP belt scale shall be interlocked to the asphalt emulsion
metering device.

The asphalt emulsion metering device shall be capable of automatically adjusting
the flow of asphalt emulsion to compensate for any variation in the amount of RAP
introduced into the mixing apparatus. Asphalt emulsion shall be metered by weight of
RAP using a calibrated meter that will accurately measure the amount of asphalt
emulsion to within a tolerance of $\pm 2.0\%$ of the specified rate.

(e) Hauling Equipment

170 Hauling equipment shall be in accordance with 409.03(b).

(f) Laydown Equipment

Laydown equipment shall be in accordance with 409.03(c).

The paver screed shall be controlled by electronic grade and cross-slope control.
Heating of the screed shall not be allowed.

180 CCPR material shall either be loaded directly into the paver hopper from transport
trucks or loaded by a pickup device. If utilizing a pickup device, it shall be capable of
removing and transferring the entire windrow of recycled mix in a single pass.

The equipment used for placement of the CCPR mixture shall be capable of the
placement in accordance with 105.03.

(g) Compaction Equipment

Compaction equipment shall be in accordance with 409.03(d). The number,
weight, and types of rollers shall be as necessary to obtain required compaction. At a
minimum, the following rollers shall be used:

- 190 1. At least one pneumatic tired roller in accordance with
409.03(d)3 with a minimum weight of not less than 20 t.

417.09

2. At least one double drum vibratory roller in accordance with 409.03(d)4 with a minimum weight of not less than 10 t.

417.09 Weather Limitations

CCPR operations shall be performed when the RAP temperature, or pavement surface temperature, is above 50°F with ambient temperatures above 35°F for seven days. The Engineer may restrict work when the heat index is greater than 100°F. The
200 CCPR shall not be performed before May 1 or after October 1.

417.10 Material Sizing and Stockpiling

The gradation of the RAP shall have 100% passing the 1 1/2 in. (37.5 mm) sieve, or be sized to meet specific contract requirements.

RAP that has been crushed and screened shall be stockpiled and maintained to prevent reconsolidation. Water may be added to RAP as it is screened and crushed to abate dust and mitigate reconsolidation.

210 Corrective aggregate, if required, shall either be mixed with RAP to create a homogenous mixture during stockpiling or fed into the mixing apparatus at the rate determined by the mix design.

417.11 Processing and Mixing Operation

The sized RAP shall be processed through a mixing unit capable of combining the sized RAP, asphalt emulsion, and any additives to produce a homogenous recycled mixture.

220 An additive used in asphalt emulsion stabilized CCPR may be dry powder or slurry and the Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used.

The asphalt emulsion shall be injected into the CCPR materials at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of asphalt emulsion at various portions of the project.

The asphalt emulsion shall have an application tolerance determined by adding $\pm 0.25\%$ to the percent total asphalt emulsion content.

230 The Contractor can request the asphalt emulsion percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

417.12 Placement

The depth of CCPR shall be as indicated on the plans.

The hauling equipment shall deliver the blended CCPR material into the paver within one hour of mixing or before the asphalt emulsion begins to break and set.

240 CCPR single lift thickness shall be a minimum compacted depth of 3 in. and shall not exceed a maximum compacted depth of 5.5 in. Tack coat in accordance with 406 shall be applied between the lifts.

417.13 Control Strip and Compaction

A minimum 500 ft long control strip shall be conducted on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

- 250
- (a) demonstrate the equipment, materials and processes proposed to produce a CCPR layer in accordance with specification requirements, and;
 - (b) determine the optimal rates for the asphalt emulsion, water and any additives recommended for the material, and;
 - (c) determine the sequence and manner of rolling necessary to obtain specified density requirements in one uniformly compacted layer.

260 The CCPR density shall be achieved with the same equipment, materials, construction methods and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside of the tolerances of the original mix design, equipment or construction methods.

A rolling pattern that produces the maximum obtainable density, or optimum field density, shall be determined during the control strip using a roller in accordance with 409.03(d)4. The Contractor shall provide a sequence and manner of rolling by establishing a roller pass versus density chart that shows the progress of densification from initial lay down through optimum field density using a properly calibrated
270 nuclear gauge in accordance with AASHTO T 310. Production may continue after approval of the control strip.

The Contractor shall perform compaction testing in accordance with AASHTO T 310 during production to ensure compaction is between 97% and 102% of the optimum field density established during the control strip. If two successive tests indicate compaction is over 102% or below 97% of the optimum field density, a new rolling pattern and roller pass versus density chart shall be established.

280 The QC technician shall be on site, observing all compaction efforts and approving areas as they reach minimum relative compaction. Care shall be taken not to over compact the mat.

Any type of rolling effort that causes cracking, displacement or other type of pavement distress shall be discontinued until such time as the problem can be resolved as approved by the Engineer.

417.14

Rollers shall not be started or stopped on recycled material unless when changing direction during the compaction process.

290 All tests shall be conducted at the stated QC testing frequencies throughout CCPR operations.

417.14 Opening to Traffic

Opening to traffic shall occur after sufficient cure time has been applied to the CCPR so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.

300 After opening to traffic, the surface of the recycled pavement shall be maintained in a condition suitable for the safe movement of traffic.

417.15 Maintenance

The Contractor shall maintain the recycled pavement in a manner satisfactory to the Engineer until the surface course has been constructed.

310 Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new asphalt concrete or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or CCPR material as directed by the Engineer. No direct payment will be made for damage repair unless approved by the Engineer.

417.16 Curing

Before placing the final surfacing, the recycled surface shall remain in-place for a minimum of three days and meet one of the following conditions:

- (a) There is less than 3.0% moisture remaining in the mixture, or;
- (b) The material has cured for a minimum of 10 consecutive days without rainfall.

320

The planned method and duration of curing for CCPR shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the CCPR final cure, but no later than November 1.

417.17 Milling and Pavement Smoothness

When the CCPR material is placed in a single lift, the entire surface of the CCPR shall be scarified in accordance with 306.04 in preparation for the overlay, except liquidated damages will not apply. Construction engineering in accordance with 105.08(b) shall be provided.

330

Pavement smoothness of the cured CCPR mat shall meet the requirements of 401.18(b) The Contractor shall correct humps or depressions exceeding the tolerances in accordance with 401.18(c).

417.18 CCPR Surface Course

The CCPR shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the tack coat. A tack coat shall be required and shall be applied to the CCPR in accordance with 406.

340 Monuments shall be reestablished in accordance with 615.10 after the surface course is placed.

417.19 Method of Measurement

The CCPR will be measured by the square yard, complete in place. Asphalt emulsion will be measured by the ton. Aggregate to adjust the CCPR gradation will be measured by the ton of material used. HMA Patching will be measured in accordance with 304.06. Re-established monuments will be measured in accordance with 615.13. Grade adjustment of existing structures will be measured in accordance with 720.06. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12. Portland cement will be measured by the ton.

350

417.20 Basis of Payment

The CCPR will be paid for at the contract unit price per square yard, complete in place. Asphalt emulsion will be paid for at the contract unit price per ton, complete in place. Aggregate used to adjust the CCPR gradation will be paid for at the contract unit price per ton, complete in place. HMA patching will be paid for in accordance with 304.07, of the thickness specified on the plans. Re-established monuments will be paid for in accordance with 615.14. Grade adjustment of existing structures will be paid for in accordance with 720.07. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.

360

Portland cement will be paid for in accordance with 104.03. The change order will include direct material costs, delivery costs, and shall not include any other markups.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Cold Central Plant Recycling	SYS
370	Corrective Aggregate, CCPR	TON
	Stabilizing Material, Asphalt Emulsion.....	TON
	Stabilizing Material, Portland Cement	TON

The costs associated with the CCPR mix design and quality control testing shall be included in the cost of the cold central plant recycling.

417.20

The costs associated with the removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the cold central plant recycling.

380

The costs associated with pulverizing, stabilizing, compacting, curing and maintenance of the CCPR not related to failing subgrade shall be included in the cost of the cold central plant recycling.

The cost associated with mixing water for cold central plant material shall be included in the cost of the cold central plant recycling.

The cost associated with aggregate when used to supplement material volume shall be included in the cost of the corrective aggregate pay item.

390

When portland cement is a required stabilizing material, costs associated with mixing, installation, compaction, curing, and maintenance shall be included in the cost of the cold central plant recycling.

The cost associated with aggregate when used to adjust the CCPR gradation shall be included in the cost of the corrective aggregate pay item.

The costs of the asphalt emulsion stabilizing material shall be included in the cost of the stabilizing material pay item.

400

In the locations of failing subgrade, removal of the CCPR shall be included in the cost of subgrade treatment.

DIVISION 500 – CONCRETE PAVEMENT

SECTION 501 – QC/QA PORTLAND CEMENT CONCRETE PAVEMENT, PCCP

501.01 Description

This work shall consist of QC/QA portland cement concrete pavement, PCCP, placed on a prepared subgrade or subbase in accordance with 105.03.

501.02 Quality Control

- The mixture for PCCP shall be produced by an approved plant in accordance with
- 10 ITM 405, transported, and placed according to a QCP, prepared and submitted by the Contractor in accordance with ITM 803, for PCCP. The QCP shall contain a plan for placing PCCP in cold weather, as defined in 501.15. The cold weather plan shall, at a minimum, provide details to address changes in materials, concrete batching and mixing processes, construction methods, curing, temperature monitoring, and protection of in-situ PCCP. Temperature monitoring shall consist of monitoring the surface temperature of the PCCP by use of a thermometer. The thermometer shall be capable of recording and maintaining a record of the day, time, and temperature every 15 minutes around the clock. The thermometer shall be located 6 in. in from the edge of the PCCP. The QCP shall be submitted to the Engineer at least 15 days prior to
- 20 commencing PCCP paving operations.

An American Concrete Institute certified concrete field testing technician, grade I, shall be on site to direct all sampling and testing.

A common testing facility shall be provided for both production control and acceptance testing.

MATERIALS

30 501.03 Materials

Materials shall be in accordance with the following:

	Admixtures	912.03
	Concrete Coarse Aggregate, Class AP	904.03, ITM 226
	Fine Aggregate, Size No. 23*	904.02
	Fly Ash	901.02
	Portland Cement	901.01(b)
	Rapid Setting Patch Materials	901.07
	Silica Fume	901.04
40	Slag Cement	901.03
	Water	913.01

* Type IS-A and Type IP-A blended cements shall not be used.

501.04 Concrete Mix Design

A concrete mix design submittal, CMDS, shall be in accordance with 501.05. The CMDS shall be submitted to and approved by the DTE. The CMDS shall be submitted a minimum of seven calendar days prior to the trial batch utilizing the Department provided spreadsheet and shall include the following:

- 50 (a) a list of all ingredients
 (b) the source of all materials
 (c) the fine to total aggregate ratio
 (d) the gradation of the aggregates
 (e) the absorption of the aggregates
 (f) the SSD bulk specific gravity of the aggregates
 (g) the specific gravity of each supplementary
 cementitious material, SCM,
 (h) the batch weights
 (i) the names of all admixtures
 60 (j) the admixture dosage rates and the
 manufacturer's recommended range.

The aggregate blend submitted on the CMDS shall produce an optimized aggregate gradation in accordance with ITM 226 sections 6.2.1 and 6.3. The aggregate blend shall consist of, at a minimum, one concrete coarse aggregate and one fine aggregate, size No. 23. One additional class A intermediate-sized coarse aggregate may be included if approved by the Engineer.

- 70 The CMDS is used to conduct a trial batch in accordance with 501.06. Upon completion of the trial batch, the Contractor shall submit the concrete mix design for production, CMDP. The CMDP shall be submitted to the DTE utilizing the Department furnished spreadsheet a minimum of three work days prior to production. Production shall not commence without an approved CMDP. Both the Contractor's and the Engineer's test results from the trial batch will be included in the CMDP submittal.

A CMDP may be changed or adjusted in accordance with the following:

(a) Change in Materials

- 80 A change in a previously approved CMDP, for a given contract, to any of the following shall be submitted to the DTE as a CMDS, referencing the original CMDP.
1. cement source or type
 2. SCM source or type
 3. coarse aggregate source or type
 4. admixture type.

A trial batch shall be conducted in accordance with 501.06, or verification of the new CMDS may be made during the first day of production by tests conducted by the

90 Contractor and the Engineer. Acceptance test results may be used for the Engineer's verification tests. Production may continue until flexural strength tests are completed, provided all other properties are in accordance with 501.06. The test results shall be submitted to the DTE utilizing the Department spreadsheet no later than one day after the flexural strength test results are complete. If the test beams indicate a modulus of rupture that is not in accordance with 501.06, production shall stop and all PCCP constructed with the new CMDS will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

(b) Adjustments to Materials

100 An adjustment in a previously approved CMDP, for a given contract, to any of the following shall be submitted to the DTE as a CMDS, referencing the original CMDP.

1. admixture source
2. admixture product of the same type and from the same source designated in the original CMDP
3. fine aggregate source
4. target unit weight due to change in aggregate properties
5. fine to total aggregate ratio in excess of $\pm 3\%$ from the value designated by the original CMDP.

110

The new CMDS shall be submitted to the DTE utilizing the Department spreadsheet a minimum of one work day prior to production. A trial batch or verification testing is not required for approval. Production shall not commence without an approved CMDP.

120

(c) Other Adjustments

Other adjustments in an approved CMDP, for a given contract, to any of the following will be allowed and DTE notification and approval prior to use is not required.

1. admixture dosage rate
2. fine aggregate to total aggregate ratio within $\pm 3\%$ of the value designated by the original CMDP.

130

An approved CMDP from a previous contract may be used on additional contracts. The CMDP shall be submitted to the DTE for review and approval prior to use.

501.05 Concrete Mix Criteria

The CMD shall contain at least one, but not more than two SCM's, and produce workable concrete mixtures having the following properties:

140	Minimum total cementitious content.....	450 lb/cu yd
	Allowable amount of single SCM, % of total cementitious, by weight	25.0 - 40.0%*
	Allowable amount of two SCM's, % of total cementitious, by weight... ..	25.0 – 40.0%**
	Minimum portland cement content.....	275 lb/cu yd
	Allowable amount of silica fume as SCM, % of total cementitious content	3.0 – 7.0%**
	Maximum allowable water/cementitious ratio of concrete mixture with fly ash as SCM	0.440
150	Maximum allowable water/cementitious ratio of concrete mixture with slag cement as SCM	0.450
	Target Air Content.....	7.0%
	Minimum modulus of rupture.....	570 psi at 7 days

* Binary binder systems shall contain either fly ash or slag cement combined with a cement. If blended cement is used, it shall be either a Type IP ($25 \leq X \leq 40$) or Type IS ($25 \leq X \leq 40$) or Type IL. Blended cements, except for Type IL, shall not be combined with plant added slag cement or fly ash to create a binary binder system. When using a Type IL blended cement, plant addition of fly ash or slag cement will be allowed. The limestone dust in Type IL cement will not be considered in calculating the amount of SCM.

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** Ternary binder systems shall contain two SCM's such as fly ash and slag cement, or fly ash and silica fume, or slag cement and silica fume, combined with a cement. If a blended cement is used, it shall not be combined with a plant added SCM of the same type of pozzolan to create a ternary system. For example: a Type IP shall not be combined with plant-added fly ash and slag cement. When using a Type IL blended cement, the plant addition of both fly ash and slag cement will be allowed. The limestone dust in Type IL cement will not be considered in calculating the amount of SCM. Silica fume shall only be a SCM component of a ternary binder system. If a blended cement is used, silica fume shall only be an SCM component of the ternary system.

170

Absorption tests shall be performed on the fine aggregate in accordance with AASHTO T 84 and on the coarse aggregate in accordance with AASHTO T 85. Absorption test results for a particular size of aggregate that differ by more than 1.0 percentage point from the Department's source value shall be investigated. The Contractor shall report any differences that exceed 1.0% to the Department. The Contractor's results shall be used when calculating the water/cementitious ratio.

180

Hand placed paving operations meeting the requirements of 508.04(c) shall utilize concrete having a ternary binder system that contains silica fume as one of the SCM's when the ambient temperature is below 50°F during placement or when the ambient temperature will fall below 50°F before the opening to traffic strength is attained. Concrete with a ternary binder system containing silica fume as one of the SCM's, may be used in any approved method of pavement placement without restriction.

190 Placement operations that involve form riding equipment in accordance with 508.04(b), may utilize an approved binary CMDP, without restriction.

Water reducing admixture type A, or water reducing and retarding admixture type D, may be used in PCCP. However, admixture type A shall not be used in conjunction with admixture type D.

501.06 Trial Batch

A trial batch shall be produced and tested by the Contractor's certified technician to verify that the CMDS meets the concrete mix criteria. Concrete produced at a plant shall be batched within the proportioning tolerances of 508.02(b). Concrete batched in a laboratory shall be in accordance with ASTM C192. The Engineer will test the trial batch and provide the Contractor with the results. The trial batch shall be of sufficient quantity to allow the Contractor and the Engineer to perform all required tests from the same batch. Trial batch concrete shall not be used for more than one test, except the concrete used for the unit weight may be used to conduct the air content test. The air content shall be 5.5% to 10.0%. The plastic unit weight shall be within $\pm 3.0\%$ from the target plastic unit weight of the CMDS. The water/cementitious ratio shall be within ± 0.015 of the target value of the CMDS and shall not exceed the maximum amount allowed for the appropriate mix in accordance with 501.05. The flexural strength shall be determined by averaging a minimum of two beam breaks and shall be a minimum of 570 psi.

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210

Test results shall be added to the Department spreadsheet and submitted to the DTE in accordance with 501.04. Adjustments to the target unit weight and the target water/cementitious ratio may be made.

501.07 Lots and Sublots

Lots will be defined as 7,200 sq yds of PCCP. Lots will be further subdivided into sublots of 2,400 sq yds of PCCP within a lot. Partial sublots of 480 sq yds or less will be added to the previous subplot. Partial sublots greater than 480 sq yds constitute a full subplot. Partial lots of one or two sublots constitute a full lot.

220

Lots and sublots will be numbered and tested for a given pay item regardless of the number of CMD's used and will be closed out at the end of the paving season or construction phase.

501.08 Acceptance

Acceptance of PCCP will be based on the results of modulus of rupture, air content, unit weight, water/cementitious ratio, and thickness measurements obtained

501.09

230 by the Engineer in accordance with 505. The Engineer will randomly select the location within each subplot for sampling in accordance with ITM 802.

The random sample per subplot shall be of sufficient quantity to perform all required tests and obtained in accordance with AASHTO R 60. Concrete and necessary labor for sampling shall be furnished as required by the Engineer. The test results of the sublots for each lot will be averaged and shall be in accordance with 501.05 and 501.06, except the lot average for thickness shall be in accordance with 501.26. Test results are to be shared in a timely manner.

Test or Determination	Frequency	Test Method	Precision
7-Day Flexural Strength	two beams per subplot	AASHTO T 97	modulus of rupture, rounded to the nearest 5 psi
Air Content	one test per subplot	AASHTO T 152 or ASTM C173	0.1%
Unit Weight	one per subplot	AASHTO T 121	0.1 lb/cu ft
Water/Cementitious Ratio	one per two lots	ITM 403	0.001
Thickness	two per subplot	ITM 404	0.1 in.

240

Rounding will be in accordance with 109.01(a).

In the event that an acceptance sample is not available to represent a subplot, all test results of the previous subplot will be used for acceptance. If the previous subplot is not available, the subsequent subplot will be used for acceptance.

CONSTRUCTION REQUIREMENTS

501.09 General

250 Equipment for PCCP shall be in accordance with 508.

501.10 Preparation of Grade

The subgrade shall be shaped to the required grade and section, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207.

501.11 Preparation of Subbase

260 Subbase, if required, shall be placed and shaped to the required grade and section in accordance with 302. Construction traffic shall not be allowed on the aggregate drainage layer of the subbase, except where PCCP placement is restricted. Exceptions shall be submitted for approval.

501.12 Placement

Placement of PCCP shall be by the slipformed or formed methods with equipment specified in 508.04. The subgrade or subbase shall be uniformly moist at the time of

PCCP placement. Excessively dry subgrade or subbase shall be sprinkled with water.

501.13 Process Control

270 The Engineer and the Contractor will jointly review the operations to ensure compliance with the QCP. Continuous violations of compliance with the QCP will result in suspension of paving operations.

501.14 Concrete Mixing and Transportation

Concrete shall be mixed and delivered by one of the following:

- (a) Central mixed concrete shall be completely mixed in a stationary mixer and transported in a truck agitator, truck mixer at agitating speed, or non-agitating equipment.
- 280 (b) Shrink mixed concrete shall be partially mixed in a stationary mixer and the mixing completed during transportation in a truck mixer.
- (c) Transit mixed concrete shall be completely mixed in a truck mixer.

290 The batch ticket for contract dedicated plants and delivery tickets for ready mix plants shall include the approved CMDP number. The tickets shall be delivered to the Engineer.

When the concrete temperature is 90°F or above, discharge from non-agitating equipment shall be completed within 30 minutes of mixing the water, cement, and aggregates. For concrete temperature below 90°F, discharge from non-agitating equipment shall be completed within 45 minutes of mixing the water, cement, and aggregates. The concrete temperature shall be measured in accordance with ASTM C1064 at the point of delivery.

300 A watertight cover shall be used for a truck agitator and non-agitating equipment. The concrete shall be incorporated into the paving equipment within 15 minutes of discharge by the truck mixer, truck agitator, or non-agitating equipment.

Discharge from a truck agitator or a truck mixer shall be completed within 90 minutes of mixing the water, cement, and aggregates.

310 Concrete shall be uniformly mixed when delivered to the job site. The Engineer may conduct additional testing to verify uniformity of the mixture. Additional testing will consist of slump tests taken in accordance with AASHTO T 119 at approximately the 1/4 and 3/4 points of a load. If the slumps differ by more than 1 in. when the average slump is 3 in. or less, or by more than 2 in. when the average slump is greater than 3 in., paving operations may be suspended while the mixing process is jointly reviewed and problems resolved by the Engineer and the Contractor.

501.15

Wash water shall not be used as a portion of the mixing water.

When concrete is delivered in transit mixers, additional water to increase the workability of a load may be added within 45 minutes of initial mixing per the QCP. Any addition of water shall be noted on the batch ticket and shall not occur as a continuing operation.

320 **501.15 Weather Limitations**

PCCP shall be placed when the ambient temperature is 32°F or rising. It shall not be placed on frozen subgrade or subbase.

When the ambient temperature is at or below 40°F during PCCP placement, the cold weather plan shall be followed as outlined in the QCP in accordance with 501.02.

330 Continuous temperature monitoring and recording shall be initiated for the day's production when the ambient temperature is at or below 38°F at any time during placement for that day. Once monitoring has started, it shall continue uninterrupted until the opening to traffic strength, in accordance with 501.23, has been achieved. A record of the temperature monitoring shall be furnished to the Engineer when the opening to traffic strength has been achieved.

Prior to attaining opening to traffic strengths in accordance with 501.23, sufficient means shall be taken to prevent the PCCP from freezing.

501.16 Placing Concrete

340 The batches shall be deposited so as to have a uniform mix and require as little rehandling as possible. The plastic concrete shall not be segregated during placement. Dowel bars and assemblies shall not be displaced during placement of concrete.

Concrete shall be thoroughly consolidated against the faces of all forms or adjacent concrete surfaces. Hand placed concrete shall be thoroughly consolidated with the use of a vibrator. Vibrators shall not operate in any one location so as to bring excessive mortar to the surface and shall not come in contact with a dowel bar assembly, subgrade, subbase, or forms.

350 Concrete shall be placed around manholes or similar structures in accordance with 720.

The Contractor shall be responsible for the protection of the existing joints from the intrusion of fresh concrete mortar, and for any damage to existing pavement caused by the operation of mechanical equipment. Concrete materials that fall on or are worked into the joints or surface tines of an existing slab, shall be removed immediately.

Concrete shall not be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated in

accordance with the QCP.

360

The Contractor shall have available at all times sufficient materials for the protection of unhardened PCCP from the effects of rain. Covering material such as burlap or polyethylene sheeting shall be provided. When rain appears imminent, paving operations shall stop. All available personnel shall be used to cover the PCCP.

501.17 Blank

501.18 Joints

Joints shall be in accordance with 503.

370

501.19 Finishing

PCCP shall be finished in accordance with 504.

501.20 Curing

PCCP shall be cured with an approved white pigmented liquid membrane forming compound. Alternative methods of curing may be approved by the Engineer. Curing shall be in accordance with 504. For formed PCCP, immediately after the forms are removed, the sides of the PCCP shall be cured.

380

501.21 Form Removal

Forms may be removed as soon as the PCCP has hardened sufficiently to prevent edge spalling or other damage. Form pullers shall not be supported on the PCCP during form removal operations.

501.22 Pavement Inspection

The Contractor and the Engineer will conduct an inspection of the new PCCP for any damage, including freezing or random cracks. The inspection and all necessary repairs shall be completed prior to opening the pavement to non-construction traffic. All random, full-depth cracks in the PCCP shall be corrected in accordance with 503.06. All other damage shall be repaired by approved methods.

390

501.23 Opening to Traffic

The Contractor shall be responsible for controlling the opening of the PCCP to construction and non-construction traffic and include the procedures in the QCP. Pavement inspection will be completed in accordance with 501.22.

400

PCCP may be opened to construction vehicles, equipment, and traffic when the flexural strength of the test beams indicates a modulus of rupture of 550 psi or greater. ITM 402 may be used as an alternate method to determine the flexural strength. If adequate strengths are not achieved, an investigation by the Engineer and the Contractor will be conducted to determine if the PCCP is deficient. Resolutions for all deficiencies will be developed at the completion of the investigation. Cracks and joints shall be sealed in accordance with 503.05 and the PCCP cleaned prior to opening to traffic.

501.24 Pavement Corrugations

Pavement corrugations shall be in accordance with 606.

501.25 Pavement Smoothness

410 Pavement smoothness will be accepted by means of a profilograph, a 16 ft long straightedge, or a 10 ft long straightedge as described below.

(a) Profilograph

When a pay item for Profilograph, PCCP is included in the contract, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 912 for the acceptance of longitudinal smoothness on the mainline traveled way and ramps, including adjacent acceleration or deceleration lanes, where both of the following conditions are met:

- 420
1. The design speed is greater than 45 mph.
 2. The traveled way or ramp lane width is constant and is 0.1 mi in length or longer.

The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor.

430 The project area, less paving exceptions and areas exempt from profilograph operation in accordance with ITM 912, will be divided into individual smoothness sections measuring 0.1 mi in length for each lane. Partial length smoothness sections adjacent to project limits, paving exceptions, or areas exempt from profilograph operation will be considered in accordance with ITM 912.

If the posted speed limit for an entire smoothness section is less than or equal to 45 mph, the section will be exempt from profilograph operation and the smoothness within the section will be accepted by a 16 ft straightedge.

If the posted speed limit is greater than 45 mph for a portion of a smoothness section and is less than or equal to 45 mph for the remainder, the section smoothness acceptance will be as follows:

- 440
1. By profilograph for the portion of the section with a posted speed limit greater than 45 mph.
 2. By 16 ft straightedge for the portion of the section with a posted speed limit less than or equal to 45 mph.

At locations where the profilograph is required, all high or low point deviations which are greater than 0.30 in. shall be corrected. Corrections shall be made in accordance with 501.25(c).

450 (b) 16 ft Straightedge and 10 ft Straightedge

The Department will furnish and operate 16 ft and 10 ft straightedges as described

below. The 16 ft straightedge is used to accept smoothness along the direction of mainline traffic and the 10 ft straightedge is used to accept smoothness transverse to the direction of mainline traffic. This includes longitudinal smoothness on public road approaches and median crossovers.

For contracts which include the profilograph, PCCP pay item, the 16 ft long straightedge will be used to accept longitudinal smoothness at the following locations:

- 460
1. All mainline traveled way lanes shorter than 0.1 mi.
 2. All mainline traveled way lanes within smoothness sections with posted speed limits less than or equal to 45 mph throughout the entire section length.
 3. All mainline traveled way lanes at locations exempted from profilograph operation in accordance with ITM 912.
- 470
4. All tapers.
 5. All turn lanes, including bi-directional left turn lanes.
 6. All ramps with design speeds of 45 mph or less.
 7. All acceleration and deceleration lanes associated with ramps with design speeds of 45 mph or less.
 8. All shoulders.

- 480 For contracts where the profilograph is not used for smoothness acceptance, the 16 ft straightedge will be used to accept longitudinal smoothness at the above locations and on all mainline traveled way lanes and ramps with design speeds greater than 45 mph. Smoothness acceptance on ramp acceleration or deceleration lanes will also be accepted by the 16 ft straightedge.

The 10 ft long straightedge shall be used for transverse slopes, approaches, and crossovers.

- 490 As soon as the PCCP has cured sufficiently, the smoothness may be checked. The Department may direct that the pavement profile be evaluated within 24 h following placement. When profile testing is consistently outside pavement surface tolerances the paving operation shall be discontinued until an amended QCP is submitted.

(c) Smoothness Correction

Pavement smoothness variations outside specified tolerances shall be corrected by grinding with a groove type cutter or by replacement. Grinding will not be allowed until the PCCP is 10 days old and flexural strength testing yields a modulus of rupture

501.26

of 550 psi or greater. The grinding of the pavement to correct the profile shall be accomplished in either the longitudinal or the transverse direction. The PCCP texture
500 after grinding shall be uniform. If the grinding operation reduces the tining grooves to a depth of less than 1/16 in. and the longitudinal length of the removal area exceeds 15 ft, or two or more areas are within 30 ft of each other, the PCCP shall be re-textured in accordance with 504.03.

At locations where the profilograph is used, all areas having a high or low point deviation in excess of 0.30 in. shall be corrected. In addition, smoothness sections with a deficient profile index in accordance with 501.28(d) shall be corrected. After the corrective action is complete, the profilograph shall be operated throughout the entire affected smoothness section to verify the adequacy of the corrective action.
510

At locations where the 16 ft straightedge is used, the pavement variations shall be corrected to 1/4 in. or less. At locations where the 10 ft straightedge is used, the pavement variations shall be corrected to 1/8 in. or less.

501.26 Pavement Thickness

PCCP thickness shall be determined after all corrective grinding. The Contractor shall obtain cores at the locations determined by the Engineer in accordance with ITM 802. Cores, 4 in. in diameter, shall be taken in the presence of the Engineer for the full depth of the PCCP. The Engineer will take immediate possession of the cores.
520 Cores shall not be taken within 6 in. of the edge of pavement, within 3 in. of longitudinal joints, within 2 ft of D-1 contraction joints, or within 5 ft of a transverse construction joint. Cores shall be taken and measured in accordance with ITM 404. All core holes shall be filled with PCC or rapid setting patch material within 24 h of drilling.

The width of adjudicated PCCP shall be the width of pavement lane in which the deficiency occurs. Pavement that has been replaced shall be investigated for thickness.

The thickness of the PCCP for each subplot shall be the average lengths of both
530 cores from the subplot. Calculations shall be to the nearest 0.1 in.

501.27 Tolerance

Plastic unit weight, water/cementitious ratio, modulus of rupture, and air content measurements will be performed during PCCP operations.

(a) Plastic Unit Weight

Sublots shall not vary by more than $\pm 3.0\%$ from the target unit weight. A stop paving order will be issued if the plastic unit weight exceeds $\pm 3.0\%$ from the target plastic unit weight. Paving operations shall not resume until satisfactory changes are made or an alternate CMDP is used.
540

Calculations for the plastic unit in lb/cu yd will be made and reported to the nearest figure in the tenth.

(b) Water to Cementitious Ratio

The weekly water to total cementitious materials ratio shall not vary more than ± 0.030 of the target value or exceed the maximum allowed for the appropriate mixture in accordance with 501.05. A stop paving order will be issued if the test results exceed these values. Paving operations shall not resume until satisfactory changes are made or an alternate CMDP is used.

Calculations for water to cementitious ratio will be made and reported to the nearest figure in the third decimal place.

(c) Flexural Strength

Average lot values for modulus of rupture of 570 psi and above shall be achieved. Price adjustments for values outside the tolerance limits will be in accordance with 501.28.

Calculations for modulus of rupture in psi will be made and reported to the nearest 5.0 psi.

(d) Air Content

The average lot air content values shall not vary more than - 1.2% to + 2.2% from the 7.0% target air content. The range of subplot air content values shall not exceed 2.5%. Price adjustments for values outside the tolerance limits or range will be in accordance with 501.28.

Calculations for air content percentage will be made and reported to the nearest figure in the first decimal place.

501.28 Pay Factors

When the PCCP measurements for air content, air content range, modulus of rupture, smoothness, and thickness exceed the allowable tolerances, pay factors will be determined. The pay factors will be used to calculate a quality assurance adjustment quantity for the lot.

The adjustment for modulus of rupture, air content, air content range, thickness, and smoothness will be calculated as follows:

580

$$q = L \times U \times (P - 1.00)$$

where:

q = quality assurance adjustment quantity

L = lot quantity

U = unit price for QC/QA-PCCP, \$/sq yd

P = pay factor.

For subplot thickness determination:

$$q_T = l_T \times U \times (P - 1.00)$$

where:

q_T = quality assurance adjustment quantity
 I_T = subplot quantity for thickness
 U = unit price for QC/QA-PCCP, \$/sq yd
 P = pay factor.

590 The quality assurance adjustment points for smoothness, Q_s , will be calculated in accordance with 501.28(d).

The total quality assurance adjustments will be calculated as follows:

$$Q_T = \Sigma (q_{T1} + q_{T2} + q_{T3}), \text{ and}$$

$$Q = \Sigma (q_F + q_A + q_R + Q_T) + Q_s$$

where:

Q = total quality assurance adjustment quantity
 Q_s = quality assurance adjustment for smoothness
 q_F = lot quality assurance adjustments for modulus of rupture from flexural strength testing
 Q_T = lot quality assurance adjustments for thickness
 q_A = lot quality assurance adjustments for air content
 q_R = lot quality assurance adjustments for range.

600 If the Contractor is not required to remove the pavement or take other corrective actions, quality assurance adjustments of the lot will be assessed as determined by the Department's Division of Materials and Tests.

(a) Modulus of Rupture

When test results for modulus of rupture from flexural strength testing exceed the allowable tolerance, a pay factor will be assessed as follows:

1. Lots

Lot Average Modulus of Rupture	
Psi	Pay Factors
570 and above	1.00
565 – 569	0.98
560 – 564	0.96
555 – 559	0.94
550 – 554	0.92
545 – 549	0.89
540 – 544	0.86
535 – 539	0.83
525 – 534	0.78
515 – 524	0.72
514 or less	*

* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

2. Sublots

610 If an individual subplot value is less than 500 psi, the PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. For a subplot completely removed, the subplot test value from the replacement subplot will replace the original test value.

(b) Air Content

When test results for air content exceed the allowable tolerance or range, a pay factor will be assessed as follows:

1. Lots

Lot Average Air Content	
Percent, %	Pay Factors
> 9.8	*
9.7 – 9.8	0.85
9.5 – 9.6	0.95
9.3 – 9.4	0.99
5.8 – 9.2	1.00
5.7	0.93
5.6	0.90
5.5	0.85
5.4	0.79
< 5.4	*
* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.	

Lot Range for Air Content	
Percent, %	Pay Factors
0.0 – 2.5	1.00
2.6 – 3.0	0.99
3.1 – 3.5	0.97
> 3.5	*
* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.	

620

2. Sublots

If a subplot value is less than 5.5% or greater than 10.0%, the PCCP will be adjudicated as a failed material in accordance with normal Department practice in accordance with 105.03. For a subplot completely removed, the subplot test value from the replacement subplot will replace the original test value.

(c) Thickness

When test results for pavement thickness do not meet the specified thickness, a pay factor will be assessed as follows:

630

Sublot Pay Factors for Thickness	
Average core depth, ACD Design depth, DD	
ACD minus DD	Pay Factor
> +0.5 in.	1.05
+0.3 in. to +0.5 in.	1.02
±0.2 in.	1.00
-0.3 in. to -0.5 in.	0.96
-0.6 in. to -0.7 in.	0.90
-0.8 in. to -1.0 in.	0.80
< -1.00 in.	*
* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.	

(d) Smoothness

When the pavement smoothness is tested with a profilograph, pavement will be based on a zero blanking band on the final profile index. A Quality Assurance Pay Factor, PF_s, for smoothness will apply to the planned thickness of the PCCP. The quality assurance adjustment for each section will include the total area of each pavement lane measured by the profilograph for 0.1 mi long section represented by the profile index calculated by the following formula:

640

$$q_s = (PF_s - 1.00) \times A \times U$$

where:

- q_s = quality assurance adjustment for smoothness for one section
- PF_s = pay factor for smoothness
- A = area of the section, sq yd
- U = unit price for the material \$/sq yd.

For smoothness sections that are less than 0.1 mi in length or require profilograph operation along both lane edges, the profile index used to obtain the smoothness pay factor used in the above formula will be determined in accordance with ITM 912.

The quality assurance adjustment for smoothness, Q_s, for the contract will be the total of the quality assurance adjustments for smoothness, q_s, on each section by the following formula:

650

$$Q_s = \sum q_s$$

Regardless of the tabulated value, the maximum pay factor for a smoothness section where corrective action has been performed will be 1.00.

Pay Factors for Smoothness (PI _{0.0}) Zero Blanking Band	
Design Speed greater than 45 mph	
Profile Index, in./0.1 mi.	Pay Factor, PFs
over 0.00 to 1.40	1.06
over 1.40 to 1.60	1.05
over 1.60 to 1.80	1.04
over 1.80 to 2.00	1.03
over 2.00 to 2.40	1.02
over 2.40 to 2.80	1.01
over 2.80 to 3.60	1.00
over 3.60 to 3.80	0.96
All pavements with a Profile Index, PI _{0.0} , greater than 3.80 in. shall be corrected to a profile index less than or equal to 3.80 in.	

501.29 Appeals

660 If the Contractor does not agree with the acceptance test results, a request may be made in writing for additional tests for a subplot or lot. The basis of the appeal shall include applicable QC test results showing acceptable quality results and shall be submitted within five calendar days of receipt of the Department's written results for that lot. Upon review of the appeal, the Engineer may accept the PCCP in accordance with 105.03 or accept the appeal.

(a) Modulus of Rupture

670 Appeals will not be considered unless QC test results for modulus of rupture obtained from flexural strength testing indicate greater than a 50 psi difference between the Department's and the Contractor's test results. Upon approval for the additional testing, the Contractor shall obtain cores, as directed, in the presence of the Engineer.

680 The Engineer will determine the location of the cores within the appealed and adjacent sublots using the same CMD. The location of the cores will be at the center of a lane at the acceptance sample location. Cores shall not be taken over dowels or within 5 ft of a header. Two cores shall be taken in each subplot for the full depth of pavement and shall be 4 in. in diameter. All core holes shall be filled with portland cement concrete within 24 h of drilling. If adjacent sublots were produced using different CMDs, the matter will be adjudicated as a failed material in accordance with normal Department practice.

Each core will be tested for split tensile strength in accordance with ASTM C496. The cores will be submerged in lime saturated water prior to testing for a minimum of 40 h.

The average core split tensile strength will be determined for the appealed and adjacent sublots. Modulus of rupture will be calculated as follows:

$$F_D = S_D \times \left[\frac{F_{A1}}{2S_{A1}} + \frac{F_{A2}}{2S_{A2}} \right]$$

690

where:

- F_D = modulus of rupture of the appealed subplot
- F_{A1} = modulus of rupture of the previous adjacent subplot
- F_{A2} = modulus of rupture of the subsequent adjacent subplot
- S_D = split tensile strength of the appealed subplot
- S_{A1} = split tensile strength of the previous adjacent subplot
- S_{A2} = split tensile strength of the subsequent adjacent subplot.

(b) Air Content

Appeals will not be considered unless QC test results indicate greater than a 0.5% difference between the Department's and the Contractor's tests. Upon approval for the additional testing, the Contractor shall obtain core as directed in the presence of the Engineer.

700 The Engineer will determine the location of the core within the appealed subplot. The location of the core will be at the center of a lane at the acceptance sample location. A core shall not be taken over dowels or within 5 ft of a header. One 4 in. diameter full depth core shall be taken from the pavement for each subplot appealed. All core holes shall be filled with PCC or rapid setting patch material within 24 h of drilling.

The air content for a subplot will be the hardened concrete air content determined from the core in accordance with ITM 401. When ACBF aggregates are used, the hardened concrete air content will be determined in accordance with ASTM C457.

501.30 Method of Measurement

710 QC/QA-PCCP will be measured by the square yard of the thickness specified. The area of QC/QA-PCCP will be the planned width of the pavement multiplied by the length of the pavement, or as directed in writing. The width of the pavement will be as shown on the typical cross section of the plans. The length of the pavement will be measured parallel to the surface of the pavement along the centerline of the roadway or ramp, excluding paving exceptions as shown on the plans.

Milled pavement corrugations will be measured in accordance with 606.02.

501.31 Basis of Payment

720 The accepted quantities of QC/QA-PCCP will be paid for at the contract unit price per square yard for the thickness specified, complete in place.

Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made at the contract lump sum price for profilograph, PCCP.

SECTION 502 – PORTLAND CEMENT CONCRETE PAVEMENT, PCCP

502.01 Description

This work shall consist of portland cement concrete pavement, PCCP, placed on a prepared subgrade or subbase in accordance with 105.03.

MATERIALS

502.02 Materials

10 Materials shall be in accordance with the following:

	Admixtures	912.03
	Concrete Coarse Aggregate, Class AP	904.03, ITM 226
	Fine Aggregate, Size No. 23.....	904.02
	Fly Ash	901.02
	Portland Cement	901.01(b)
	Rapid Setting Patch Materials	901.07
	Silica Fume.....	901.04
	Slag Cement	901.03
20	Water	913.01

502.03 Concrete Mix Design

A concrete mix design submittal, CMDS, shall be in accordance with 502.04. The CMDS shall be submitted to the DTE. The CMDS shall be submitted a minimum of seven calendar days prior to production. The CMDS shall use the Department provided spreadsheet and shall include the following:

- 30
- (a) a list of all ingredients
 - (b) the source of all materials
 - (c) the fine to total aggregate ratio
 - (d) the absorption of the aggregates
 - (e) the SSD bulk specific gravity of the aggregates
 - (f) the specific gravity of pozzolan
 - (g) the batch weights
 - (h) the names of all admixtures
 - (i) the admixture dosage rates and the manufacturer's recommended range.

40 The aggregate blend submitted on the CMDS shall produce an optimized aggregate gradation in accordance with ITM 226 sections 6.2.1 and 6.3. The aggregate blend shall consist of, at a minimum, one Concrete Coarse Aggregate and one fine aggregate, No. 23. One additional class A or higher intermediate-sized coarse aggregate may be included if approved by the Engineer.

The absolute volume of the mix design shall be 27.0 cu ft at the design air content of 6.5%.

50 Production shall not commence until the DTE has assigned a mix number to the CMDS. The mix design will henceforth be identified as a concrete mix design for production, CMDP.

Any of the following changes or adjustments to an existing CMDP shall require a new CMDS to be submitted to the DTE.

- 60
- (a) cement source or type
 - (b) pozzolan source or type
 - (c) aggregate source or type
 - (d) admixture source or type
 - (e) addition or deletion of an admixture
 - (f) proportioning of the concrete in accordance with 502.04 as follows:
 - 1. cement content or cement reduction
 - 2. pozzolan to cement substitution ratio
 - 3. target water/cementitious ratio
 - 4. proportion of aggregate by weight exceeding $\pm 2\%$.

70 A CMDP in accordance with 501.05 or a CMDP in accordance with 502.04 from a previous contract may be submitted for review for use on the current contract to the DTE. The DTE will notify the Contractor when the review is complete and whether or not the previously used CMDP can be used on the current contract.

502.04 Concrete Mix Criteria

Chemical admixtures type A, type B, type C, type D, type E, and type F may be allowed if shown on the CMDP. The supplied concrete mix shall include one of the following water reducing admixtures: type A, type D, type E, or type F.

(a) Portland Cement Concrete

80 The CMD shall produce workable concrete mixtures, with the minimum amount of water, and having the following properties.

Targets for the CMD:

	Portland cement content	564 lb/cu yd ^A
	Maximum portland cement content.....	752 lb/cu yd ^A
	Minimum water/cementitious ratio	0.340 ^B
	Maximum water/cementitious ratio	0.435 ^B
	Maximum portland cement reduction	
	for slag cement replacement.....	30%
90	Slag cement/portland cement substitution ratio.....	1.00 by weight
	Maximum cement reduction for fly ash replacement	20%
	Fly ash/portland cement substitution ratio.....	1.25 by weight
	Air Content	6.5%

502.05

Minimum modulus of rupture..... 570 psi at 7 days^C
Relative Yield..... 1.00

Field Acceptance Properties:

100 Minimum water/cementitious ratio 0.320^B
Maximum water/cementitious ratio..... 0.450^B
Slump 2 to 6 in.
Air Content..... 5.0% to 8.0%
Minimum modulus of rupture..... 570 psi at 7 days^C
Relative Yield..... 0.98 to 1.02

^A The target cement content during production shall not be adjusted from the value stated on the CMDP.

110 ^B The water cementitious ratio during production shall not deviate more than 0.020 from the target stated in the CMDP and shall not fall outside the limits above.

^C Beams shall be standard cured in a water tank in accordance with AASHTO T 23 and 505.01(a). The water does not need to be saturated with calcium hydroxide. Minimum flexural strength for opening to traffic shall be in accordance with 506.12.

Class C concrete in accordance with 702 using Class AP coarse aggregate may be substituted in PCCP.

120

Blended portland pozzolan cements, fly ash, or slag cement may only be incorporated in the concrete mix when the ambient temperature is above 50°F during the entire placement period. If type IP, type IP-A, type IS or type IS-A cements are to be used, the minimum portland cement content shall be increased to 598 lb/cu yd. The use of fly ash or slag cement will not be allowed when blended cement types IP, IP-A, IS, or IS-A are used.

(b) High-Early Strength Concrete

Patching concrete in accordance with 506.04(b) shall be used.

130

502.05 Job Control

Control of PCCP for air content, slump, or relative yield will be determined on the basis of tests performed by the Engineer in accordance with 505. Concrete and necessary labor for sampling shall be furnished as required by the Engineer. Testing will be in accordance with the Frequency Manual.

140 The Engineer will notify the Contractor when test results for air content, slump, or relative yield are outside the requirements of 502.04. Rounding will be in accordance with 109.01(a). The Contractor shall adjust the mixture such that it is in accordance with 502.04.

CONSTRUCTION REQUIREMENTS

502.06 General

Equipment for PCCP shall be in accordance with 508.

150 Aggregate stockpiles shall be located in well drained areas to prevent the soil from pumping into and contaminating the aggregate that is to be used in PCCP. Stockpiles shall be built in layers not to exceed 6 ft. Upper layers shall be prevented from spilling onto the lower layers.

Aggregate stockpiles shall be worked to minimize segregation and maintain uniform moisture content. Aggregates which have become contaminated shall not be used.

The water measuring device will be checked under actual working conditions or at any other time deemed necessary. All labor and equipment required for calibrating and checking shall be furnished.

160 The volume of the batched concrete shall not exceed the manufacturer's standard rating for the concrete mixer.

502.07 Preparation of Grade

The subgrade shall be shaped to the required grade and section, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

502.08 Preparation of Subbase

170 Subbase, if required, shall be placed and shaped to the required grade and section in accordance with 302. Construction traffic shall not be allowed on the aggregate drainage layer of the subbase, except where PCCP placement is restricted. Exceptions shall be submitted for approval.

502.09 Placement

Placement of PCCP shall be by the slipformed or formed methods with equipment specified in 508.04. The subgrade or subbase shall be uniformly moist at the time of PCCP placement. Excessively dry subgrade or subbase shall be sprinkled with water.

180 If the slip-form method is used the subgrade or subbase shall firmly support the paving equipment to construct the specified alignment and grade. The slip-form paver shall be operated with as nearly a continuous forward movement as possible. If it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped. Edge slump of PCCP shall not exceed 1/4 in.

When the slip-form method is used, the Contractor shall have metal or wood forms available for protection of the PCCP edges should excessive edge slump occur.

190 If forms are used they shall be firmly supported by the subbase or subgrade for the entire length of the form at the specified alignment and grade. The alignment of the forms shall not deviate more than 1/4 in. in the horizontal direction from the planned PCCP width for tangent sections.

Forms shall be staked into place with a minimum of three pins for each 10 ft section. A pin shall be placed at each side of every joint. Form sections shall be locked tightly and be free from play or movement in any direction. No excessive settlement or springing of forms under the finishing machine will be allowed. Forms shall be cleaned and oiled prior to the placing of concrete.

200 Forms shall be kept a minimum of 500 ft ahead of concrete placement when distance allows. Any material displaced during form setting operations shall be thoroughly compacted. If material under the forms becomes unstable before concrete is placed, the forms shall be removed, the grade corrected, and the forms reset.

502.10 Concrete Mixing and Transportation

210 Concrete mixing and transportation shall be completed by central mixed, shrink mixed, or transit mixed methods. The minimum batch of concrete shall be 2 cu yds. When the concrete temperature is 90°F or above, discharge from non-agitating equipment shall be completed within 30 minutes of mixing the water, cement, and aggregates. For concrete temperature below 90°F, discharge from non-agitating equipment shall be completed within 45 minutes of mixing the water, cement, and aggregates. The concrete temperature will be measured in accordance with ASTM C1064 at the point of delivery. Discharge from a truck agitator or a truck mixer shall be completed within 90 minutes of mixing the water, cement, and aggregates.

220 Concrete shall be uniformly mixed when delivered to the job site. Batch tickets for each load of PCC shall indicate the weight of cement, pozzolan, and aggregates, volume or weight of water, and the type and volume of admixtures. The weight of the cement shall be within 1% of the CMDP, the saturated surface dry weight of the aggregates shall be within 2% of the CMDP, and the volume or weight of water shall be within 1% of the required amount.

230 The Engineer may conduct additional testing to verify uniformity of the mixture. Additional testing will consist of slump tests taken in accordance with AASHTO T 119 at approximately the 1/4 and 3/4 points of a load. If the slumps differ by more than 1 in. when the average slump is 3 in. or less, or by more than 2 in. when the average slump is greater than 3 in., paving operations may be suspended while the mixing process is jointly reviewed and problems resolved by the Engineer and the Contractor.

Wash water shall not be used as a portion of the mixing water.

When concrete is delivered in transit mixers, additional water to increase the

workability of a load may be added within 45 minutes of initial mixing. Any addition of water shall be noted on the batch ticket and shall not occur as a continuing operation.

Stationary mixers shall be operated at the manufacturer's recommended drum speed. Batches shall not exceed the nominal capacity of the mixer.

240 **(a) Central Mixed Concrete**

Central mixed concrete shall be completely mixed in a stationary mixer and transported in a truck agitator, truck mixer at agitating speed, or non-agitating equipment.

Mixing for central mixed concrete shall be no less than 60 s per batch. The mixing time shall be measured from the time all cement and aggregates are in the drum. The batch shall be so discharged into the mixer that some of the water enters in advance of the cement and aggregates. All required water shall be in the drum by the end of the first quarter of the specified mixing time.

250

If a truck mixer or truck agitator is used for transportation, the concrete shall be agitated at the agitation speed designated by the manufacturer.

(b) Shrink Mixed Concrete

Shrink mixed concrete shall be partially mixed in a stationary mixer and the mixing completed at the plant in a truck mixer.

The time in a stationary mixer for shrink mixed concrete may be reduced to approximately 30 s. Mixing shall then be completed in a truck mixer at the plant by 50 to 100 revolutions of the drum at the mixing speed designated by the manufacturer. Agitation during transportation shall be at the agitation speed designated by the manufacturer.

260

(c) Transit Mixed Concrete

Transit mixed concrete shall be completely mixed and transported in a truck mixer.

Mixing for a truck mixer loaded to rated capacity shall be 70 to 100 revolutions of the drum at the mixing speed, but not less than the number of revolutions recommended by the manufacturer. Discharge shall be completed prior to 300 revolutions of the drum.

270

502.11 Weather Limitations

PCCP shall not be placed on a frozen subgrade or subbase. PCCP operations shall not begin until the ambient temperature is 35°F and rising. PCCP operations shall be discontinued when the ambient temperature is descending and is 40°F or below. PCCP operations may occur outside these temperatures when authorized in writing. Regardless of placement temperature, sufficient means shall be taken to prevent the PCCP from freezing prior to attaining opening to traffic strengths in accordance with

502.12

280 502.18. Any PCCP damaged by freezing shall be removed and replaced.

When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and prevent the occurrence of overheated areas which might damage the materials. Unless authorized, the temperature of the mixed concrete shall not be less than 50°F and not more than 80°F at the time of placement.

290 When the water or the aggregates are heated, they shall be a minimum of 70°F or a maximum of 150°F. When either aggregates or water are heated to above 100°F, they shall be combined in the mixer before the cement is added.

502.12 Placing Concrete

The batches shall be deposited so as to have a uniform mix and require as little rehandling as possible. The plastic concrete shall not be segregated during placement. Rakes shall not be used to handle plastic concrete. Dowel bars and assemblies shall not be displaced during placement of concrete. Plastic concrete shall not be contaminated with earth or other foreign matter.

300 Concrete shall be thoroughly consolidated against the faces of all forms or adjacent concrete surfaces. Hand placed concrete shall be thoroughly consolidated with the use of a vibrator. Vibrators shall not operate in any one location so as to bring excessive mortar to the surface and shall not come in contact with a dowel bar assembly, subgrade, subbase, or forms.

Concrete shall be placed around manholes or similar structures in accordance with 720.

310 The Contractor shall be responsible for the protection of the existing joints from the intrusion of fresh concrete mortar and for all damage to existing pavement caused by the operation of mechanical equipment. Concrete materials that fall on or are worked into the joints or surface tines of an existing slab shall be removed immediately.

Concrete shall not be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

320 The Contractor shall have available at all times sufficient materials for the protection of unhardened PCCP from the effects of rain. Covering material such as burlap or polyethylene sheeting shall be provided. When rain appears imminent, paving operations shall stop. All available personnel shall be used to cover the PCCP.

502.13 Joints

Joints shall be in accordance with 503.

502.14 Finishing

PCCP shall be finished in accordance with 504.

502.15 Curing

330 PCCP shall be cured with an approved white pigmented liquid membrane forming compound. Alternative methods of curing may be approved by the Engineer. Curing shall be in accordance with 504. For formed PCCP, immediately after the forms are removed, the sides of the PCCP shall be cured.

502.16 Form Removal

Forms may be removed as soon as the PCCP has hardened sufficiently to prevent edge spalling or other damage. Form pullers shall not be supported on the PCCP during form removal operations.

502.17 Pavement Inspection

340 The Contractor and the Engineer will conduct an inspection of the new PCCP for any damage, including freezing or random cracks. The inspection and all necessary repairs shall be completed prior to opening the pavement to non-construction traffic. All random, full-depth cracks in the PCCP shall be corrected in accordance with 503.06. All other damages shall be repaired by approved methods.

502.18 Opening to Traffic

350 PCCP may be opened to equipment and traffic when the flexural strength of the test beams indicates a modulus of rupture of 550 psi or greater. ITM 402 may be used as an alternate method to determine the flexural strength. If adequate strengths are not achieved, an investigation by the Engineer and the Contractor will be conducted to determine if the PCCP is deficient. Resolutions for all deficiencies will be developed at the completion of the investigation. Prior to opening to traffic, cracks and joints shall be sealed in accordance with 503.05 and the PCCP shall be cleaned.

502.19 Pavement Corrugations

Pavement corrugations shall be in accordance with 606.

502.20 Pavement Smoothness

360 Pavement smoothness will be in accordance with 501.25 except profilograph requirements will not apply.

502.21 Pavement Thickness

370 PCCP thickness shall be determined after all corrective grinding. The Contractor shall obtain cores at the locations determined by the Engineer in accordance with ITM 802. Cores, 4 in. in diameter, shall be taken in the presence of the Engineer for the full depth of the PCCP. The Engineer will take immediate possession of the cores. Cores shall not be taken within 2 ft of the edge of PCCP, over dowels, or within 5 ft of a transverse construction joint. Cores shall be taken and measured in accordance with ITM 404. All core holes shall be filled with PCC or rapid setting patch material within 24 h of drilling.

If a core measurement reveals that the pavement is more than 1/2 in. deficient in

thickness, additional cores shall be drilled at 20 ft intervals on each side of the original core. These additional cores shall be on a line which passes through the original core and parallel to the centerline of the pavement. The drilling shall continue in both directions at 20 ft intervals until two successive cores indicate a thickness deficiency of 1/2 in. or less, or where cores can no longer be drilled in the new PCCP.

380 If a core indicates a thickness deficiency of more than 1 in. and two cores drilled adjacent at 20 ft intervals indicate a thickness deficiency of not more than 1 in., additional cores shall be drilled at 5 ft intervals on each side of the initial core. The drilling shall continue in both directions at 20 ft intervals until two successive cores indicate a thickness deficiency of 1/2 in. or less, or where cores can no longer be drilled in the new PCCP.

390 When a single core indicates a thickness deficiency of more than 1 in., or if two or more adjacent cores indicate a thickness deficiency of more than 1/2 in., the investigation will be expanded to include adjoining PCCP. The additional cores shall be taken from the adjoining traffic lanes or shoulders at the same station at which the first core or cores indicated the deficiency, whether the lane was paved at the same time or not.

The width of adjudicated PCCP shall be the width of pavement lane in which the deficiency occurs. Pavement that has been replaced shall be investigated for thickness.

(a) Sections

400 The quantity of PCCP for each pay item will be defined as a section. The section will be divided into subsections of 1,200 sq yds. Sections less than 1,200 sq yds shall not be cored. A minimum of one core shall be drilled at a random location within each subsection. A section greater than or equal to 1,200 sq yds shall have a minimum of four cores drilled. Partial subsections shall not be cored unless otherwise directed. Widening of 3 ft or less shall not be cored unless otherwise directed.

Formed drives shall not be cored unless otherwise directed. Verification of the required pavement depth on formed drives shall be checked in the presence of the Engineer prior to pouring, by making stringline measurements every 10 ft across the width of the drive. Any location deficient in thickness by 1/4 in. or more shall be corrected prior to placing PCCP.

410 **(b) Average PCCP Thickness**

The thickness of the PCCP for each section shall be the average lengths of all cores from the section. However, no cores shall be included from areas for which no payment will be made. Where PCCP has been removed and replaced the initial core lengths will be discarded and the core lengths of the replaced PCCP will be substituted. Any core measurements exceeding the specified PCCP thickness by more than 1/2 in. will be recorded as the specified PCCP thickness plus 1/2 in. Calculations shall be to the nearest 0.1 in.

(c) PCCP Adjusted Payment

420 If the average PCCP thickness is equal to or greater than the specified thickness, no adjustments will be made. If an average PCCP thickness is less than the specified thickness by up to 1/2 in., payment for that section will be adjusted in accordance with the following:

$$Q_T = Q \times U \times (1 - M^2/S^2)$$

where:

Q_T = quality assurance assessment for thickness

Q = placed quantity of the PCCP section

M = average PCCP thickness of the section

S = specified PCCP thickness of the section

U = unit bid price.

430 **(d) PCCP Non-Payment**

Where two adjacent cores indicate a thickness deficiency of more than 1/2 in., no payment will be made unless the PCCP is removed and replaced. Payment for PCCP with non-adjacent cores indicating a thickness deficiency of more than 1/2 in. will be in accordance with 502.21(c).

The limits of non-payment shall extend from deficient core to the transverse joint location nearest the first additional core indicating a thickness deficiency of less than 1/2 in.

440 **(e) PCCP Removal**

Where two adjacent cores indicate a thickness deficiency of more than 1 in. the PCCP shall be removed and replaced. Non-adjacent cores indicating a thickness deficiency of more than 1 in. do not require removal and replacement.

The limits of removal and replacement shall extend from the deficient core to the transverse joint location nearest the first additional core indicating a thickness deficiency of less than 1/2 in.

502.22 Method of Measurement

450 PCCP will be measured by the square yard of the thickness specified. The area of PCCP will be the planned width of the pavement multiplied by the length of the pavement, or as directed in writing. The width of the pavement will be as shown on the typical cross section of the plans. The length of the pavement will be measured parallel to the surface of the pavement along the centerline of the roadway or ramp, excluding paving exceptions as shown on the plans.

Milled pavement corrugations will be measured in accordance with 606.04.

SECTION 503 – PCCP JOINTS

503.01 Description

This work shall consist of the construction of joints in PCC pavements, placing dowel bar assemblies and joint sealing operations in accordance with 105.03.

MATERIALS

503.02 Materials

10 Materials shall be in accordance with the following:

	Chemical Anchor System	901.05
	Concrete, Class A	702
	Dowel Bars	910.01(b)10
	Epoxy Coated Reinforcing Bars	910.01(b)9
	Hot Poured Joint Sealant	906.02(a)2
	Joint Filler.....	906.01
	Joint Materials	906
	PCC Sealer/Healers	901.06
20	Reinforcing Bars.....	910.01
	Support Devices	910.01(b)9
	Threaded Tie Bar Assembly.....	910.01(b)2

Tie bars shall be epoxy coated reinforcing bars.

Bent tie bars shall be deformed billet steel in accordance with 910.01 and ASTM A615, grade 40.

30 The epoxy coating on the bent and straight tie bars shall be protected in accordance with 703.04.

CONSTRUCTION REQUIREMENTS

503.03 Joints

Joints shall be constructed in accordance with the type and dimensions and at the locations shown on the plans or as directed. All joints shall be perpendicular to the subgrade.

40 Longitudinal joints shall be parallel to the centerline. The longitudinal joint shall not deviate from the true line shown on the plans by more than 1/4 in. Transverse joints shall be at right angles to the centerline and be continuous for the full width of the pavement.

All joints shall be cut to the required dimensions and sealed. All sawed joints shall be made by sawing equipment in accordance with 508.07 and shall be in accordance with the following.

(a) Type D-1 Contraction Joint

50 Type D-1 contraction joints shall be created by sawing slots in the pavement unless alternative methods are approved. The sawed contraction joint spacing shall be as shown on the plans or as directed, but shall not exceed 18 ft.

The saw cut shall commence as soon as the concrete has hardened sufficiently to enable sawing without raveling, usually 2 to 12 h after placement. All joints shall be saw cut through the edges of the pavement to the required depth before uncontrolled shrinkage cracking takes place. The sawing operations shall be carried on during day and night, regardless of weather conditions. The sawing of a joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued if a crack develops ahead of the saw. Formed contraction joints may be
60 used where conditions make sawing impractical.

The width of the saw cut will be measured for specification compliance at the time of the sawing operations. Slurry or saw residue remaining in the slot shall be immediately flushed with water. Construction traffic shall not be allowed on the PCCP after the saw cut until the joint is sealed.

The sawed slot shall be cleaned to remove all foreign matter from the entire depth of cut. Joint sealing shall be in accordance with 503.05.

70 (b) Longitudinal Joint

Longitudinal joints shall be created by sawing slots in the pavement unless alternative methods are approved. The longitudinal joint spacing shall be as shown on the plans or as directed, but shall not exceed 14 ft. Tie bars shall be placed by mechanical equipment in accordance with 508.04(a), or rigidly secured in place.

Longitudinal joints shall be cut to the depth, width, and line shown on the plans. The longitudinal joint slots shall be sawed concurrently with the D-1 contraction joint slots. If random cracking occurs ahead of sawing, the sawing operations shall be discontinued in that area. The sawed joint shall be cleaned as specified in 503.03(a).
80 Joint sealing shall be in accordance with 503.05.

Longitudinal joints may be replaced with longitudinal construction joints when approved by the Engineer.

(c) Transverse Construction Joints

90 Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the PCCP placement operations. A transverse construction joint located at a D-1 contraction joint shall be in accordance with 503.03(a), except the initial saw cut shall be omitted. All other transverse construction joints shall be located at least 6 ft from an adjacent D-1 contraction joint.

Tie bars for transverse construction joints may be placed in the plastic or hardened concrete. A header board with openings for tie bars shall be used when placing tie bars

in plastic concrete. The header board shall be rigid and accurately set to grade. Tie bars placed in hardened concrete shall be retrofitted in accordance with 503.03(g).

(d) Longitudinal Construction Joint

The longitudinal construction joint spacing shall be as shown on the plans or as approved. Tie bars shall be placed by mechanical equipment in accordance with 100 508.04(a) or other approved methods. Longitudinal construction joint saw cuts may be made as soon as the PCCP has sufficiently hardened.

Longitudinal construction joints shall be cut to the depth, width, and line shown on the plans. Construction traffic shall not be allowed on the PCCP after the saw cuts are made until the joints are sealed. Joint sealing shall be in accordance with 503.05.

Bent tie bar spacing shall be adjusted to prevent interference with the D-1 contraction joints. Bent tie bars shall not be omitted. Bent tie bars shall be replaced with retrofitted tie bars when more than one tie bar breaks within 30 ft during 110 straightening.

The longitudinal construction joint for shoulder widths 4 ft or less may be replaced by a longitudinal joint with tie bars. If the construction joint is eliminated, the mainline and shoulder shall be constructed at the same time.

(e) Terminal Joints

A terminal joint of the type specified shall be constructed at the locations as shown on the plans. The embankment shall be shaped to the required grade and section, free from all ruts, corrugations, or other irregularities, and uniformly compacted and 120 approved in accordance with 203. The embankment shall be furnished within a tolerance of 1/2 in. from the grade as shown on the plans. The subgrade shall be prepared as shown on the plans and in accordance with 207. The sleeper slab shall be placed on top of the prepared subgrade.

1. Terminal Joint, Type PCCP

Terminal joint, type PCCP, shall consist of a sleeper slab, polyethylene bond breaker, pre-compressed foam joint, and jointed reinforced concrete pavement, JRCP, transition slabs. The polyethylene bond breaker shall be an approved polyethylene 130 sheeting having a thickness of 6 mils or greater. The portion of the sleeper slab on which the polyethylene bond breaker is to be placed shall be finished to a smooth trowel finish. The pre-compressed foam joint shall be in accordance with 724 and as shown on the plans. The concrete and placement for JRCP transition slabs shall be in accordance with 502 and as shown on the plans. Steel reinforcement shall be epoxy coated and placed in accordance with 703. The metal chairs, spacers, clips, wire, or other mechanical means used for fastening or holding reinforcement in place shall be epoxy coated.

2. Terminal Joint, Type HMA

Terminal joint, type HMA, shall consist of a sleeper slab, concrete lug,

- 140 polyethylene bond breaker, and pre-compressed foam joint. The polyethylene bond breaker shall be an approved polyethylene sheeting having a thickness of 6 mils or greater. The portion of the sleeper slab on which the polyethylene bond breaker is to be placed shall be finished to a smooth trowel finish. A type A construction joint shall be constructed as shown on the plans. The pre-compressed foam joint shall be in accordance with 724 and as shown on the plans.

The saw cut shall be sealed with hot poured joint sealant in accordance with 906.02(a)2.

150 **(f) Expansion Joints**

Expansion joints shall be constructed at the locations shown on the plans and shall consist of joint filler.

The joint filler shall be shaped to the subgrade, parallel to the surface, and be full width of the pavement. Damaged or repaired joint filler shall not be used.

- 160 The joint filler shall be held in a position which is normal to the surface. Finished joints shall deviate no more than 1/4 in. in the horizontal alignment from a straight line. There shall be no offsets between adjacent sections when the joint filler consists of more than one section. No plugs of concrete shall be within the expansion joint.

(g) Retrofitted Tie Bars

- 170 Retrofitted tie bars shall be secured at right angles to the pavement with a chemical anchor system in accordance with the manufacturer's recommendation. The chemical anchor system shall be injected to the back of the hole to eliminate air pockets prior to inserting the bar. The quantity of material injected shall be sufficient to disperse the material along the entire length of the bar and completely fill the annular space. After the anchor system has been injected, the bar shall be fully inserted using a back-and-forth twisting motion, leaving the proper length exposed. If it is necessary to use a hammer to seat the bar, the exposed end shall be protected with a wood block.

When a capsule type chemical anchor system is used, the capsules shall be conditioned as per the manufacturer's installation instructions, if required, and placed at the back of the hole. The number of capsules shall be sufficient to disperse the material along the entire length of the bar and completely fill the annular space. After the capsules have been placed the bar shall be fully inserted in accordance with the manufacturer's installation instructions.

(h) Expansion Joint with Load Transfer

- 180 Expansion joints with load transfer shall be constructed at the locations shown on the plans. The joint shall be an assembly of dowel bars, expansion caps, and joint filler components as shown on the plans. The components shall be supported by an approved welded wire assembly which holds the components rigid and in proper alignment during placement of the concrete.

Damaged or repaired joint filler shall not be used. The joint filler shall be held in a position which is normal to the surface and secured in place. The bottom of the joint filler shall be set firmly in place. The top of the joint filler shall be parallel to the pavement surface and be the full width of the pavement. The expansion joint assembly shall be held in place in accordance with 503.04(g). Finished joints shall deviate no more than 1/4 in. in the horizontal alignment from a straight line. There shall be no offsets between adjacent sections when the joint filler consists of more than one section. No plugs or leakage of concrete shall be allowed to occur through the joint filler or into the air gap of expansion caps.

The expansion joint opening shall be sealed with hot poured joint sealant in accordance with 906.02(a)2.

503.04 Dowel Bar Assemblies

The dowel bar assemblies shall be in accordance with the following:

- (a) The dowel bars shall be supported by an approved welded wire assembly which shall hold the bars rigid during placement of the PCCP. The wire for the welded assembly shall be in accordance with ASTM A1064. The maximum angle of deviation shall not exceed 1 in 48 units during placement.
- (b) The assembly shall have two continuous parallel spacer bars and two continuous parallel bearing members of size W 7.5 or greater. One spacer bar shall be located at or near each end of the dowel. Alternate ends of dowels shall be welded to a spacer bar so that the dowels remain parallel to each other and enable sliding movement in the joint. The free ends of each dowel shall be retained securely in place by means of wire loops.
- (c) Suitable struts or tie wires shall be provided to hold the assembly in correct position during installation. The tie wires shall be size W 7.5 or smaller and there shall be a maximum of five tie wires for each dowel bar assembly.
- (d) The assembly shall have an upright support welded to the spacer bar and a continuous bearing member at the end of each dowel.
- (e) If the upright support consists of a single vertical wire, the support shall be size W 7.5 or greater wire. Otherwise, the support shall be 1/4 in. or greater in diameter.
- (f) At the time of placement, dowel bars shall be free of dirt, loose rust, or scale. If the Engineer suspects the epoxy coating has been damaged by exposure to ultraviolet light, a sample will be obtained and will be tested in accordance with 910.01(b)9.

- 240 (g) The dowel bar assembly shall be held securely in place during placing, consolidating, and finishing the PCCP by means of metal pins. Pins used on granular subbase shall penetrate a minimum of 12 in. below the dowel bar assembly. Pins shall be size W 7.5 or greater wire and shall be provided with a hook or arm welded to the pin so that it shall secure the assembly in place. A minimum of eight pins shall be used for each 10, 11, or 12 ft section of assembly. A minimum of 10 pins shall be used for assembly sections greater than 12 ft and less than or equal to 16 ft.
- (h) Dowel bars shall be coated with a bond breaking material and the coating shall be evident at the time of placement of the PCCP.
- 250 (i) Dowel bars shall be placed 6 in. from the edges of the pavement and spaced at 1 ft on center across the joint.

503.05 Sealing Cracks and Joints

All joints and cracks in the PCCP shall be cleaned and sealed with hot poured joint sealant in accordance with the sealant manufacturer's recommendations. Water blasting shall not be applied under pressure which may damage the concrete. All cracks and joints shall be sealed prior to discontinuing work for the winter.

503.06 Random Crack Remediation

Random cracks shall be corrected.

260 (a) Transverse

Random transverse cracks shall be corrected by PCCP replacement. The replacement shall be full lane width and a minimum of 6 ft in length. Transverse PCCP removal limits shall be perpendicular to the centerline and shall include the entire random crack. Load transfer for the replacement PCCP shall be obtained by using dowel bars and retrofit epoxy coated tie bars. PCCP replacement areas shall have dowel bars which match contraction joints in any adjacent panels. All remaining panels shall be a minimum of 6 ft in length.

(b) Longitudinal

270 Random longitudinal and skewed cracks within 18 in. of a longitudinal joint shall be routed and sealed. All longitudinal saw cuts in areas of random cracks shall be sealed with a sealer/healer or a bonding agent in accordance with ASTM C881, grade 1.

Random longitudinal and skewed cracks outside 18 in. of a longitudinal joint shall be corrected by PCCP replacement in accordance with 503.06(a).

504.01

For the construction of expansion joints, the cost of dowels, dowel bar assemblies, expansion caps, joint filler, joint sealants and all necessary incidentals shall be included in the cost of the expansion joint with load transfer.

330 The cost of the sleeper slab, reinforcing bars, bond breaker, pre-compressed foam joint, joint sealant and all necessary incidentals shall be included in the cost of the terminal joint. When required, removal of an existing terminal joint and sleeper slab shall be included in the cost of the terminal joint.

The cost of retrofitted tie bars or PCCP replacement used to repair damaged PCCP due to fault or negligence, remediation of random cracking, or the replacement of broken deformed bars shall be included in the cost of the PCCP.

SECTION 504 – PCCP FINISHING AND CURING

504.01 Description

All PCCP surfaces shall be finished and cured in accordance with the following.

MATERIALS

504.02 Materials

The materials shall be in accordance with the following:

10

Curing Materials..... 912.01

CONSTRUCTION REQUIREMENTS

504.03 Finishing

PCCP shall be finished with equipment in accordance with 508.04. The operations shall be controlled so that an excess of mortar and water is not worked to the top. Long handled floats may be used to smooth and fill in open textured areas in the PCCP.

20

Hand methods of finishing may be used when finishing equipment breaks down or in tight working areas where field conditions limit the use of mechanical devices. Hand placed concrete shall be further finished by means of a longitudinal float or an approved transverse smoothing float in accordance with 508.08(a).

The edges of formed PCCP adjacent to HMA or compacted aggregate shall be tooled. A continuous radius with a uniform smooth dense mortar finish shall be produced.

30

The PCCP surface shall be textured with a double thickness burlap drag or a minimum 4 ft wide turf drag.

The textured surface of PCCP shall be tined, unless otherwise specified. Tining shall consist of transverse grooves that are between 3/32 and 1/8 in. in width, between 1/8 and 3/16 in. in depth, and be spaced as follows: 5/8 in., 1 in., 7/8 in., 5/8 in., 1 1/4 in., 3/4 in., 1 in., 1 in., 1 in., 1 in., 3/4 in., 7/8 in., 1 3/4 in., 7/8 in., 3/8 in., 1 in., 1 in., 1 1/4 in., 1 1/2 in., 7/8 in., 3/4 in., 7/8 in., 1 in., 7/8 in., 1 in. The grooving pattern shall be repeated across the pavement. The grooves shall be formed in the plastic concrete without tearing the surface and without bringing pieces of the coarse aggregate to the top of the surface.

40

Texturing and curing operations may be performed by a single machine subject to satisfactory performance.

Areas of PCCP which are not finished in accordance with these requirements shall be corrected by retexturing.

Retexturing shall consist of cutting longitudinal or transverse grooves in the PCCP surface by means of saw blades or other approved devices. The grooves shall be spaced 3/4 in. center to center and be 1/8 in. in width and depth. Alternative patterns may be used, subject to approval. The PCCP surface, after cutting, shall not be polished.

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504.04 Curing

Curing materials shall be applied to exposed surfaces and sides of newly placed PCCP within 30 minutes after the finishing operations have been completed, or as soon as marring of the concrete does not occur. Paving operations shall be immediately suspended if sufficient curing materials are not available on site.

When forms are used, the edges of the pavement shall be cured immediately upon removal of the forms. The edge shall be covered with curing materials equal to the material used on the surface or banked with soil 12 in. wide or greater.

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When conditions arise which prevent immediate application of curing materials, the paving operation shall be suspended and the PCCP shall be kept wet with a fine spray of water. The fine spray of water shall continue until application of curing materials resumes.

When blended portland pozzolan cements, fly ash, or slag cement are used in the concrete mix, the average ambient temperature must be above 50°F for the curing period. The average temperature shall be calculated based on hourly temperature measurements taken at the jobsite or from published weather station data within 10 miles of the jobsite. If the temperature restrictions are not met during placement or during the required curing period, curing shall continue and the PCCP shall not be opened to traffic until the strength requirements are met.

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If liquid membrane forming compounds are used as the curing method and open to traffic strength has been achieved, the road may be opened to traffic and the 96 h stipulation stated below will not apply. Except when liquid membrane forming

compounds are used, curing shall be continuous for 96 h unless a longer period is ordered. Curing shall be in accordance with the following.

80

(a) Liquid Membrane Forming Compounds

The curing compound shall be mixed thoroughly within 1 h before use. The rate of application shall be as approved, with a minimum spreading rate per application of 1 gal. of liquid coating for 150 sq ft of concrete surface.

90

Curing compound shall be applied to provide a uniform, solid, white opaque coverage on all surfaces, similar to a white sheet of paper. All concrete cured by this method shall receive two applications of the curing compound. The first application shall be applied immediately after surface water has disappeared and surface texturing has been applied. If formwork has been used, both applications of curing compound shall be applied immediately after the formwork is removed. The second application shall be applied after the first application has set.

The curing compound may be warmed in a water bath during cold weather at a temperature not exceeding 100°F. Thinning with solvents will not be allowed. Non-uniform film rates will result in the discontinuance of that application method.

100

A new coat of curing compound shall be applied to areas damaged by rain or other means during the curing period. The recoating shall be applied as soon as possible and at a rate equal to that specified for the original coat.

(b) Double Burlap

The PCCP shall be covered with wet burlap, laid directly on the surface, and kept wet with a fine spray of water. This initial burlap shall receive an additional covering of wet burlap no later than 9:00 a.m. the day following its placement. The two layers of burlap shall be kept wet for the required curing period.

(c) Waterproof Covers

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The PCCP shall be kept wet with a fogged spray of water, or be covered with wet burlap laid directly on the surface and kept wet with a fine spray of water. The PCCP shall receive a cover no later than 9:00 a.m. the day following its placement. If white burlap polyethylene sheets are used, the burlap side shall be wet or the surface of the concrete thoroughly wetted just prior to the blanket being placed.

The covers shall be weighted down on each edge and shall be as wide as the full width of the pavement being cured. Adjoining covers shall overlap 12 in. or more and the laps held securely in place.

120

Covers may be reused provided they are airtight. All torn covers shall be repaired with patches. All units not in accordance with these requirements shall not be used.

The covers shall remain in place for the required curing period.

504.05 Method of Measurement

Finishing and curing operations will not be measured for payment.

504.06 Basis of Payment

The cost of finishing and furnishing and placing curing materials shall be included in the cost of the PCCP.

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SECTION 505 – TESTS AND PROCEDURES**505.01 Test Methods and Procedures**

The following test methods and procedures shall be used with exceptions as listed below.

	Air Test.....	AASHTO T 152* or ASTM C173**
	Flexural Strength	AASHTO T 97*
10	Making and Curing Specimens.....	AASHTO T 23*
	Sampling Fresh Concrete	AASHTO R 60
	Sieve Analysis of Aggregates.....	AASHTO T 27
	Slump	AASHTO T 119
	Specific Gravity and Absorption, Coarse Aggregate.....	AASHTO T 85
	Specific Gravity and Absorption, Fine Aggregate.....	AASHTO T 84
	Thickness of PCCP.....	ITM 404
	Unit Weight and Relative Yield	AASHTO T 121*
	Water/Cementitious Ratio	ITM 403

20 * The concrete shall be consolidated by the method of internal vibration in beam forms or in an aluminum measure or air meter bowl, as appropriate for the test.

** If slag aggregate is used, the method and procedure for the test shall be in accordance with ASTM C173.

The chosen method of concrete consolidation shall be the same for all concrete test specimens.

30 (a) Exceptions to AASHTO T 23

The exceptions to AASHTO T 23 for making and curing specimens in the field shall be as follows:

1. Non-watertight beam forms, molds, will be allowed.
2. After 24 h the molded specimens are taken to the storage location and removed from the molds.
3. Field stored beams will not require 24 ±4 h lime water soak prior to time of testing.

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(b) Exceptions to AASHTO T 97

The exceptions to AASHTO T 97 for conducting a flexural test on concrete beams shall be as follows:

1. The beam size shall be measured to the nearest 1/16 in.
2. The test result shall be discarded when the break occurs outside the middle 1/3 of the beam.

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(c) Exceptions to AASHTO T 121

The exceptions to AASHTO T 121 for determining the unit weight of concrete shall be as follows:

1. Weight shall be determined to the nearest 0.01 lb.

(d) Exceptions to AASHTO R 60

The exceptions to AASHTO R 60 for sampling fresh concrete shall be as follows:

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1. Where job conditions dictate, the entire sample may be obtained from one portion of the load.

(e) Exceptions to AASHTO T 152

The exceptions to AASHTO T 152 for determining the air content in portland cement concrete shall be as follows:

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1. The sample for aggregate correction factor shall be prepared in accordance with 6.0. The aggregate correction factor shall be determined in accordance with 8.3 and read directly from the meter.
2. The aggregate correction factor test shall be re-run for confirmation if the test results for gravel is greater than 0.4% or if the test results for crushed stone is greater than 0.6%.
3. For aggregates indicating a high correction factor, the aggregate may be washed from the concrete sample and used to determine the correction factor.

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SECTION 506 – PCCP PATCHING

506.01 Description

This work shall consist of the removal and replacement of jointed plain PCCP or jointed reinforced PCCP in accordance with 105.03.

MATERIALS

506.02 Materials

10 Materials shall be in accordance with the following:

	Admixtures	912.03
	Calcium Chloride, Type L.....	913.02
	Chemical Anchor System.....	901.05
	Coarse Aggregate, Class A or Higher, Size No. 11	904.03
	Concrete Coarse Aggregate, Class AP	904.03, ITM 226
	Dowel Bar Assemblies	503.04
	Dowel Bars	910.01(b)10
	Fine Aggregate, Size No. 23.....	904.02
20	Fly Ash	901.02
	Joint Fillers	906.01 ^A
	Joint Sealing Materials	906.02(a)2
	Portland Cement	901.01(b)
	Rapid Hardening Hydraulic Cement	901.01(d)
	Silica Fume.....	901.04
	Slag Cement	901.03
	Water	913.01

30 ^A A flexible foam expansion joint material meeting the requirements of ASTM D5249, type 2 may also be used for the retrofit pressure relief joint. If the flexible foam expansion joint is used, the basis for use will be a type C certification in accordance with 916.

Coarse aggregate for partial depth patching shall be size No. 11. Coarse aggregate for full depth patching shall be size No. 8. Coarse aggregate for patches shall be dolomite, limestone, or gravel.

40 Retrofitted tie bars shall be No. 5 or No. 6 epoxy coated reinforcing bars in accordance with 910.01(b)9.

The rapid hardening hydraulic cement or calciumsulfoaluminate, CSA, cement type selected shall be a type shown in ASTM C1600 that will enable opening to traffic in accordance with the contract requirements. Food grade citric acid may be used as an organic retarding admixture in concrete utilizing CSA cement. The use and strength of food grade citric acid, or any other admixture, shall be approved in writing by the manufacturer of the CSA cement. The basis for use for the food grade citric acid will be visual inspection.

50 A bonding agent shall be selected from the QPL of Non-Vapor Barrier Type Bonding Agents.

506.03 Concrete Mix Design

A concrete mix design submittal, CMDS, shall be in accordance with 506.04. The CMDS shall be submitted to the DTE. The CMDS shall be submitted a minimum of seven calendar days prior to the trial batch. The CMDS shall use the Department provided spreadsheet and shall include the following:

- 60
- (a) a list of all ingredients, including the type of CSA cement, if applicable
 - (b) the source of all materials
 - (c) the fine to total aggregate ratio
 - (d) the absorption of the aggregates
 - (e) the SSD bulk specific gravity of the aggregates
 - (f) the specific gravity of pozzolan
 - (g) the batch weights
 - (h) the names of all admixtures
 - (i) the admixture dosage rates and the manufacturer's recommended range.

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The aggregate blend submitted on the CMDS shall produce an optimized aggregate gradation in accordance with ITM 226, sections 6.2.1 and 6.3. The aggregate blend shall consist of, at a minimum, one Concrete Coarse Aggregate and one fine aggregate, No. 23. One additional class A or higher intermediate-sized coarse aggregate may be included if approved by the Engineer.

The absolute volume of the mix design shall be 27.0 cu ft at the design air content of 6.5%.

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The CMDS shall be used to conduct a trial batch in accordance with 506.05. Upon completion of the trial batch, the Contractor shall submit the CMDS and the Contractor's and the Engineer's trial batch results for the CMDS to the DTE. The results shall be submitted to the DTE utilizing the Department furnished spreadsheet a minimum of three work days prior to production. Production shall not commence until the DTE has assigned a mix number to the CMDS. The concrete mix design will henceforth be identified as a concrete mix design for production, CMDP.

90

A CMDP from another contract in the current or previous calendar year may be submitted for review for use on the current contract to the DTE. The DTE will notify the Contractor when the review is complete and whether or not the previously used CMDP can be used on the current contract.

A CMDP may be changed or adjusted in accordance with the following:

(a) Change in Materials

A change in a previously approved CMDP, for a given contract, to any of the following shall be submitted to the DTE as a CMDS, referencing the original CMDP.

- 100
1. cement source or type
 2. pozzolan source or type
 3. coarse aggregate source or type
 4. admixture type.

A trial batch shall be conducted in accordance with 506.05.

(b) Adjustments to Materials

An adjustment in a previously approved CMDP, for a given contract, to any of the following shall be submitted to the DTE as a CMDS, referencing the original CMDP.

110

1. admixture source
2. admixture product of same type and from same source designated in the original CMDP
3. fine aggregate source
4. fine to total aggregate ratio in excess of $\pm 3\%$ from the value designated by the original CMDP
5. Increase in cement content from amount designated in the original CMDP.

- 120 The new CMDS shall be submitted to the DTE utilizing the Department spreadsheet a minimum of one work day prior to production. A trial batch or verification testing is not required for approval. Production shall not commence without an approved CMDP.

(c) Other Adjustments

Other adjustments in previously approved CMDP, for a given contract, to the admixture dosage rate will be allowed and DTE notification and review prior to use is not required.

130 **506.04 Concrete Mix Criteria**

The design flexural strength of each CMDP shall be set such that the minimum opening to traffic strength is achieved at an age consistent with the work schedule, including any lane closure restrictions.

Chemical admixtures type A, type B, type C, type D, type E, and type F may be allowed if shown on the CMDP. The supplied concrete mix shall include one of the following water reducing admixtures: type A, type D, type E, type F, or type G.

- 140 Type C admixtures or calcium chloride, type L, shall not be used in conjunction with type III portland cement. Calcium chloride, type L, may only be used in mixes for non-reinforced PCCP and for mixes in accordance with 506.04(a).

Blended portland pozzolan cements, fly ash, or slag cement may only be incorporated in the concrete mix when the ambient temperature is above 50°F during

506.04

the entire placement period. If type IP, type IP-A, type IS or type IS-A cements are to be used, the minimum portland cement content shall be increased to 598 lb/cu yd. The use of fly ash or slag cement will not be allowed when blended cement types IP, IP-A, IS, or IS-A are used.

150 The Contractor may use either portland cement or CSA cement in the concrete. Fly ash or slag cement may also be used.

If concrete has a permeability of 900 coulombs or less at 56 days, the acceptable range of air content will be 0 - 6.0%. Verification of this property for a mix design will be determined by testing specimens cast at the trial batch. Testing will be done per AASHTO T 23 Section 10.1 Standard Cure conditions.

The CMD shall produce workable concrete mixtures having the following targets and field acceptance properties.

160

(a) Patches Less than or Equal to 15 ft in Length

The Contractor shall use either concrete as described below or concrete in accordance with 506.04(b). If concrete in accordance with 506.04(b) is used, 506.12(b) shall be used for the minimum open to traffic strength.

Targets for the CMD:

	Minimum portland cement content.....	564 lb/cu yd ^A
	Maximum portland cement content.....	752 lb/cu yd ^A
170	Minimum CSA cement content	564 lb/cu yd ^{A, B}
	Maximum CSA cement content	658 lb/cu yd ^{A, B}
	Minimum water/cementitious ratio (types I or IL)	0.340 ^C
	Maximum water/cementitious ratio (types I or IL)	0.400 ^C
	Minimum water/cementitious ratio (type III or CSA)	0.340 ^C
	Maximum water/cementitious ratio (type III or CSA)	0.435 ^C
	Maximum fly ash or slag cement addition	30% of the cement content ^B
	Maximum silica fume addition.....	7% of the cementitious content
180	Air Content.....	6.5%
	Minimum modulus of rupture.....	400 psi at 24 h
	Minimum modulus of rupture.....	550 psi at 3 days ^D
	Relative Yield.....	1.00

Field Acceptance Properties:

	Minimum water/cementitious ratio (types I or IL)	0.320 ^C
	Maximum water/cementitious ratio (types I or IL)	0.420 ^C
	Minimum water/cementitious ratio (type III or CSA)	0.340 ^C
190	Maximum water/cementitious ratio (type III or CSA)	0.450 ^C

Slump	2 to 6 in.
Air Content	5.0% to 8.0%
Minimum modulus of rupture.....	550 psi at 3 days ^D
Relative Yield.....	0.98 to 1.02

- A The cement content shall not be adjusted from the target stated on the CMDP during production.
- 200 B Fly ash or slag cement shall not be used in combination with CSA cement unless approved in writing by the manufacturer of the CSA cement.
- C The water/cementitious ratio shall not deviate more than 0.020 from the target stated in the CMDP and shall not fall outside the limits shown.
- D Beams shall be standard cured in a water tank in accordance with AASHTO T 23 and 505.01(a). The water does not need to be saturated with calcium hydroxide.

210

When a calcium chloride solution is added, the maximum amount of solid calcium chloride contained in solution shall not exceed 2%, of the total batch weight of cement. If the ambient temperature is above 80°F, the maximum amount of solid calcium chloride contained in solution shall not exceed 1% of the total batch weight of cement.

(b) Patches Greater than 15 ft in Length

The Contractor shall use either concrete as described below, or portland cement concrete in accordance with 502.04(a). If concrete in accordance with 502.04(a) is used, a trial batch will not be required.

220

Targets for the CMD:

Minimum portland cement content (types I, IL or III)	564 lb/cu yd ^A
Maximum portland cement content (types I, IL, or III).....	752 lb/cu yd ^A
Minimum CSA cement content	564 lb/cu yd ^{A, B}
Maximum CSA cement content	658 lb/cu yd ^{A, B}
Minimum water/cementitious ratio (types I or IL)	0.340 ^C
Maximum water/cementitious ratio (types I or IL)	0.400 ^C
Minimum water/cementitious ratio (type III or CSA)	0.340 ^C
230 Maximum water/cementitious ratio (type III or CSA)	0.435 ^C
Maximum fly ash or slag cement addition	30% of the cement content ^B
Maximum silica fume addition.....	7% of the cementitious content
Air Content.....	6.5%
Minimum modulus of rupture.....	425 psi at 24 h
Minimum modulus of rupture.....	550 psi at 3 days ^D
Relative Yield.....	1.00

240 Field Acceptance Properties:

Minimum water/cementitious ratio (types I or IL)	0.320 ^C
Maximum water/cementitious ratio (types I or IL)	0.420 ^C
Minimum water/cementitious ratio (type III or CSA)	0.340 ^C
Maximum water/cementitious ratio (type III or CSA)	0.450 ^C
Slump	2 to 6 in.
Air Content	5.0% to 8.0%
Minimum modulus of rupture.....	550 psi at 3 days ^D
Relative Yield.....	0.98 to 1.02

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- A The target cement content during production shall not be adjusted from the value stated on the CMDP.
- B Fly ash or slag cement shall not be used in combination with CSA cement unless approved in writing by the manufacturer of the CSA cement.
- C The water cementitious ratio during production shall not deviate more than 0.020 from the target stated in the CMDP and shall not fall outside the limits above.

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- D Beams shall be standard cured in a water tank in accordance with AASHTO T 23 and 505.01(a). The water does not need to be saturated with calcium hydroxide.

506.05 Trial Batch

A trial batch shall be produced and tested by the Contractor’s certified technician to verify that the CMDS is in accordance with the concrete mix criteria. Concrete produced at a plant shall be batched within the proportioning tolerances of 502.10. An American Concrete Institute certified concrete field testing technician, grade 1 shall be on site to direct all sampling and testing. The trial batch shall be produced at the plant prior to production.

270

A sufficient number of flexural strength test beams shall be made and will be tested to demonstrate that opening to traffic strength is achieved at an age consistent with the proposed range of usage of the mixture. At a minimum, flexural strength gain will be determined at the target opening to traffic times and at the specified 24 h and 3 day targets as specified by the respective mix criteria. The Engineer will test the concrete’s air content and determine the water/cementitious ratio, and prepare and test flexural beams. The flexural strength will be determined by averaging a minimum of two beam breaks. The Department will provide the apparatus to test the beams for flexural strength.

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Personnel shall be provided to assist the Department in casting, curing, and testing the beams. The Engineer will provide the Contractor the results of the tests. The Contractor shall submit, along with the CMDS, all supporting test results for approval

to the DTE prior to placing concrete. The supporting test results shall be signed by the technician and include air content, slump, relative yield, water/cementitious ratio, and the flexural strengths at the targets listed in 506.04(a) or 506.04(b).

290

Maturity in accordance with ITM 402 may be used as an alternate method to determine the flexural strength for opening to traffic.

A trial batch will not be required when the total quantity of full depth patching requires less than 10 cu yds of material per contract.

The trial batch shall be of sufficient quantity to allow the Engineer to perform all required tests from the same batch. Trial batch concrete shall not be used for more than one test, except concrete used to measure relative yield may also be used to measure air content.

300

506.06 Job Control

Control of PCCP for air content, relative yield, and flexural strength beams will be determined on the basis of tests performed by the Engineer in accordance with 505. Concrete and necessary labor for sampling shall be furnished as required by the Engineer. Testing for air content and relative yield will be on the first load of the day and once per every 50 cu yds.

(a) Beams for Validation of CMDP

At least one set, consisting of three beams per set, will be made once per every 150 cu yds of concrete placed and tested for compliance with either the 3 day or 7 day flexural strength requirements in accordance with 506.04, for the purpose of CMDP validation. Air content and relative yield will be measured on each sample of concrete from which beams are made.

310

Beams for validation shall be placed on the concrete pavement or shoulder adjacent to the patch and cured in a similar manner as the patch in accordance with 505.01(a) until patch area is open to traffic. At which point the beams shall be relocated off-site and standard cured in accordance with AASHTO T 23, Section 10.1.2 with the exception that the water does not need to be saturated with calcium hydroxide until the 3 or 7 day time period has elapsed.

320

Failure of the validation beams to meet or exceed the 3-day or 7-day flexural strength requirements specified herein will result in the use of the CMDP being suspended until the Department concludes an investigation into why the failure occurred. If the CMDP is subsequently shown to be acceptable, another set of validation beams will be tested on the next use of the CMDP.

(b) Beams for Opening to Traffic

Additional beams shall be cast for the purpose of opening to traffic for concrete meeting the requirements of 506.04(a) or 506.04(b). Such beams shall be cast from sampling the last load to finish the patching operations for the day's production for

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506.07

each of the concrete mixes used. Beams for opening to traffic shall be placed on top of a concrete patch that they represent and cured in a similar manner as the patch.

The Engineer will notify the Contractor when test results for air content, relative yield, or flexural strength are outside the requirements of 506.04. Rounding will be in accordance with 109.01(a).

340

CONSTRUCTION REQUIREMENTS

506.07 General

Patch areas shown on the plans or marked by the Engineer as greater than 15 ft in length may be subdivided. If a patch is subdivided, concrete mix in accordance with 506.04(b) shall be used in all portions of the patch and the requirements for opening to traffic will be in accordance with 506.12(b).

506.08 PCCP Removal

350 PCCP removal areas will be marked. The Contractor may saw cut the patch areas prior to removing the patch. When the lane is subject to intermittent closures, the saw cutting shall occur no more than 24 h prior to removing the patch.

Vertical saw cuts around the perimeter of the removal areas shall be made in the PCCP and shall be full depth. Transverse cuts that define the ends of the patch shall be straight and perpendicular to the centerline. In no case shall the transverse joint be over-cut into the adjacent pavement. Following the saw cutting, the concrete that remains in the corners of the patch area shall be removed by pneumatic hammers that do not damage the adjacent PCCP or shoulders. Pneumatic hammers shall not exceed 45 lb.

360

PCCP removal areas shall not remain open overnight. Shoulders or adjacent PCCP damaged during the removal shall be repaired as directed.

(a) Partial Depth Removal

370 The saw cut shall be a minimum of 1 in., to a maximum of 1/3 of the thickness of the existing pavement. Removal of all unsound concrete to a minimum depth of 2 in. shall be by hand chipping tools or handheld mechanically driven equipment. Mechanical hammers shall not be heavier than a nominal 45 lb class. Mechanically driven tools shall be operated at a maximum angle of 45° from the PCCP surface. If the saw cut face is damaged, a parallel saw cut 1 in. outside the initial saw cut shall be made and the concrete in this area shall be removed by hand chipping.

In lieu of using hand chipping tools or handheld mechanically driven equipment, a milling machine may be used. If a milling machine is used it shall be one that does not damage the adjacent pavement.

If reinforcing bars are encountered during the removal operation, the patch shall be changed to a full depth patch in accordance with 506.08(b). Wire mesh

380 reinforcement exposed during the removal operations shall be removed.

If concrete is exposed below 1/3 of the thickness of the existing pavement, the patch shall be changed to a full depth patch in accordance with 506.08(b).

Partial depth cavities shall be thoroughly sandblasted and, just prior to placing new concrete, cleaned of all dust, chips, and water. The air lines for sandblasting and air cleaning shall be equipped with oil traps to prevent contamination of the surfaces.

(b) Full Depth Removal

390 After the full depth saw cut is completed, vehicle mounted removal equipment may be used to remove the concrete provided this equipment does not damage the adjacent sound concrete.

Removal areas in the same lane which are closer than 10 ft shall require the PCCP between these areas to be removed and replaced. If a transverse joint is located within the removal area, the limits of removal shall be as shown on the plans.

400 Full depth saw cutting and removal shall be extended at the direction of the Engineer until sound PCCP is encountered to allow the drilling and installation of dowel bars for load transfer, without inflicting further damage to the existing PCCP. Removal operations shall not damage the existing PCCP that is sound and is to remain in place.

Existing subbase shall be completely removed. Before removing any type of asphalt treated, cement treated or concrete subbase, the Contractor shall saw cut the outline of the removal area using a power-driven saw with a diamond blade. The Contractor shall cut the asphalt treated subbase at least 2 in. deep on a neat line perpendicular to the subbase surface. The Contractor shall cut the cement treated subbase or concrete subbase full depth.

410 **506.09 Concrete Mixing and Transportation**

(a) For Patches Less than or Equal to 15 ft in Length

420 Concrete batching tolerances, mixing, and transportation shall be in accordance with 502.10 and the following. Discharge from non-agitating equipment shall be completed within 30 minutes of mixing the water, cement, aggregates, and calcium chloride solution. Discharge from a truck agitator or a truck mixer shall be completed within 90 minutes of mixing the water, cement, and aggregates or within 30 minutes of the addition of calcium chloride solution. If the location of the plant is such that this time limit cannot be met, the calcium chloride solution shall be added to the concrete in a transit mixer at the site and the concrete shall then be mixed for an additional 40 revolutions prior to discharge.

1. Central Mixed Concrete

Central mixed concrete shall be in accordance with 502.10(a).

2. Shrink Mixed Concrete

Shrink mixed concrete shall be in accordance with 502.10(b).

3. Transit Mixed Concrete

430 Transit mixed concrete shall be in accordance with 502.10(c).

(b) For Patches Greater than 15 ft in Length

For patches containing portland cement, the mixing and transportation shall be in accordance with 502.10. If concrete containing CSA cement is used, it may be batched and mixed in a mobile volumetric mixer meeting the requirements of 722.09, regardless of the patch length. Calibration of the mobile mixer shall be in accordance with 722.13. Alternatively, a mixer from a CSA cement supplier may be used, contingent upon approval by the Engineer.

440 506.10 Weather Limitations

PCCP patches shall not be placed on frozen subgrade, subbase, or PCCP.

506.11 Placing Concrete

The concrete shall be placed level to the adjacent PCCP and consolidated by internal vibration. The concrete shall be hand finished in accordance with 504. Texturing and tining are not required if the PCCP is to be resurfaced with HMA or diamond ground in accordance with 507.06.

450 The PCCP patch shall be cured with liquid membrane forming curing compound in accordance with 504.04(a). In addition to applying liquid membrane forming curing compound, if the ambient temperature is below 55°F at the time of placement, polyethylene film shall be placed over the patch and covered with a 4 in. layer of rigid or flexible insulation and firmly anchored. Otherwise, polyethylene film, insulation, or any other covering shall not be used. Small dimension lumber weighted with sandbags may be used, but large objects such as rocks or concrete blocks shall not be used.

Covering with polyethylene film or any other covering does not replace the requirement to use liquid membrane forming curing compound.

460

The PCCP patch shall be inspected in accordance with 502.17.

For patches which are not to be overlaid and have a length greater than 20 ft, pavement smoothness will be in accordance with 501.25 except profilograph requirements will not apply.

(a) Partial Depth

470 A non-vapor barrier type bonding agent shall be applied to the vertical and horizontal surfaces prior to placing concrete. Coated surfaces shall be protected from contaminants such as dust and dirt. Contaminated surfaces shall be recleaned and recoated. The bonding agent and concrete shall be placed in accordance with the

bonding agent manufacturer's recommendations. The recommended time limits will be strictly enforced.

Existing joint openings within the patch shall be maintained for the full depth of the patch by preformed joint fillers or forms. After the patch has cured, these joints shall be sawed and sealed in accordance with 503.

(b) Full Depth

480 Subgrade treatment and subbase shall be constructed as shown on the plans.

Dowel bars shall be installed to provide load transfer from the adjoining PCCP to the patch. The diameter of the drilled holes shall be no more than 1/8 in. greater than the diameter of the dowel bar. Dowel bars shall be placed parallel to the pavement surface and to the longitudinal joint. Dowel alignment tolerances shall be as shown on the plans.

490 Dowel holes shall be drilled using hydraulic, electric, or pneumatic percussion drills without spalling or damaging the existing concrete. Drills shall be capable of independent adjustment of each drill shaft in the horizontal and vertical direction. The device used to drill dowel holes shall be slab-riding and be capable of drilling a minimum of three holes at a time. The drilled holes shall be free of dust, moisture, and grease prior to installation of the dowel bars. The chemical anchor system shall be injected to the back of the hole to eliminate air pockets prior to inserting the dowel bar.

500 The quantity of material injected shall be sufficient to disperse the chemical anchor material along the entire length of the dowel bar and completely fill all voids around the bar. Application of the chemical anchor system by buttering it onto the dowel bar will not be allowed.

After the anchor system has been injected, the dowel bar shall be fully inserted in the hole using a back-and-forth twisting motion, leaving the proper length exposed. If it is necessary to use a hammer to seat the dowel bar, the exposed end shall be protected with a wood block.

510 A lightweight plastic, clear or semi-transparent grout retention ring shall be installed after each dowel bar is inserted into the hole. The grout retention ring shall be pushed flush to the vertically sawn concrete surface and shall be used to help retain the chemical anchor system in the dowel hole.

Retrofit tie bars shall be installed in accordance with 503 and as shown on the plans. The tolerance for horizontal and vertical translation shall be the same as for dowel bars.

Joint filler and grout retention rings shall be placed and installed at the pressure relief joint as shown on the plans. Oversized holes shall be drilled in the joint filler no

520 more than 1/2 in. over the dowel bar diameter and at a spacing to match the installed dowel bars. The oversized holes are to allow a tolerance for ease of installation of the joint filler up against the sawed face without interference with the dowel bars. The joint filler shall be attached to the sawed face without wrinkles or buckling.

Joint filler material with vertical slits or cuts will be rejected. Grout retention discs shall be installed to make the annular space between the dowel and the oversized hole mortar tight. The joint material may be spliced along vertical joints that are joined and sealed with tape. The joint material shall not be spliced in the horizontal direction. An alternate method of installing a joint filler that has a mortar tight seal around the dowel bar may be allowed if approved by the Engineer.

530 All patches greater than 15 ft shall be placed in accordance with 502.12 and shall have joints in accordance with 503. Dowel bars shall be installed within the boundaries of the patch at a spacing as shown on the plans or as approved by the Engineer.

Patches longer than 15 ft shall be finished in accordance with 504.

Patches longer than 15 ft, constructed with concrete containing portland cement, shall be cured in accordance with 504.04(a) unless ambient air and concrete temperatures warrant following the requirements in 506.11.

540 Patches constructed in accordance with 506.04(b) and containing CSA cement shall be water cured in accordance with 702.22(a)1 except that soaker hoses will not be required. Water curing shall be initiated after finishing and as soon as the concrete patch can support the wet covering. Water curing shall be maintained for a minimum of 1 1/2 h, and shall be removed no sooner than 1 h before the patch is opened to traffic.

Concrete shall be placed around manholes or similar structures in accordance with 720.

550 Sawing and sealing of transverse joints may be omitted when the existing PCCP is to be overlaid as part of the contract.

506.12 Opening to Traffic

For purposes of this section, traffic shall include construction vehicles, construction equipment, and all non-construction vehicles. Any construction vehicle or equipment that may damage the PCCP shall not be used on the PCCP unless adequate protection is provided. Joint cutting saws may be operated on the PCCP as determined by the Contractor.

560 **(a) For Patches Less than or Equal to 15 ft in Length**

A patch may be opened to traffic in accordance with the following when calcium chloride is used in accordance with 506.04(a).

T	H	HT	T	H	HT
40 - 42°F	30	26	61 - 63°F	14	9
43 - 45°F	27	23	64 - 66°F	14	9
46 - 48°F	24	21	67 - 69°F	14	8
49 - 51°F	21	19	70 - 72°F	14	7
52 - 54°F	19	16	73 - 75°F	14	6
55 - 57°F	16	14	above 75°F	14	5
58 - 60°F	16	11			
T = Lowest ambient temperature during placement, or the temperature of concrete at time of delivery, whichever is lower H = Time in hours to open to traffic HT = Time in hours to open to traffic when the average daily traffic is less than 10,000					

PCCP patches with calcium chloride may be opened to traffic sooner than specified in the above table if test beams indicate a modulus of rupture of 300 psi or greater. ITM 402 may be used as an alternative method to determine the flexural strength.

- 570 When other admixtures or admixture systems are used, the PCCP patches may be opened to traffic when flexural strength tests indicate a modulus of rupture of 300 psi or greater. ITM 402 may be used as an alternate method to determine the flexural strength.

(b) For Patches Greater than 15 ft in Length

Traffic shall not be allowed on the PCCP until a modulus of rupture of 425 psi from flexural strength testing is achieved. The modulus of rupture will be determined by averaging two beams.

580 **506.13 Method of Measurement**

Partial depth patching and full depth patching will be measured by the square yard.

D-1 contraction joints and retrofitted tie bars used in PCCP patching will be measured in accordance with 503.07.

When subgrade treatment is specified, it will be measured in accordance with 207.05. New subbase will be measured in accordance with 302.08.

- 590 PCCP removal, subbase removal, concrete, finishing, curing, and sawing and sealing of joints will not be measured for payment.

Retrofit pressure relief joints, retrofit contraction joints, non-vapor barrier bonding agent, anchored dowel bars installed at the beginning and end of the patch, individual dowel bars, joint fillers, joint materials, drilling holes for dowel bars, grout retention rings, and chemical anchor systems will not be measured for payment.

506.14

506.14 Basis of Payment

600 PCCP patching will be paid for at the contract unit price per square yard for the type of patching required.

D-1 contraction joints and retrofitted tie bars used in PCCP patching will be paid for in accordance with 503.08.

Subgrade treatment will be paid for in accordance with 207.06. New subbase will be paid for in accordance with 302.09.

610 Partial depth patches which have been directed to be full depth will be paid for at the contract unit price per square yard for PCCP patching, partial depth, plus 80% of the contract unit price per square yard for PCCP patching, full depth.

Payment will be made under:

Pay Item	Pay Unit Symbol
PCCP Patching, Full Depth	SYS
PCCP Patching, Partial Depth	SYS

620 The cost of PCCP removal, subbase removal, concrete, finishing and curing, and sawing and sealing of joints shall be included in the cost of PCCP patching.

The cost of retrofit pressure relief joints, retrofit contraction joints, non-vapor barrier bonding agent, anchored dowel bars installed at the beginning and end of the patch, individual dowel bars, joint fillers, joint materials, drilling holes for dowel bars, grout retention rings, and chemical anchoring system shall be included in the cost of PCCP patching.

630 The cost of corrections for pavement smoothness and re-texturing shall be included in the cost of PCCP patching.

Repair or replacement of adjacent PCCP or shoulder damaged by the Contractor shall be made at no additional cost to the Department.

SECTION 507 – PCCP RESTORATION

507.01 Description

This work shall consist of cleaning and sealing of joints and cracks, patching, profiling, underseal, and retrofit load transfer in accordance with 105.03.

MATERIALS

507.02 Materials

10 Materials shall be in accordance with the following:

Asphalt Binder, PG 64-22	902.01(a)
Dowel Bars	910.01(b)10
Fine Aggregates, Size No. 23 or 24.....	904.02
Joint Sealing Materials	906.02
Rapid Setting Patch Materials	901.07

Dowel bars and dowel bar assemblies shall be in accordance with 503.04.

20

CONSTRUCTION REQUIREMENTS

507.03 Cracks

Sealing and filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F, or when other unsuitable conditions exist, unless approved by the Engineer.

(a) Routing, Cleaning and Sealing

30 Cracks in PCCP shall be routed and cleaned when specified. Cracks shall be routed with a routing machine capable of cutting a uniform shape to form a reservoir not exceeding 3/4 in. wide with a minimum depth of 3/4 in. The operation shall be coordinated such that routed materials do not encroach on pavement lanes carrying traffic and all routed materials are disposed of in accordance with 104.07. The cracks shall be cleaned with compressed air or by other suitable means. Air compressors shall be capable of producing a minimum air pressure of 100 psi. Water blasting shall not be utilized.

40 Cracks shall be sealed with hot poured joint sealant in accordance with the manufacturer's recommendations within 1/4 in. below the surface. A distributor in accordance with 409.03 shall be used with an indirect-heat double boiler kettle and mechanical agitator. The hot poured joint sealant shall be placed utilizing a "V" shaped wand tip, to allow the penetration of the materials into the cracks.

Application of hot poured joint sealant shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section, temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the hot poured joint sealant has set.

(b) Cleaning and Filling

50 The cracks shall be cleaned by blowing with compressed air or by other suitable means when specified. Air compressors shall be capable of producing a minimum air pressure of 100 psi. Water blasting shall not be utilized.

Cracks shall be filled with asphalt material. The cracks shall be completely filled or overbanded not to exceed 5 in., or as required. Asphalt material shall be placed utilizing a "V" shaped wand tip, to allow the penetration of the materials into the cracks. The filled cracks shall be covered with sufficient fine aggregate or other

507.04

suitable material to prevent tracking of the asphalt material. All excess cover material shall be removed from the pavement within 24 h, when directed.

- 60 Application of asphalt material shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section, temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the asphalt material has set.

507.04 Joints

Sealing and filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F, or when other unsuitable conditions exist, unless approved by the Engineer.

- 70 **(a) Sawing, Cleaning and Sealing**

Joints in PCCP shall be sawed, cleaned and sealed when specified. Air compressors shall be capable of producing a minimum air pressure of 100 psi. Water blasting shall not be applied under pressure which may damage the concrete. The existing joints shall be sawed to the width and depth as shown on the plans. Slurry or saw residue remaining in the slot shall be immediately flushed with water. Traffic may be allowed on the PCCP for up to seven calendar days after the saw cutting prior to sealing.

- 80 Joints shall be sealed with joint sealing materials in accordance with the sealant manufacturer's recommendations. Transverse joints shall be sealed with hot poured joint sealant, silicone sealant or preformed elastomeric joint sealant. Longitudinal joints shall be sealed with hot poured joint sealant or silicone sealants.

Application of asphalt materials shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section, temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the asphalt material has set.

(b) Cleaning and Filling

- 90 Joints in PCCP shall be cleaned and filled when specified. Cleaning shall include removal of old sealant and backer rod. Air compressors shall be capable of producing a minimum air pressure of 100 psi. Water blasting shall not be utilized.

Joints shall be filled with hot poured joint sealant in accordance with the manufacturer's recommendations within 1/4 in. below the surface. A distributor in accordance with 409.03 shall be used with an indirect-heat double boiler kettle and mechanical agitator. The hot poured joint sealant shall be placed utilizing a "V" shaped wand tip, to allow the penetration of the materials into the joints.

- 100 **507.05 PCCP Patching**

(a) Full Depth and Partial Depth Patching

PCCP patching shall be in accordance with 506.

(b) Joint Repair

PCCP joint repair shall be in accordance with 509.

507.06 Profiling

110 Profiling consists of the diamond grinding of the pavement. The grinding shall be completed by mechanical grinding equipment in accordance with 508.08(c). Grinding shall be completed in a longitudinal direction and shall begin and end at lines normal to the pavement centerline in any ground section. The operation shall be coordinated such that the slurry or residue materials are continuously removed from the pavement. The slurry shall not encroach into adjacent pavement lanes carrying traffic, or flow into gutters or other drainage facilities and shall be immediately and directly deposited into a tanker truck and removed from the jobsite. Final disposal of the material shall be in an approved manner and in accordance with 104.07. Pavement smoothness will be measured and adjusted in accordance with 501.25 and 501.28(d) after the cracks are routed, cleaned, and sealed in accordance with 507.03 and joints are sawed, 120 cleaned, and resealed in accordance with 507.04.

507.07 Undersealing

Undersealing shall be in accordance with 612.

507.08 Retrofit Load Transfer for PCCP

Retrofit load transfer consists of diamond saw slot cutting and placing dowel bar assemblies in the PCCP, parallel to the centerline of the roadway without damaging adjacent PCCP. The diamond-sawed slot shall be cut using two diamond saw blades per slot to cut the edges of the slot. The PCC within the slot and the burrs and bumps 130 remaining in the base of the slots after cutting shall be removed with hand or mechanical chipping hammers which shall not exceed a nominal 15 lb in weight and shall be operated at a maximum angle of 45° from the pavement surface.

All surfaces of the slots shall be thoroughly cleaned by sand blasting and all cracks in the slots shall be sealed with a silicone sealer. The slots shall be cleaned and blown dry with compressed air.

Dowel bar assemblies shall be as shown on the plans. Prior to placement, the assemblies shall be coated with a bond breaking material and placed on non-metallic 140 supports in the slots. Dowel bars shall be parallel to the pavement surface.

Rapid setting patch material shall be mixed and cured in accordance with the manufacturer's recommendations. The material shall be placed in the slots and troweled to match existing adjoining PCCP. Excess material removed during placing and troweling shall not be reused.

Transverse contraction joints with retrofitted load transfers shall be sawed for the full lane width and sealed in accordance with 503.03(a) except the joint shall be cut in one operation. Transverse random cracks with retrofitted load transfer slots shall be 150 routed and sealed for the full lane width in accordance with 503.05.

PCCP damaged outside the area of the slots due to the Contractor’s operations shall be repaired in an acceptable manner or replaced.

507.09 Method of Measurement

160 Routing and sealing of cracks, filling of cracks, sawing and sealing of joints, and filling of joints will be measured by the linear foot, complete in place. Retrofit load transfer will be measured by each dowel bar assembly installed, complete in place. PCCP patching will be measured in accordance with 506.13. PCCP joint repair will be measured in accordance with 509.18. Profiling, regardless of depth, will be measured by the square yard. Asphalt material and drilled holes for undersealing will be measured in accordance with 612.07.

Construction activities for the cutting, cleaning of the PCCP, dowel bars, dowel bar supports, dowel bar end caps, foam core board, patching material and all other incidentals will not be measured.

170 Routing of cracks or sawing of joints will not be measured. Routing and sealing of transverse random cracks at retrofitted load transfer assemblies will not be measured.

Temporary traffic control measures for routing, sealing or filling of cracks or sawing, sealing, or filling of joints, and profiling will be measured in accordance with 801.17.

507.10 Basis of Payment

180 Routing and sealing of cracks, filling of cracks, sawing and sealing of joints and filling of joints will be paid for by the linear foot, complete in place. The accepted quantities of retrofit load transfer will be paid for at the contract unit price per each assembly installed, complete in place. PCCP patching will be paid for in accordance with 506.14. PCCP joint repair will be paid for in accordance with 509.19. Profiling will be paid for by the square yard. Undersealing and drilled holes will be paid for in accordance with 612.08.

The cost of temporary traffic control measures for routing, sealing or filling of cracks or joints, and profiling will be paid for in accordance with 801.18.

Payment will be made under:

190	Pay Item	Pay Unit Symbol
	Cracks in PCCP, Filled.....	LFT
	Cracks in PCCP, Rout and Seal.....	LFT
	Joints in PCCP, Filled.....	LFT
	Joints in PCCP, Saw and Seal	LFT
	Profiling PCCP	SYS
	Retrofit Load Transfer.....	EACH

200 The cost of milling, cleaning, tacking, and all incidentals shall be included in the cost of the pay item, partial depth patching.

The cost of cutting of slots, cleaning, dowel bars, dowel bar supports, dowel bar end caps, foam board, mortar, and curing materials shall be included in the cost of the pay item retrofit load transfer.

The cost of cleaning, sealing materials, and all incidentals shall be included in the cost of the pay item cracks in PCCP, filled or joints in PCCP, filled.

210 The cost of routing, cleaning, sealant materials, and all incidentals shall be included in the cost of the pay item cracks in PCCP, rout and seal. The cost of sawing, cleaning, sealant materials, and all incidentals shall be included in the cost of the pay item joints in PCCP, saw and seal.

The cost of all grinding, diamond cutting heads, and cleaning of the pavement, shall be included in the cost of the pay item for profiling.

SECTION 508 – EQUIPMENT

508.01 Production, Transportation, and Placement of PCC Mixtures

The Contractor shall provide and calibrate all equipment necessary for the mixing, transportation, and placement operations for PCCP.

508.02 Mixing Plant

(a) Plant Inspection

10 The concrete production equipment shall be capable of producing a uniform mixture. A plant inspection in accordance with 106.03 will be made by the Engineer annually, after a plant is moved, or as deemed necessary.

(b) Proportioning System

Batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices. PCCP produced in accordance with 501 and 502 shall document each ingredient in each batch.

20 All scales shall be accurate to within $\pm 0.5\%$ throughout their range unless otherwise approved. For applied loads less than 1,000 lb on the cement scale and 4,000 lb on the aggregate scale, the scales shall be accurate to 2.0% or 1 gradation.

Meters for both admixtures and water shall be accurate to within 1.0%.

Means of control shall be provided so that as the quantity desired in the weighing hopper is approached, the materials may be added at a slower rate and shut off with

precision. The following proportioning tolerances shall be used for batching:

- | | |
|----|--|
| 30 | <ol style="list-style-type: none"> 1. admixtures.....±3% 2. aggregates.....±2% 3. cementitious materials.....±1% 4. water, volume or weight.....±1%. |
|----|--|

The plant shall be equipped with a recording device capable of producing a ticket to permanently record the batch number, time of day, weight of all materials in the mix, volume or weight of mixing water added, and admixture quantities or equipped with a suitable non-resettable batch counter which will indicate correctly the number of batches produced. The CMD number shall be included on the ticket.

40 **(c) Material Storage**

The plant shall have separate storage bins or tanks for each material in the mixture. Each compartment shall discharge efficiently and freely into the weighing hopper or feed through a meter.

1. Aggregates

The aggregate storage area shall be well drained. All stockpiles shall be sufficiently separated and identified by signs or other approved methods.

2. Cementitious Materials

- 50 The storage bins shall be sealed and vented to preclude dusting during operation and have a sampling port.

3. Admixtures

Separate tanks for each admixture shall be provided.

(d) Hoppers

- 60 Weighing hoppers shall be constructed to eliminate accumulation of materials and to discharge fully. The fine aggregate and coarse aggregate shall be weighed separately into a weigh hopper in the respective amounts defined in the CMD. Separate scales and hoppers shall be used for weighing the cement. Pozzolans may be weighed into the cement hopper in one cumulative operation provided that the portland cement is weighed in first.

(e) Mixing System

The concrete mixing system shall be either a central stationary mixer or a transit truck mixer. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete, the speed of rotation of the mixing drum or blades, and the manufacturer's name and address.

70

The mixer shall be capable of combining the ingredients of the concrete within the specified time into a thoroughly mixed and uniform mass.

1. Central or Stationary Mixers

Stationary mixers shall be equipped with a timing device which does not enable the batch to be discharged until the specified mixing time has elapsed.

2. Truck Mixers

80 Truck mixers shall be equipped with means by which the number of revolutions of the drum at mixing speed may be verified.

508.03 Transportation

(a) Truck Mixers and Truck Agitators

Truck mixers and agitators shall be capable of maintaining and discharging the concrete at a satisfactory rate and degree of uniformity. The haul units shall be examined daily for accumulations of hardened concrete or mortar and compared to the manufacturer's standard for wear of blades.

90 (b) Non-Agitator Trucks

Bodies of non-agitating hauling equipment shall be smooth, mortar tight, metal containers. They shall be capable of discharging the concrete at a controlled rate. The bodies shall be examined daily for accumulations of hardened concrete, mortar, or foreign matter.

508.04 Placement Equipment

(a) Slipform

100 The paver shall spread, consolidate, and shape the freshly placed concrete in one complete pass to provide a dense and homogeneous pavement. The paver shall be of sufficient weight and power to construct the specified PCCP, at an adequate variable forward speed, and without transverse, longitudinal, or vertical instability. The paver shall be equipped with an automated steering and elevation control system.

110 The paver shall consolidate by vibrating the concrete for the full width and depth of the PCCP. Vibration shall be accomplished by internal vibrators, which have a variable frequency range of 7,000 to 12,000 vibrations per minute. The amplitude of vibration shall be between 0.025 in. and 0.06 in. The vibrators shall be spaced and operated to achieve acceptable consolidation. The paver shall include a handheld tachometer or other suitable device for measuring the frequency of the vibrators. The automated vibrator control shall be capable of stopping vibration when forward movement ceases.

Mechanical tie bar inserters shall be rigidly attached to the paver and may be operated manually or automatically controlled.

A mechanical belt placer, if used, shall have a re-combining deflector plate mounted on the end of the discharge belt.

120 **(b) Form Riding Equipment**

The finishing machine shall be supported by forms and be equipped with two or more oscillating type transverse screeds and a transverse smoothing float.

Forms for riding equipment shall be of sufficient thickness to maintain the true cross section and shall be furnished in sections no less than 10 ft in length. Forms shall have a minimum depth equal to the prescribed edge thickness of the concrete pavement without a horizontal joint, and a minimum base width equal to the depth of the forms. Flexible or curved forms shall be of an acceptable design.

130 Forms shall be provided with adequate devices for secure setting so that when in place they can withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base a minimum of 2/3 of the height of the form. The top face of the form shall not vary from a true plane by more than 1/8 in. in 10 ft and the upstanding leg shall not vary by more than 1/4 in. The forms shall contain provisions for locking the ends of abutting form sections together tightly for secure setting.

140 The transverse screed and transverse smoothing float shall be suspended from and guided by a rigid frame. The frame shall have a maximum effective wheel base of 14 ft. The length of the float shall be approximately 2 in. less than the normal width of the pavement and have an adjustable crown section. The forward speed of the float shall be adjustable.

The vibration equipment shall consolidate the full width and depth of the strip of PCCP being placed. Vibrators may be either the surface pan type or the internal type with either immerse tube or multiple spuds.

150 Vibrators may be attached to the spreader or the finishing machine or mounted on a separate carriage. The frequency of the surface pan type shall be 3,500 impulses per minute or greater. The frequency of the internal type shall have no less than 5,000 impulses per minute for tube vibrators and spud vibrators shall have a frequency of from 10,000 to 12,000 impulses per minute in air.

The paver shall include a device, such as a handheld tachometer for measuring the frequency of the vibrators. Vibrators shall have automatic controls, which stop vibration when forward motion ceases. The maximum spacing of spud vibrators shall be 2 ft. A warning device shall be connected to each vibrator circuit to indicate a failure of any individual vibrator and shall be visible from the ground.

160 **(c) Hand Placement**

1. Steel Forms

Steel forms shall be 10 ft or greater in length. Forms shall be capable of being staked in three locations or more for each 10 ft section and shall be equipped to interlock. Forms shall support finishing equipment without deflection in either the

vertical or horizontal direction. The top face of the form shall not vary from a true plane by more than 1/8 in. in 10 ft.

2. Wood Forms

170 Wood forms shall support finish equipment without deflection in either vertical or horizontal direction.

3. Finishing Equipment

The finish device or machine shall be capable of producing a uniform surface free of voids and in accordance with the planned profiles and cross section.

180 A mechanical tube finisher shall consist of a single or multiple rotating strike-off/finish tubes setting approximately transverse to the longitudinal movement of the machine. The length of finish tubes shall be a minimum of 2 ft longer than the planned PCCP width. The forward speed of the machine as well as the rate of the finish tube rotation shall be variable and it shall be reversible to allow for multiple finish passes.

190 A vibratory screed finisher shall consist of a truss frame with a minimum base width of 1 ft, which extends across the transverse width of the PCCP. The frame shall extend 2 ft beyond the width of the PCCP and shall hold its shape when moved forward. The screed shall move forward with either hydraulic or manual winches, which are capable of maintaining the screed at a right angle to the direction of travel. The screed shall be vibrated as it moves forward and the vibration shall stop when forward motion ceases. Vibration shall be accomplished with mechanical driven eccentric weights or with auxiliary driven pneumatic vibrators.

A mechanical bridge deck finishing machine shall consist of a single or multiple rotating cylinders setting approximately parallel to the longitudinal movement of the machine and operating transversely. The forward motion of the machine as well as the transverse movement of the finish cylinders shall be variable.

200 A hand operated strike off shall be rigid and shall hold its shape when moved forward with a combined longitudinal and transverse motion.

A mechanical belt placer, if used, shall have a re-combining deflector plate mounted on the end of the discharge belt.

4. Vibrators

Hand spud vibrators shall be capable of transmitting 7,000 to 10,800 impulses per minute in air. The diameter of the head shall be 1 1/4 to 2 1/2 in.

508.05 Curing

210 Mechanical equipment shall be self-supported and ride on wheels or tracks located outside the paving lane. The mechanical sprayer shall be capable of applying a continuous uniform film at a minimum rate of 1 gal./150 sq ft and shall be of the fully

508.06

atomizing type. The equipment shall provide adequate agitation of the compound during application.

Hand spraying equipment shall be of the fully atomizing type.

508.06 Texturing Equipment

220 Mechanical texturing equipment shall be capable of forming transverse grooves of uniform depth and alignment in the plastic PCCP, without tearing the surface. The texturing comb shall have steel tines spaced as specified.

Hand tools consisting of fluted floats, rakes with spring steel tines, or finned floats with a single row of fins shall produce grooves which conform to the same requirements as those specified for the grooves formed by the mechanical equipment.

508.07 Sawing Equipment

230 Sawing equipment shall be self-propelled single or gang-mounted units. The saw shall be capable of maintaining the specified alignment and depth of cut without damaging the PCCP.

508.08 Miscellaneous Equipment

(a) Hand Tools

Long handled floats used to smooth and fill in open texture areas in the pavement shall have blades no less than 5 ft in length and 6 in. in width. Equipment made of or coated with aluminum or aluminum alloys shall not be used.

240 Straightedges shall be 10 ft in length and mounted on a long handle. The handle shall be 3 ft longer than 1/2 of the width of the pavement being placed.

(b) Joint Sealing

Joint sealant material shall be installed using manufacturer's recommended equipment.

Air compressors shall be capable of producing a minimum air pressure of 80 psi.

Water blasting equipment shall be capable of operating at 1,500 psi without damaging the PCCP.

(c) Grinding

250 Grinding shall be completed by mechanical grinding equipment using diamond tipped saw blades mounted on a power driven, self-propelled machine containing transverse and longitudinal grade controls. The cutting head shall be no less than 36 in. wide to produce a uniform texture per the full width of the cutting head shaft.

The pavement surface after cutting shall have a uniform texture but shall not be smooth or polished. Tearing or dislodging of aggregates will not be allowed.

508.09 Testing Facility and Equipment

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(a) Testing Facility

Testing facility shall be capable of maintaining a controlled curing environment in accordance with AASHTO T 23 and contain sufficient storage tanks with curing solution to cure both production control and acceptance test beams.

Water shall be conveniently available for cleaning testing equipment and for serving other tasks at the facility. Office space, having suitable heat and air conditioning, shall be provided to the Department within the testing facility. A telephone shall be provided in the testing facility. Floor space shall be provided for a Department furnished beam breaker.

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A current set of AASHTO's Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part 2 Tests, and ASTM C173 shall be provided.

(b) Testing Equipment

Testing equipment shall be provided to perform production control testing and shall be maintained in suitable working order. The equipment shall be in accordance with AASHTO requirements where applicable. The Contractor shall provide a spud vibrator with power source in suitable working order.

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(c) Profilograph

The profilograph shall be in accordance with ITM 912.

(d) Straightedge – 16 ft

A 16 ft straightedge shall be a rigid beam mounted on two solid wheels on axles 16 ft apart. The straightedge has a mounted push bar to facilitate propelling the device along or across the pavement. Tolerance points are located at the 1/4, 1/2, and 3/4 points and may be composed of threaded bolts capable of being adjusted to the tolerance required.

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(e) Straightedge – 10 ft

A 10 ft straightedge is the same as a 16 ft straightedge except that the wheels are mounted 10 ft apart. A handheld rigid beam may be substituted.

SECTION 509 - PORTLAND CEMENT CONCRETE PAVEMENT, PCCP, JOINT REPAIR

509.01 Description

This work shall consist of partial depth repairs and bottom-half of slab repairs at PCCP joints in accordance with 105.03.

MATERIALS

10 **509.02 Materials**

Materials shall be in accordance with the following:

	Admixtures for Use in Concrete	912.03
	Chemical Anchor System	901.05
	Coarse Aggregate, Class A, Size No. 12*	904.03
	Curing Materials	912.01(e)2
	Epoxy Coated Reinforcing Bars	910.01(b)9
	Fine Aggregate, Size No. 23	904.02
	Joint Filler	906.01
20	Joint Sealant, Hot Poured	906.02(a)2
	Latex Modifiers	912.04
	Portland Cement	901.01(b)
	Rapid Hardening Hydraulic Cement	901.01(d)
	Rapid Setting Patch Materials**	901.07
	Water	913.01

* Crushed stone only

** The material may be extended with a coarse aggregate that is approved by the manufacturer and the Engineer.

30 Organic retarders, including food grade citric acid, may be used in concrete containing rapid hardening hydraulic cement.

Prepackaged concrete patching material shall be identified as grade 3U18 or 3U58 and selected from the QPL of Concrete for PCCP Joint Repair.

509.03 Concrete Mix Design

A concrete mix design, CMD, for the partial depth joint repair and bottom-half joint repair shall be identified as being one of the following types and shall be in accordance with 509.04.

40

- (a) Prepackaged concrete patching material, CPM
- (b) Ordinary portland cement-based concrete, OPCC
- (c) Rapid hardening cement-based concrete, RHCC
- (d) Latex modified concrete, LMC
- (e) Latex modified concrete, very early strength, LMC-VE
- (f) Rapid setting patch materials, RSP.

50 A concrete mix design submittal, CMDS, for OPCC, RHCC, LMC, and LMC-VE shall be submitted in accordance with 506.03, except that the trial batch shall be in accordance with 509.05. Prepackaged concrete patching materials, CPM and RSP, are not required to follow the submittal format of a CMDS, however, the Department shall be notified of their intended use. The CMDS, or notification of using CPM or RSP, shall be submitted a minimum of seven calendar days prior to the trial batch.

509.04 Concrete Mix Criteria

The fine aggregate for OPCC, RHCC, LMC, or LMC-VE shall be at least 48% but not more than 52% of the total volume of the aggregate in each unit volume of concrete. Proportions shall be based on aggregates in the bulk SSD condition.

- 60 The blend of coarse and fine aggregates for OPCC, RHCC, LMC, or LMC-VE shall meet the requirements stated in the table below. Aggregate volumes within the repair concrete will be determined based on the bulk SSD properties for each aggregate:

Combined Gradation of Coarse and Fine Aggregates	
Sieve Size	Percent Passing
3/8 in. (9.5 mm)	98 - 100
No. 4 (4.75 mm)	77 - 93
No. 8 (2.36 mm)	40 - 80
No. 16 (1.18 mm)	25 - 50
No. 30 (600 μ m)	15 - 35
No. 50 (300 μ m)	0 - 18
No. 100 (150 μ m)	0 - 8
No. 200 (75 μ m)	0 - 2.3

(a) CPM or OPCC

CPM or OPCC shall produce workable mixtures, with the minimum amount of water, having the following properties:

- 70 Portland cement content 846 lb/cu yd
 Maximum slump for OPCC and CPM 3U18..... 1.5 in.^A
 Maximum slump for CPM 3U58..... 6 in.^A
 Maximum water/cementitious ratio 0.400^B
 Air Content 7.0% \pm 1.5%
 Minimum modulus of rupture..... 500 psi at 7 days^C
 Minimum compressive strength 3,200 psi at 7 days^D
 Maximum shrinkage in air..... 0.060% at 28 days^D
 Relative Yield for OPCC 1.00 \pm 0.02

- 80 ^A Measured five minutes after discharge from the mixer.

^B The target water cement ratio shall be established at the time of the trial batch and shall be based on the slump requirement.

^C Concrete beams and cylinders cast for the purpose of evaluating the mix criteria shall be cured in accordance with AASHTO T 23 Section 10.1, Standard Cure conditions.

- 90 ^D The maximum allowable shrinkage will only apply if the Contractor requests to omit tooling as part of re-establishing the

longitudinal joint prior to sawing. Testing shall be in accordance with ASTM C157 and conducted on specimens cast using the same materials stated in the CMDS. Approval will be based on a type A certification in accordance with 916 which shall be submitted to the Department's Concrete Engineer.

Air entraining admixtures may be used. No other chemical admixtures shall be used.

100 **(b) RHCC, LMC, or LMC-VE**

RHCC, LMC, or LMC-VE shall be proportioned to meet the following requirements and properties:

	Portland cement content for LMC	658 lb/cu yd, minimum
	Rapid hardening cement content	
	for RHCC or LMC-VE	658 lb/cu yd, minimum
	Latex modifier for LMC or LMC-VE	3.5 gal/94 lb cement
	Maximum allowable water/cementitious ratio	
	for LMC.....	0.400 ^A
110	Maximum allowable water/cementitious ratio	
	for LMC-VE	0.440 ^A
	Maximum allowable water/cementitious ratio	
	for RHCC.....	0.450 ^B
	Slump	3 to 7 in. ^C
	Air Content for RHCC.....	6.5% ±1.5% ^D
	Air Content for LMC and LMC-VE.....	0.0% - 6.0%
	Minimum modulus of rupture.....	500 psi ^E
	Minimum compressive strength	3,200 psi ^E
	Maximum shrinkage in air.....	0.060% at 28 days ^F

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^A Including the water in the latex.

^B During production of RHCC, the water cement ratio shall be maintained within ±0.020 of the target stated on the CMDP, not to exceed 0.450.

^C Measured four to five minutes after discharge from the mixer.

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^D If the RHCC has a permeability of 900 coulombs or less at 56 days, the acceptable range of air content is allowed to be the same as LMC and LMC-VE. Verification of this property will be determined from testing of specimens cast at the trial batch. Testing will be done per AASHTO T 277, with the value determined by averaging the result of two specimens.

^E Concrete beams and cylinders cast for the purpose of evaluating the mix criteria shall be cured in accordance with AASHTO T 23 Section 10.1, Standard Cure conditions. RHCC and LMC-VE shall achieve the minimum modulus of rupture in 12 hours or less.

140 LMC shall achieve the minimum modulus of rupture in 24 hours or less. RHCC, LMC, and LMC-VE shall provide opening to traffic within the requirements for maintenance of traffic and lane closure restrictions.

150 ^F The maximum allowable shrinkage will only apply if the Contractor requests to omit tooling the longitudinal joint prior to sawing. Testing shall be in accordance with ASTM C157 and conducted on specimens cast from concrete at the trial batch. Approval will be based on a type A certification in accordance with 916, which shall be submitted to the Department's Concrete Engineer.

(c) RSP

Prepackaged RSP material may be extended with a coarse aggregate as recommended by the manufacturer. Water shall be added in an amount not to exceed the amount recommended by the manufacturer. The material shall meet the same requirements for slump, compressive strength, and shrinkage as stated in 509.04(b).

509.05 Quality Control Plan

160 A quality control plan, QCP, shall be in accordance with sections 1.1 through 4.7 of ITM 803, except that the Quality Control Technician shall be an ACI Certified Technician, Level I or higher. As a minimum, the QCP shall contain the following information concerning aspects of producing, placing, finishing, and curing the joint repair concrete for joint restoration:

- (a) Copies of all applicable AASHTO, ASTM, and ITM standards relevant to work being performed.
- 170 (b) Testing facility, if applicable, and a list of testing equipment meeting the requirements of Section 6.3.1 of ITM 803.
- (c) Materials shall be identified as to their source, transportation, handling, and storage.
- (d) Process control of aggregate when bulk aggregate is used. To include, but not limited to:
 - 180 1. Gradation testing for each aggregate and calculation of blended gradation for control within allowable tolerance.
 - 2. Absorption values for each aggregate, how they were determined, and subsequently checked.
 - 3. Daily measurement and control of moisture content of each aggregate used in the concrete.

- 190 (e) Trial batch demonstration shall be described as to procedures, location, mixing equipment, batching sequence, accuracy, and verification. The identification and intended use of each concrete mix.
- (f) Batching of concrete during repair operations shall be described to include weighing on scales, intended size of the batch, batching method, sequence, and mixing time. The methods to monitor materials used and the record of each batch shall also be included.
- 200 (g) Process control of concrete to address sampling and testing for slump, relative yield, air content, water cementitious ratio, and temperature. The frequency of tests shall be the first batch of the day and not less than three times per day including the first. If volumetric batching of concrete is utilized, the yield will be checked as described in 722.05(a) at the beginning of the day and not less than two times per day including the first load from each mobile mixer. The QCP shall include details as to actions in response to test results.
- 210 (h) Joint repair operations shall be described, to include the materials and equipment used for re-establishing longitudinal and transverse joints; delivery, placement, consolidation, finishing, smoothness, texturing, curing of concrete, and procedures for monitoring each operation.
- (i) Process control for weather restrictions shall be addressed, including what materials will be on-hand to protect the edges and surface of the repair area, and what corrective actions are proposed in case the joint repair concrete is damaged by rain.
- 220 (j) Documentation and submittals.

509.06 Trial Batch

A trial batch shall be produced and tested to verify that the repair concrete is in accordance with the appropriate concrete mix criteria for CPM, OPCC, RHCC, LMC, LMC-VE, or RSP material. The trial batch shall be conducted prior to production. The equipment used for mixing concrete at the trial batch shall be the same as what is identified in the QCP for use during field production.

- 230 The modulus of rupture from flexural strength testing and compressive strength will be determined by averaging a minimum of two tested specimens for each age. The beams and cylinders shall be cured in accordance with AASHTO T 23 Section 10.1, Standard Cure conditions. Only the specimen types intended for job control in accordance with 509.14 and determining opening to traffic strength in accordance with

509.17 are required to be included in the trial batch. The Engineer will test the concrete for the plastic and hardened concrete properties as follows using the property values listed in 509.04.

	CPM	OPCC	LMC	RHCC, LMC-VE	RSP
Compressive strength	12, 36, 72 h	12, 36, 72 h	12, 24, 48 h	3, 6, 12, 24 h	3, 6, 12 h
Modulus of rupture	12, 36, 72 h	12, 36, 72 h	12, 24, 48 h	3, 6, 12, 24 h	3, 6, 12 h
Plastic testing	air, slump, W/C ratio*	relative yield, air, slump, W/C ratio*	relative yield, air, slump	relative yield, air, slump	slump
*The W/C ratio will be calculated after mix has been tested for slump.					

240 The Engineer will provide the Contractor the results of the tests. Relative yield will be measured in accordance with 722.05(a) for repair concrete produced in a volumetric mixer. Mobile mixers will be calibrated in accordance with 722.13.

The trial batch shall be of a sufficient quantity to allow the Engineer to perform all required tests from the same batch. Trial batch concrete shall not be used for more than one test.

CONSTRUCTION REQUIREMENTS

509.07 Pre-Work Meeting Requirements

250 A pre-work meeting between the Engineer and the Contractor will be held on-site prior to beginning the work. The Contractor shall be prepared to discuss the following:

- (a) Work schedule
- (b) Traffic control plan
- (c) Equipment calibration and adjustments
- 260 (d) Inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials
- (e) CMDP
- (f) The Contractor's daily rate of production per work crew
- (g) QCP.

509.08 PCCP Removal

PCCP removal areas for partial depth repairs will be determined by sounding and

270 will be marked. The Contractor shall remove all concrete to the limits shown on the plans or as directed by the Engineer. A machine configured to safely and consistently mill the necessary profile as detailed on the plans shall be provided. The teeth on the milling head shall be spaced at either 1/2 in. or 5/8 in. The milling machine shall be subject to approval by the Engineer prior to the start of milling operations. Whenever possible, the rotating axis of the milling head shall operate perpendicular to the joint being repaired. Should PCCP removal be confined to one side of a joint, the milling machine shall be controlled so as to not cause damage to the adjacent pavement.

280 Unless otherwise approved by the Engineer, areas that are less than 1 sq ft shall be removed by saw cutting and chipping. The saw cutting shall be to a depth of 2 in. within the marked area. Overlapping saw cuts at the outer perimeter of the repair shall not extend more than 2 in. beyond the intersection. Removal of the concrete within the limits of the saw cuts shall be by hand chipping tools or handheld mechanically driven equipment. Mechanical hammers may be used to remove the concrete inside the area delineated by the saw cuts, but shall not be heavier than a nominal 35 lb class. Mechanically driven tools shall be operated at a maximum angle of 45° from the PCCP surface. A jack hammer with a wide chisel bit shall be used at a distance of 2 in. from the saw cut to remove the vertical edge and create a taper similar to the milling operations.

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Removal areas within jointed reinforced concrete pavement, JRCP, are not required to utilize milling to initiate partial depth repairs. Saw cutting and hand chipping may be used as described above. Any wire mesh reinforcement exposed during the removal operations shall be removed.

PCCP removal areas shall not remain open overnight unless otherwise approved by the Engineer. Shoulders or adjacent PCCP damaged during the removal operations shall be repaired as directed.

300 Milling, or sawing and hand chipping, is allowed for transverse joint repairs that intersect a longitudinal joint that has already undergone partial depth joint repair. Removal areas along a longitudinal joint shall not disturb a transverse joint that has already undergone partial joint repair in accordance with this specification. Prior to any transverse joint repair that intersects a previous longitudinal repair, the existing partial depth repair along the longitudinal joint shall have achieved at least 12 h of curing, a passing soundness inspection, and adequate strength, as defined in 509.17. If there is no need for the transverse joint repair to completely cross the longitudinal joint, milling operations along the transverse joint shall stop short of the longitudinal joint so as not to cause damage beyond the longitudinal joint. Sawing and hand
310 chipping shall be used to complete the removal process up to the longitudinal joint.

Longitudinal joint repairs shall be terminated 12 in. or more from a transverse joint.

The Engineer will check milled surfaces after PCCP removal to identify any

unsound concrete that remains. Limits of the removal area will be identified by sounding with a rock hammer. Areas of unsound concrete will be marked and shall be removed with a chipping hammer. Removal of unsound concrete below the elevation of the tops of dowel bars or tie bars is not intended and unsound concrete shall remain
 320 in place in these areas. For transverse joints, any voids or significant surface irregularities resulting from the hand chipping operations that extend below the elevation of the top of the dowel bars shall be filled using hand placed clean sand to make a uniform, level, bedding material to support the joint filler. For longitudinal joints, void space below the elevation of the top of tie bars shall be filled with repair concrete.

Dowel bars shall not be damaged during the removal of unsound concrete. At locations where a transverse joint meets the edge of pavement, or where joints intersect, the Engineer will determine if the concrete is deteriorated for the entire
 330 depth, within the limits detailed on the plans for bottom-half joint repair. If either end of a dowel bar is exposed or misaligned in a bottom-half joint repair, the exposed portion shall be removed or cut flush with the concrete surface, as directed by the Engineer.

If the combination of removal for partial depth joint repair and bottom-half joint repair exposes more than two adjacent dowels at a contraction joint, the Engineer shall be notified to determine if full depth patching is to be conducted in accordance with 506.08(b).

340 If a snowplowable raised pavement marker is to be installed in an area of partial depth joint repair, the width of the removal area, in proximity to where the RPM is to be installed, may be increased in order to provide the necessary clearances as specified in 509.16.

509.09 Surface Preparation and Joint Filler Installation

The milled or hand chipped cavities shall be prepared to provide a clean, irregular surface for the development of a good bond between the joint repair concrete and the existing pavement.

350 Broken concrete pieces shall be removed and the cavities shall be swept clean. The surface of the cavity shall be thoroughly sandblasted and cleaned with compressed air to remove all dust and chips. Cleaning with compressed air shall be performed as close to placing the concrete as possible, but not after installing any joint filler. If joint filler material has been installed, the surface may be cleaned again by using compressed air at low pressure so as to not damage the in-place filler or sand below the top of any exposed dowel bar just prior to placing the grout or concrete. The air lines for sandblasting and compressed air cleaning shall be equipped with oil traps to prevent contamination of the surfaces.

360 (a) Joint Filler - General Requirements

The installation of joint filler is required before concrete placement and shall be

of a width that matches the existing transverse or longitudinal joint being repaired or a minimum width of 3/8 in, whichever is greater. The joint filler shall extend at least 3 in. beyond the length of the patch area. Joint filler shall be installed as one piece for the depth of the repair. Splicing long lengths of joint filler may be allowed. The method of splicing shall be subject to approval by the Engineer.

(b) Joint Filler at Transverse Joints and Bottom Half Repairs

370 Use of joint filler is required for establishing compression relief at all existing transverse D-1 contraction joints and along both the longitudinal and transverse joint sides of a bottom-half repair.

The joint filler shall not only re-establish the joint within the repair but shall also prevent the infiltration of the concrete into and across the crack or joint. Prior to placement of the joint filler at a transverse contraction joint, the joint shall be tooled or widened sufficiently at the bottom of the repair to create a slot so that the joint filler can be inserted a minimum of 1/4 in. below the bottom of the repair concrete. The base of the slot shall not extend below the elevation of the top of any exposed dowel bar. Joint filler shall be cut or trimmed to match the irregularities of the concrete at the 380 bottom of the slot. Duct tape shall be placed as a bond breaker on exposed dowel bars.

Any void space that exists below the top of exposed dowels shall be filled with clean No. 23 natural sand that is sufficiently dry to flow into the gap.

(c) Longitudinal Joints

Joint repairs at longitudinal joints shall utilize either a joint filler to re-establish the joint or perform both of the following:

- 390 1. Tool the plastic repair concrete after placement to create a weak plane at the original joint location. The joint tooling equipment shall be identified in the QCP and approved by the Engineer prior to use. Tooling of the joint may be eliminated if the concrete used in the patch has been verified by the Engineer as meeting the shrinkage requirements stated in 509.04.
- 400 2. Saw the joint after the repair concrete has adequately hardened. Sawing of the tooled joint shall be performed with a 1/4 in. blade. Sawing shall be done with care as soon as possible without causing excessive raveling of the repair material. The depth of the saw cut shall extend below the full depth of the repair by at least 1/4 in., but no closer than 1 in. above the tie bar. If it is determined that a crack forms at the bottom of the tooled joint before sawing can be performed without raveling, sawing to re-establish the joint shall not be performed.

Areas designated by the Engineer as requiring bottom-half joint repair shall be prepared as shown on the plans. The reinforcing bars shall be installed in accordance with 503.03(g).

509.10 Concrete Mixing and Transportation

For onsite weighing and batching of OPCC or RHCC, the appropriate number of pre-packaged bags of cement, shall be at the mixing site to accommodate the day's production. The fine and coarse aggregate shall be pre-weighed to within 2% of their target for the batch size and placed in appropriate containers. Each aggregate component for a batch shall be identified as to material and weight, to facilitate accurate batching into the mixer in the proper sequence.

Water, air entraining agent, and chemical admixtures, if appropriate, shall be at the mixing site. The water necessary to provide the required slump shall be measured by weight or volume and recorded for each batch. All components of cement, aggregates, water, air entraining agent, and any organic retarder shall be charged into a paddle type mixer according to the sequence defined in the QCP and mixed for a minimum of five minutes. The location of mixing shall be on the job site in close proximity to the joint repair operations.

Prepackaged concrete, CPM 3U18, and an air entraining admixture, may be used instead of batching individual components. Pre-packaged concrete, CPM 3U58, shall not be modified with admixtures.

A prepackaged RSP material containing coarse aggregate may be used. Addition of water and mixing shall be in accordance with the manufacturer's instructions.

Wash water shall not be used as a portion of the mixing water for any joint repair concrete.

LMC and LMC-VE shall be mixed in a mobile type volumetric mixer meeting the requirements of 722.09(a). The Engineer may also allow batching and mixing of OPCC or RHCC in a mobile-type volumetric mixer except the mixer shall carry sufficient quantities of unmixed ingredients to produce at least 2 cu yds and is not required to be self-propelled. Calibration of the mixer shall be in accordance with 722.13.

509.11 Weather Limitations

Joint repair concrete that has been placed shall be protected from rain. Materials described in the QCP for protection of the edges and surface of the repair area shall be readily available for use. Should any damage result, the Engineer will suspend operations until corrective action as described in the QCP is taken.

Joint repair concrete shall not be placed when either the ambient temperature or existing concrete pavement temperature is less than 50°F.

Temperature restrictions for chemical anchor systems used in anchoring deformed steel reinforcement for bottom half repairs shall be in accordance with the manufacturer's recommendations.

509.12 Placing and Finishing Concrete

460 CPM, OPCC, and RSP repair concrete shall be placed within 15 minutes of mixing. RHCC, LMC, and LMC-VE shall be placed within five minutes of mixing. All repair concrete shall be placed such that a cold joint does not occur within the limits of an individual, or intersecting, longitudinal or transverse joint repair. Placement may be isolated to one side of a joint if the joint face or joint filler is properly supported. Repair along a transverse joint that intersects a previously repaired longitudinal joint is allowed as described in 509.08.

470 For CPM and OPCC material, the cleaned surface shall be lightly sprayed with water to wet the surface without ponding and a bonding grout shall be applied to the prepared surface. The grout shall consist of two parts Type I or Type II portland cement and one part sand mixed with sufficient water to form a slurry that can be spread evenly onto the prepared concrete surface. The grout shall be mixed mechanically and applied by brushing or scrubbing, with a stiff bristle broom, onto the prepared and wetted concrete surface. The pot life of the grout shall not extend beyond 1 h. CPM or OPCC repair material shall be placed immediately after applying the bonding grout.

480 For RHCC, LMC, and LMC-VE, thoroughly soak the cleaned surface and maintain it in a wet condition for at least 2 h immediately prior to placing the repair concrete. Maintaining a wet surface shall be accomplished by covering the soaked surface with wet burlap. The burlap shall be re-wetted as necessary. A layer of white opaque polyethylene film, that is at least 4 mils thick, may be used to offset the need to rewet the burlap. Prior to placing the joint repair material, the burlap shall be removed. Any standing water in depressions, holes, or areas of concrete removal shall be blown out with compressed air or other type of blower sufficient for removal, or by the use of an approved vacuum system. The surface shall be damp at time of placing the repair concrete. Bonding grout shall not be used.

490 For RSP material, the cleaned surface shall be lightly sprayed with water to thoroughly wet the surface without ponding. RSP repair material shall be placed immediately after wetting the surface. Bonding grout shall not be used.

When using a bonding grout, if the material dries or whitens prior to placing the concrete joint repair material, the repair material shall not be placed. The dried grout shall be thoroughly removed by sandblasting and cleaning as specified in 509.09.

Concrete for partial depth joint repair shall be placed monolithically with concrete for bottom-half joint repair, using the same concrete mixture. Concrete shall be consolidated by internal vibration and struck off level to the adjacent PCCP. Joint filler shall remain straight for the length of the repair, within a tolerance of $\pm 1/4$ in. Concrete

500 shall be hand finished and shall be controlled so that excess mortar and water is not worked into the surface. Final hand finishing shall have the trowels or floats work the surface from the joint toward the edge of the patch to avoid tearing the new concrete away from the existing pavement.

Edging is required for fresh concrete adjacent to all joint filler or forms. Concrete repairs at transverse joints shall not protrude into an HMA shoulder by more than 3/8 in. by forming or sawing the edges. The concrete surface of the partial depth joint repair shall be textured by brooming in the longitudinal direction of the repair. All repairs shall be broom textured regardless of subsequent surface treatments.

510

The final finished surface of the repair shall not vary more than 1/8 in. from the existing pavement surface as measured with a straight edge over the joint. Partial depth patches that are not smooth shall be corrected by diamond grinding. Such grinding shall be completed after the concrete has gained sufficient strength for opening to traffic.

Immediately upon completion of finishing and texturing of the partial depth joint repair for all material types including CPM, OPCC, RHCC, LMC, LMC-VE, and RSP, grout shall be applied with a brush to the entire perimeter of the repair. Proportioning and mixing of the grout shall be the same as previously described in this section for bonding of CPM and OPCC material.

520

509.13 Curing

A resin-based liquid membrane forming compound in accordance with 912.01(e)2 shall be applied as soon as possible after the bleed water has dissipated. The compound shall be agitated in the shipping container to obtain a homogenous mixture for transfer to the job site application equipment. Application of curing compound shall be in accordance with the following:

530

(a) Rate of application shall be at least one gallon per 200 sq ft of surface curing area.

(b) Curing compound shall be applied to provide a uniform, solid, white opaque coverage on all exposed concrete surfaces similar to a white sheet of paper.

540

(c) If the applied curing compound is damaged by rain or other means during the curing period, the damaged area shall be repaired as soon as possible by re-application at a rate equal to the original coat.

(d) If the Engineer determines that the initial, or corrective re-application, results in unsatisfactory curing, the Engineer may prohibit the use of curing compound and instead require the use of wet double burlap or waterproof covers in accordance with 504.04.

Whenever weather conditions exist that cause unusual or adverse placing and finishing conditions or equipment failures occur, the application of curing materials shall be expedited, or the mixing and placing operations shall be temporarily suspended as the conditions require.

When a deficiency is identified in the curing process, the joint repair shall be removed and replaced. If the repair is removed exposing an underlying bottom-half repair, the bottom-half repair shall also be removed and replaced.

509.14 Job Control

Control of concrete for slump, air content, or relative yield, as appropriate for the mix, and strength based on modulus of rupture obtained from flexural strength beams or compressive cylinders will be determined on the basis of tests performed by the Engineer in accordance with 505.

The labor necessary for concrete sampling shall be furnished as required by the Engineer. Testing for slump, air content, and relative yield as appropriate for the mix, will be on the first batch of the day and a minimum of once per every 400 cu ft thereafter. Beams or cylinders will be made for evaluating the quality of the delivered mix at least once for every three days of production or whenever slump, relative yield, or air content are failing the upper limit. The beams or cylinders will be tested for compliance with strength requirements, at an age consistent with the mixtures intended use as defined in 509.04. Beams or cylinders for this purpose shall be cured in accordance with Section 10.1 of AASHTO T 23 and 505.01(a).

The Engineer will notify the Contractor when measurements for slump, unit weight, air content, or modulus of rupture are outside of the specified requirements. Rounding will be in accordance with 109.01(a).

509.15 Joint Sealing

Joint openings within a repair area shall be maintained for the full depth of the joint repair concrete as described in sections 509.09 and 509.12. Longitudinal and transverse joints shall be sawed to create a reservoir for the sealant, to be followed by cleaning and sealing. If the longitudinal joint was re-established by sawing in accordance with 509.09(c)2, additional sawing to create a reservoir for the sealant is not required. If the longitudinal joint was not sawed due to cracking in accordance with 509.09(c)2, the reservoir for the sealant shall be sawcut to a maximum depth of 7/8 in.

The cleaning and sealing of the joint shall be in accordance with 507.04(a) and as follows. Transverse and longitudinal joints shall be sealed with hot poured joint sealant in accordance with the sealant manufacturer's recommendations. Joints shall be sealed with joint sealing materials within 1/4 in. below the surface and shall extend beyond the limits of the patch to any existing sealant that is to remain in place. A distributor in accordance with 409.03 shall be used with an indirect-heat, double boiler kettle and

mechanical agitator. The hot poured joint sealant shall be placed utilizing a “V” shaped wand tip to allow the penetration of the material into the joints.

Any grinding to correct smoothness of partial depth patches shall be completed prior to joint sealing.

509.16 Snowplowable Raised Pavement Markers

600 Snowplowable raised pavement markers, RPM, shall be located and installed in accordance with 808.11, except that the marker shall be installed a minimum of 2 in. from the longitudinal joint. If the marker is installed within the limits of the partial depth patch, the slot shall be at least 2 in. from the edge of the repair. The repair material shall have attained a modulus of rupture of 500 psi or greater from flexural strength testing or 4,000 psi from compressive testing, prior to creating the slot for the adhesive and RPM. The slot may be created by grinding or by saw cutting and hand chipping. Each RPM installation will be inspected for proper installation. There shall be no visual cracks at the surface of the partial depth patch and the installation will be sounded to detect any loss of bond between the partial depth patch material and the
610 substrate PCCP. Any such defect shall require repair of the partial depth patch and reinstallation of the RPM to the satisfaction of the Engineer, which may involve removal and replacement of the partial depth patch along the longitudinal joint between the limits of the transverse contraction joints. Any such repairs shall be made at no additional cost to the Department.

509.17 Opening to Traffic

Opening to traffic strength will be based on the modulus of rupture from one flexural strength test or the average of two cylinders. Cylinders will be either 6 in. by 12 in. or 4 in. by 8 in. Completed partial depth repairs and bottom-half repairs may be
620 opened to traffic when flexural strength tests indicate a minimum modulus of rupture of 500 psi or when compressive strength tests indicate a minimum of 3,200 psi based on the average of the two individual cylinder breaks. Beams or cylinders for this purpose will be cast from repair concrete placed near the very end of each day’s production for each different CMDP used and cured in accordance with Section 10.2 of AASHTO T 23 and 505.01(a).

Prior to opening to traffic, the Contractor and the Engineer will conduct an inspection of the partial depth patches to determine if there are any failures. Failures will include, but are not limited to, debonding of the repair concrete or random surface
630 cracks. Repair of the failed partial depth joint repair or bottom-half joint repair shall be completed by an approved method prior to opening the pavement to non-construction traffic.

509.18 Method of Measurement

Partial depth joint repair will be measured at the surface, by the square foot, using linear dimensions measured to the nearest 0.1 ft.

Bottom-half joint repair will be measured by the square foot using linear

640 dimensions measured to the nearest 0.1 ft at the mid-depth of the pavement, when the following conditions are met:

- (a) The PCCP is removed full depth to visibly expose the subbase below.
- (b) The minimum number of reinforcing bars are furnished and installed as shown on the plans.

650 If the above requirements for bottom-half repairs are not met, the Engineer will only take measurements for payment under partial depth joint repair regardless of depth of the repair.

Additional removal width to accommodate the Contractor’s equipment will not be measured.

For repairs at intersecting joints, the same area of joint repair will not be measured twice.

Sawing and sealing of joints in areas of partial depth joint repair will not be measured.

660

509.19 Basis of Payment

Partial depth joint repair and bottom-half joint repair will be paid for at the contract unit price per square foot. Measured areas of partial depth joint repair that are not located at a joint or crack will be paid as partial depth joint repair.

Payment will be made under:

	Pay Item	Pay Unit Symbol
670	Joint Repair, Partial Depth	SFT
	Joint Repair, Bottom-half	SFT

680 The cost of the trial batch for each concrete mixture, removing and disposing of the in-place concrete pavement as marked by the Engineer, tapering the edges of the repair back at 30 to 60 degrees, cleaning, sandblasting and air blasting, treatment of dowel bars, furnishing and installing bonding grout, furnishing and installing joint filler or tooling and sawing to re-establish the joint within or along the repair, furnishing and placing the concrete within the repair, vibrating, screeding, finishing, texturing, placing cement slurry around the edges, curing and protecting the concrete, sawing and sealing to re-establishing joints, cleanup, and any other materials, labor, equipment, or incidentals necessary to complete the work as specified shall be included in the cost of the joint repair, partial depth pay item.

The cost of removal and disposal of the in-place concrete pavement as determined by the Engineer, cleaning sandblasting and air blasting, treatment of dowel bars,

690 furnishing and installing steel reinforcement, furnishing and installing bonding grout, furnishing and installing joint filler and sawing to re-establish the joint within or along the repair, furnishing, placing, and vibrating the concrete within the repair, sawing and sealing to re-establishing joints, cleanup, and any other materials, labor, equipment, or incidentals necessary to complete the work as specified shall be included in the cost of the joint repair, bottom-half pay item.

Areas of removal for PCCP Joint Repair, which after inspection by the Engineer, are determined to need PCCP Patching, Full Depth in accordance with 506.08(b), will be paid at 40% of the contract unit price per sq ft for the work represented for both Joint Repair, Partial Depth and Joint Repair, Bottom-half. PCCP Patching, Full Depth will be paid at 100% of the contract unit price.

700 During periods of overnight lane closure, if the Engineer inspects an area of joint repair and determines that PCCP Patching, Full Depth in accordance with 506.08(b) is necessary, the joint repair may be completed if needed to meet the opening to traffic requirement. If completed in order to meet the opening to traffic requirement, the joint repair will be paid at 100% of the contract unit price.

Joint repair areas that do not meet the curing requirements of 509.13 shall be removed and replaced at no additional cost to the Department.

710 Additional removal width to accommodate the Contractor's equipment shall be at no additional cost to the Department.

Removal and replacement of partial depth patches and snowplowable raised pavement markers as described in 509.16 for debonding and other defects shall be at no additional cost to the Department.

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DIVISION 600 – INCIDENTAL CONSTRUCTION

SECTION 601 – GUARDRAIL

601.01 Description

This work shall consist of the fabrication, assembly, and installation of guardrail, guardrail transitions, and guardrail end treatments, in accordance with these requirements, and as shown on the plans. This work may also consist of the extension of existing guardrail with new guardrail, the removal of existing guardrail, or adjusting the height of existing guardrail.

10

MATERIALS

601.02 Materials

Materials shall be in accordance with the following:

	Alternate Material Blockouts.....	926.03
	Guardrail Posts	910.10
	Rail Accessories, Fittings, and Hardware.....	910.11
	Steel Thrie-Beam Rail	910.09
	Steel W-Beam Rail	910.09
20	Timber Posts and Blockouts.....	911.02(f)

All guardrail, post, accessories, fittings, and hardware shall be supplied from a manufacturer listed on the QPL of Guardrail Manufacturers in accordance with 910.09. Guardrail end treatments shall be selected from the QPL of Guardrail End Treatments in accordance with 601.07 and impact attenuators shall be selected from the QPL of Impact Attenuators in accordance with 601.08.

30

PCC in anchors and in pads or bases for impact attenuators shall be class A and in accordance with 702. Sheet signs and sign posts shall be in accordance with 802.

Barrels used in impact attenuators shall be yellow with black lids. The coarse aggregate used in the barrels shall be size 93PG, class F or higher, in accordance with 904.

All other impact attenuators shall have end reflectorization as shown on the plans or attached to the nose of the attenuator in accordance with the attenuator manufacturer’s recommendation.

40

Thrie-beam guardrail elements shall be steel and shall be in accordance with the applicable requirements for steel beam guardrail shown in 910.09, 910.10, and 910.11.

W-beam or Midwest Guardrail System, MGS, W-beam guardrail, components, assembly, post spacing, post lengths, and installation for each location shall be as

shown on the plans. Double-facing of the guardrail will be required at the locations shown on the plans. For W-beam guardrail, in locations where conditions will not allow the use of 7 ft posts, 6 ft posts may be substituted when approved. Timber posts may be used within a run of MGS W-beam guardrail as shown on the plans. Timber posts shall not be used within a run of W-beam guardrail.

- 50 The base metal thickness of the steel W-beam rail element for a curved guardrail system shall be 0.105 in. The base metal thickness of the steel W-beam terminal connector shall be 0.138 in. The controlled released terminal, CRT, timber breakaway posts shall be S4S timber and shall otherwise be in accordance with 911. The curved rail timber posts shall be in accordance with 911. All structural tubing shall be in accordance with ASTM A500. The remaining steel components shall be in accordance with 910.

CONSTRUCTION REQUIREMENTS

60 **601.03 General Requirements**

Posts shall be installed plumb at the spacing and embedment depth shown on the plans. Posts shall be driven where subsurface conditions enable the use of normal driving equipment. Where subsurface conditions prohibit driving the posts, a 12 in. diameter hole shall be bored to the required embedment depth. The hole shall be backfilled with suitable material in 6 in. maximum lifts, compacted as directed, and then the posts driven.

Posts damaged during installation shall be repaired or replaced as directed with no additional payment.

70

When new guardrail is being installed to replace existing guardrail and traffic is to be maintained during the work, the installation of the new guardrail shall follow the removal of the existing guardrail as closely as practical. Adequate safety protection shall be provided as directed between the time that the existing guardrail is removed and the time that the installation of the new guardrail is completed.

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When new guardrail is being installed where there is no existing guardrail and traffic is to be maintained during the work, the mounting of the blockouts and the rail elements to the posts shall be completed as soon as practical after the posts are installed. The time between the installation of the posts and the mounting of the blockouts and rail elements shall not exceed 24 h. Drums shall be placed to mark all installed guardrail posts left bare overnight. The spacing of these devices shall be numerically equal to the worksite speed limit, but not less than 20 ft.

All damaged galvanized surfaces shall be coated in accordance with 910.11(a)4.

W-beam guardrail shall be installed as shown on the plans with the W-beam rail element splice at the post. MGS W-beam guardrail shall be installed as shown on the

90 plans with the W-beam rail element splice at midspan. MGS W-beam guardrail installed with half or quarter post spacing shall be spliced as shown on the plans.

The nested W-beam guardrail element shall consist of two rail elements, one set inside the other. The length of nested guardrail placed over a culvert shall not be spliced.

601.04 Guardrail Erection

100 Blockouts and rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts shall be of sufficient length to extend beyond the nuts and shall be drawn tight. Rail installed along a radius of 150 ft or less shall be shop curved. Rail elements shall be lapped as shown on the plans.

601.05 Curved W-Beam Guardrail Systems

This work shall consist of the fabrication, assembly, and installation of specified types of curved W-beam guardrail connector system or curved W-beam guardrail terminal system in accordance with the requirements herein and as shown on the plans.

The installation of the terminal end buffer may utilize an alternate single piece having similar dimensional shape to the terminal end buffer as shown on the plans, and which mates with the W-beam guardrail.

110

Where the W-beam terminal connector is lapped on the outside of the guardrail, a galvanized 1 in. inside diameter, 2 in. outside diameter, 0.134 in. thick, narrow plain washer shall be placed under the splice bolt heads.

Nuts for the anchor cable assembly shall be hand tightened, plus one complete turn at the anchor plate end. All other nuts shall be torqued to 50 ft lb.

The installation of the type 5 anchor shall include tightening the cable with the swaged end to eliminate all slack.

120

The W-beam rail in the type 5 anchor shall be attached to the steel pipe with 5/8 in. diameter by 1 1/4 in. button head bolt with no washer. Connection to the post will not be required.

601.06 Guardrail Transitions

Guardrail transitions shall be required to connect guardrail to bridge rail, guardrail to piers, and new W-beam guardrail to existing rub rail type guardrail. The required type of guardrail transition shall be as shown on the plans.

130

An MGS guardrail transition, with or without curb, shall be required to connect guardrail to bridge rail, guardrail to piers. An MGS height transition shall be required to connect MGS W-beam guardrail to existing W-beam or existing rub rail type guardrail. The required type of guardrail transition shall be as shown on the plans.

601.07

The fabrication, assembly, and installation of thrie-beam rail, W-beam rail components, and posts and blockouts for guardrail transitions will be required for the locations shown on the plans.

601.07 Guardrail End Treatments

140 Guardrail end treatments shall be required to terminate guardrail installations at the locations shown on the plans. The type I guardrail end treatment shall be either as shown on the plans, or shall be selected from the QPL of Guardrail End Treatments. The type II guardrail end treatment shall be as shown on the plans. The type OS or MS guardrail end treatments shall be selected from the QPL of Guardrail End Treatments. The grading requirements shall be as shown on the plans.

150 Assembly and installation or resetting shall be supervised or performed at all times by an installer trained and certified by the unit's manufacturer, and shall be in accordance with the manufacturer's recommendations. The installer shall be included on the Department's list of Qualified Guardrail End Treatment and Impact Attenuator Installers prior to the start of work.

The Contractor shall provide the Department with original copies of all necessary current manufacturer's installation manuals and working drawings in accordance with 105.02.

Double facing of guardrail end treatment type I will be required when it is used in conjunction with double faced guardrail.

160 When installing end treatments to existing rub rail type guardrail, the rub rail, if spliced at the last existing post, shall be cut and the end repositioned behind the flange of the post. If the rub rail is spliced at the last existing post, the existing splice material shall be removed, and the end of the rub rail repositioned behind the flange of the post. In both cases, the rub rail shall be connected to the post as shown on the plans.

170 Guardrail end treatments shall be installed within 24 h of the completion of the guardrail installation to which they are to be attached. Drums in accordance with 801.09 shall be placed for overnight marking of the bare end of the guardrail when the installation of the guardrail end treatment will not be completed until the day following the completion of the guardrail installation to which it is to be attached.

601.08 Impact Attenuators

Impact attenuators shall be placed or reset to obtain the proper height where shown on the plans. The unit for each new location shall be of the width recommended by the manufacturer and for the test level specified and shall be chosen from those shown on the QPL of Impact Attenuators. Each unit shall be placed in accordance with the manufacturer's recommendations, on a PCC pad.

180 Assembly and installation or resetting shall be supervised or performed at all times by an installer trained and certified by the unit's manufacturer, and shall be in

accordance with the manufacturer's recommendations at the locations shown on the plans. The installer shall be included on the Department's list of Qualified Guardrail End Treatment and Impact Attenuator Installers prior to the start of work.

The Contractor shall provide the Department with original copies of all necessary current manufacturer's installation manuals and working drawings in accordance with 105.02.

190 Transition panels and all other necessary hardware shown in the manufacturer's recommendations to be required for bi-directional traffic protection shall be included in the installation or resetting, if the unit is installed at a location where traffic is passing the unit on both sides in opposite directions.

601.09 Extension of Existing Guardrail

200 Extension of existing rub rail type guardrail with new W-beam guardrail shall require adjusting the post heights in the last 25 ft of existing rub rail type guardrail adjacent to the extension as shown on the plans. Guardrail transition type VH shall be used to make this adjustment. The post spacing of the guardrail transition type VH shall equal that of the last 25 ft of existing rub rail type guardrail adjacent to the extension. The rub rail shall be terminated at the last existing post in the transition in accordance with 601.06.

Extension of existing rub rail type or W-beam guardrail with new MGS W-beam guardrail shall require adjusting the splice location and post height in the last 37 ft 6 in. of the existing rub rail type or W-beam guardrail as shown on the plans. MGS height transition shall be used to make this adjustment. The rub rail shall be terminated at the last existing post in the transition in accordance with 601.06.

601.10 Removal of Existing Guardrail

210 Removal of existing guardrail shall be in accordance with the applicable requirements of 202 and these requirements. The locations shall be as shown on the plans. When it is specified that the removed guardrail is to become the property of the Department, the rail elements, posts, and blockouts shall be removed without being damaged. The removed material shall be stored as directed.

601.11 Adjusting Existing Guardrail Height

220 The height of the existing guardrail shall be adjusted by the use of moveable blockouts as shown on the plans. The height shall be measured to the top of the rail element along the face of the rail. Existing fixed blockouts shall be replaced with moveable blockouts installed at the proper height. Existing moveable blockouts shall be disconnected from the posts and re-mounted at the proper height.

601.12 Resetting Guardrail

This work shall consist of the removal of existing guardrail and, and if necessary, storing it, and then re-erecting it where shown on the plans or as directed.

601.13 Method of Measurement

Guardrail, guardrail with rub rail, shop curved guardrail, adjusting guardrail height, guardrail removal, and resetting guardrail will be measured by the linear foot
 230 along the top of the rail element, complete in place. Nested guardrail will be measured per each 100 lft run placed. Modified posts for nested guardrail will be measured per each, complete in place. MGS structure top-mounted posts will be measured per each, complete in place. Long span MGS W-beam guardrail will be measured per each for the type specified and corresponding run length between outermost CRT posts. Guardrail transitions, W-beam and MGS W-beam guardrail cable terminal anchors, and guardrail end treatments will be measured per each, complete in place. Guardrail buried end treatments type II will be measured per each. Impact attenuators and resetting impact attenuators will be measured per each for the type and width and test level, complete in place. The curved W-beam guardrail connector system and the
 240 curved W-beam guardrail terminal system will be measured per each for the type specified. Grading at guardrail end treatments, the reflectorization of guardrail end treatments, and concrete used in anchoring guardrail end treatments will not be measured for payment.

Aggregate used to fill gravel barrel impact attenuators will not be measured for payment.

601.14 Basis of Payment

W-beam and MGS W-beam guardrail will be paid for at the contract unit price
 250 per linear foot for the specified post spacing. Thrie-beam and thrie-beam double faced guardrail will be paid for at the contract unit price per linear foot for guardrail, thrie-beam and guardrail, thrie-beam, double faced, complete in place. Nested guardrail will be paid for at the contract unit price per each 100 lft run, complete in place for guardrail, W-beam, nested. Long span MGS guardrail will be paid for at the contract unit price per each type specified and corresponding run length between outermost CRT posts, complete in place for guardrail, MGS, long span. W-beam and MGS W-beam guardrail cable terminal anchor will be paid for at the contract unit price per each, complete in place. Modified posts for nested guardrail will be paid for at the contract unit price per each for modified posts, nested guardrail. Structure top-
 260 mounted posts will be paid for at the contract unit price per each for guardrail, MGS, structure top-mounted posts.

W-beam guardrail with rub rail will be paid for at the contract unit price per linear foot for guardrail, WR-beam complete in place. Shop curved guardrail, adjusting guardrail height, guardrail removal, and resetting guardrail will be paid for at the contract unit price per linear foot. Guardrail transitions and guardrail end treatments will be paid for at the contract unit price per each for the type specified. Guardrail buried end treatments type II will be paid for at the contract unit price per each, complete in place.
 270

Impact attenuators and resetting impact attenuators will be paid for at the contract unit price per each for the type and width, and test level specified. The curved W-beam

guardrail connector system and curved W-beam guardrail system will be paid for at the contract unit price per each for the type specified, complete in place.

Where existing guardrail height is adjusted, such work will be paid for at the contract unit price per linear foot. The cost of removal, all necessary storage, new adjustable post brackets, attachment of rail section, and miscellaneous nuts and bolts as required shall be included in the cost of adjust guardrail height.

280

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Guardrail Connector System, W-Beam, Curved, _____	EACH
	type	
	Guardrail End Treatment, _____	EACH
	type	
	Guardrail Height Transition, MGS	EACH
290	Guardrail Height Transition, VH, ____ ft ____ in. Spacing	EACH
	Guardrail Transition, _____	EACH
	type	
	Guardrail Transition, MGS, _____	EACH
	type	
	Guardrail, Adjust Height	LFT
	Guardrail, MGS W-Beam, ____ ft ____ in. Spacing	LFT
	Guardrail, MGS W-Beam, Cable Terminal Anchor	EACH
	Guardrail, MGS W-Beam, Double Faced,	
	____ ft ____ in. Spacing	LFT
300	Guardrail, MGS W-Beam, Shop Curved,	
	____ ft ____ in. Spacing	LFT
	Guardrail, MGS, Long Span, _____	EACH
	type	
	Guardrail, MGS, Structure Top-Mounted Posts	EACH
	Guardrail, Remove	LFT
	Guardrail, Reset	LFT
	Guardrail, Terminal System, W-Beam Curved, _____	EACH
	type	
	Guardrail, Thrie-Beam	LFT
310	Guardrail, Thrie-Beam, Double Faced	LFT
	Guardrail, W-Beam, ____ ft ____ in. Spacing	LFT
	Guardrail, W-Beam, Cable Terminal Anchor	EACH
	Guardrail, W-Beam, Double Faced,	
	____ ft ____ in. Spacing	LFT
	Guardrail, W-Beam, Nested	EACH
	Guardrail, W-Beam, Shop Curved,	
	____ ft ____ in. Spacing	LFT
	Guardrail, WR-Beam	LFT

MATERIALS

602.02 Materials

10 Materials shall be in accordance with the following:

Barrier Delineators	926.02(c)
Cast-in-Place Barriers.....	702
Cast-in-Place Concrete Glare Screens	702
Concrete Sealers	709
Construction Warning Lights	923.03
Precast Barriers.....	707
Precast Concrete Glare Screen	707
Reinforcing Bars.....	910.01

20

CONSTRUCTION REQUIREMENTS

602.03 Concrete Barrier and Concrete Glare Screen

Concrete barrier and concrete glare screen may be precast or cast-in-place. The option selected shall be used continuously throughout the project. Irregular sections shall be cast-in-place regardless of the option selected.

30 Concrete glare screen may only be precast when constructed in combination with new precast barrier. Concrete glare screen shall be cast-in-place when constructed in combination with cast-in-place barrier, and also when constructed on top of existing concrete barrier.

Excavation and compaction shall be in accordance with 605.03(a). Backfilling shall be in accordance with applicable requirements of 605.03(d).

(a) Precast Concrete Barrier and Concrete Glare Screen

40 Precast concrete barrier and concrete glare screen shall be constructed in accordance with applicable requirements of 707, except the minimum 28-day compressive strength shall be 3,000 psi. The precast units shall not be shipped or used until this strength is attained. The surfaces of individual precast units shall vary no more than 1/4 in. in 10 ft from the specified cross section, as measured from a longitudinal straightedge. The maximum variation in the vertical and horizontal alignment of adjacent units shall be 1/4 in. across the joint, as measured from a 10 ft longitudinal straightedge. Approved bedding may be used to obtain proper alignment of the concrete barrier sections.

(b) Cast-in-Place Concrete Barrier and Concrete Glare Screen

50 Cast-in-place concrete barrier and concrete glare screen shall be constructed in accordance with applicable requirements of 706.03 or by the use of an approved slip-form machine. The surfaces of the concrete shall vary no more than 1/4 in. in 10 ft from the specified cross section, as measured from a longitudinal straightedge.

602.04

Where concrete pavement or concrete shoulder abuts the concrete barrier, 1/2 in. preformed joint filler shall be placed as shown on the plans.

Where the concrete barrier is to be placed on PCCP, epoxy coated reinforcing bars shall be placed as shown on the plans. The epoxy coated reinforcing bars shall be installed in the PCCP by drilling and grouting.

60 The barrier wall shall be constructed in single pours without subsequent vertical extensions.

When shown on the plans, cast-in-place modified concrete barrier sections shall be in accordance with the above requirements and the concrete shall be class A in accordance with 702.02.

(c) Finishing

70 Concrete barrier and concrete glare screen shall be finished in accordance with 702.21. If slip-form construction is used, an approved brush finish will be allowed. Curing material in accordance with 912.01(e) shall be applied as a bond breaker to all areas which result in concrete to concrete contact. It shall be applied at a minimum rate of 1 gal./75 sq ft. If material is applied at a rate less than the minimum rate, a second application shall be applied.

(d) Sealing

Regardless of the method of construction, all exposed surfaces of the concrete barrier and concrete glare screen shall be sealed in accordance with the applicable requirements of 709.

(e) Joints

80 The type, size and location of joints and preformed joint filler shall be as shown on the plans.

(f) Reflectorization

90 All concrete barrier shall be reflectorized with barrier delineators spaced a minimum of 40 ft apart and centered 2 ft above the surface of adjacent pavement or shoulder. The reflectorization shall be on both sides of the wall if traffic is on both sides. All delineators damaged during installation or placement of the concrete barrier shall be replaced with no additional payment. The color of the reflectors shall match the color of the adjacent pavement traffic markings.

602.04 Blank

602.05 Method of Measurement

Concrete barrier will be measured by the linear foot along the centerline of the barrier, including irregular barrier sections around median obstructions such as bridge piers. Barrier delineators will be measured per each provided there is a pay item shown in the Schedule of Pay Items. Concrete glare screen will be measured by the linear foot

100 along the centerline of the glare screen. Class A concrete for cast-in-place modified concrete barriers will be measured by the cubic yard for the modified barrier section. No deductions will be made for reinforcing bars or joints. Reinforcing bars for cast-in-place modified concrete barriers will be measured in accordance with 703.07.

602.06 Basis of Payment

Concrete barrier will be paid for at the contract unit price per linear foot, complete in place. Class A concrete for cast-in-place modified concrete barriers will be paid for at the contract unit price per cubic yard. Reinforcing bars for cast-in-place modified concrete barriers will be paid for in accordance with 703.08. Barrier delineators used on concrete barrier will be paid for at the contract unit price per each, complete in place.

110 Concrete glare screen will be paid for at the contract unit price per linear foot, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Barrier Delineator.....	EACH
	Concrete Barrier Glare Screen.....	LFT
120	Concrete Barrier	LFT
	Concrete Barrier, Modified Section.....	CYS

The cost of polyethylene film, surface seal or curing-sealing material for concrete barrier and curing material shall be included in the cost of concrete barrier.

SECTION 603 – FENCES

603.01 Description

This work shall consist of the construction of fence and gates in accordance with 105.03.

603.02 Materials

Materials shall be in accordance with the following:

10	Barbed Wire	910.18(b)4
	Chain Link Fabric.....	910.18(b)
	Concrete, Class B	702
	Concrete, Packaged Dry	901.08
	Farm Field/Woven Wire.....	910.18(a)
	Fence Posts	910.13
	Gates.....	910.18(d)
	Tension Wire	910.18(b)1

CONSTRUCTION REQUIREMENTS

20

603.03 General Requirements

Clearing and grubbing shall be in accordance with 201.03.

At locations where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made in accordance with the requirements for the type of closure indicated.

30

When the plans require that posts, braces, or anchors be imbedded in concrete, temporary guys or braces shall be installed, if required to hold the posts in proper position. Unless otherwise specified, no materials shall be installed on posts or strain placed on guys and bracing set in concrete until 96 h have elapsed from the time of placing of the concrete.

The tops of all posts shall be set to the required grade and alignment. Cutting of the posts will only be allowed with the approval of the Engineer. Post caps shall be installed at the time the fence fabric is placed on the posts.

40

Wire or fencing of the size and type required shall be firmly attached to the posts and braces in the manner indicated. All wires shall be stretched taut and installed to the required elevations.

At each location where an electric transmission, distribution, or secondary line crosses any of the types of fences covered by these specifications, a ground, conforming to applicable requirements of the National Electric Safety Code, shall be furnished and installed.

603.04 Setting Posts

50

Posts, including the concrete foundation for posts, braces and anchors shall be set so that the entire fence is inside the right-of-way and the fence can be placed on the side of the post facing the roadway. If an object, such as a tree, is located on the right-of-way and is to remain in place, the fence may be adjusted to miss the obstruction. There shall be a gradual offset for at least three posts in each direction of the obstruction.

Line posts for farm field type fence shall be set on 16 ft centers, and for chain link fence on 10 ft centers. In either case, a tolerance of ± 2 ft in spacing will be allowed at special locations as approved. Spacing of these posts shall be as uniform as practicable under the existing conditions. However, additional posts shall be set to maintain the bottom clearance dimensions as required.

60

Pull posts shall be set at 500 ft maximum intervals in straight runs and at each vertical angle point of 10° or more.

Corner posts shall be set at each horizontal angle point of 10° or more.

End, corner, and pull posts for both types of fence, line posts for chain link fence and diagonal braces for farm field type fence shall be set in concrete as shown on the plans.

- 70 Except where rock is encountered, intermediate or line posts shall be driven and furnished with an approved anchor plate or other satisfactory device to hold the post in proper alignment and plumb. The plate or anchor shall be welded or riveted to the post with no less than two rivets.

Gate posts shall be set in concrete as shown on the plans.

- 80 Extra length posts shall be required at stream crossings as shown on the plans or as directed and also at ground depressions where it is not practicable for the fencing to follow closely the contour of the ground. These posts shall be set in concrete as shown on the plans.

At small stream crossings and ground depressions, the space below the fence fabric shall be closed with barbed or ground tension wire, either on horizontal lines or fanned, as shown on the plans or as directed. The wires shall be stretched taut between and fastened to the posts to prevent vertical movement of the wires. Barbed or tension wire shall not be placed where its installation would cause collecting drifts in the channel.

603.05 Placing Barbed and Tension Wire and Fabric

- 90 The bottom of the fabric shall be placed above the ground line as shown on the plans. Over irregular ground, a minimum of 1 in. and a maximum of 4 in. clearance will be allowed. All necessary excavation and backfilling required shall be in accordance with 201.03.

The tension required to stretch the fabric and wire shall be applied by mechanical fence stretchers and with single wire stretchers designed and manufactured for the purpose, and in accordance with the fence manufacturer's recommendations.

- 100 All splices in the fabric and wire shall be securely made in accordance with the best practice and the manufacturer's recommendations, and by the use of tools designed for that purpose.

Farm field fence shall be placed by fastening one end and then applying sufficient tension to remove all slack before making permanent attachments elsewhere. The line wires shall be fastened to end, corner, and pull posts by wrapping the wires around the posts and tying the wire back on itself with no less than 1 1/2 tightly wrapped twists. Tying shall be with tools designed for the purpose in accordance with the fence manufacturer's recommendations. This same method shall be used in placing barbed or tension wire. Fence fabric shall be fastened to intermediate or line posts with at least

110 five wire ties. Barbed or tension wire shall be fastened in the same manner with one fastening device for each post.

The top and bottom tension wires of chain link fence shall be placed, stretched taut, and secured at the ends and to all posts before the fabric is placed. The ends of the fabric shall be secured by the use of stretcher-bars threaded through the loops of the fabric and secured to the posts by means of clamps with bolts and nuts. The number of clamps shall be as indicated on the plans. The fabric shall be placed by securing one end and then applying tension to remove all slack before making attachments elsewhere. The fabric shall be fastened to the line posts and to the top and bottom tension wires with tie wires spaced as shown on the plans.

603.06 Resetting Fence

Resetting fence shall consist of the removal of existing fence within the specified limits and, if necessary, storing and then resetting it in accordance with the plans, or as directed. Resetting fence shall be in accordance with 603.03, 603.04, and 603.05. Damaged or missing parts, including posts shall be replaced.

603.07 Method of Measurement

130 Fence and resetting fence will be measured by the linear foot for the type specified. Measurement will be made along the top of the fence from outside to outside of end posts for each continuous run of fence.

Gates will be measured as complete units of the size and type specified.

603.08 Basis of Payment

The accepted quantities of fence and resetting fence will be paid for at the contract unit price per linear foot for the type specified, complete in place. Gates will be paid for at the contract unit price per each for fence gate, of the type and size specified, complete in place.

140 Payment will be made under:

Pay Item	Pay Unit Symbol
Fence Gate, _____, _____ in. x _____ ft.....	EACH
type height length	
Fence, _____, _____ in.	LFT
type height	
Fence, _____, Reset.....	LFT
type	
Fence, Farm Field, Barbed Wire, _____ in.	LFT
Fence, Farm Field, Tension Wire, _____ in.	LFT

The cost of adding grounding in accordance with the National Electric Safety Code including all materials, and labor shall be included in the cost of the fence.

The cost of fence, and corner, end, line, and pull posts shall be included in the cost of the fence.

160 The cost of fence, post and miscellaneous hardware shall be in the cost of the gate.

The cost of all miscellaneous hardware related to the type of fence including brace connections, caps, clips, clamps, hinges, rivets, ties, truss rods, diagonal braces and stretcher bars shall be included in the cost of the fence.

The cost of concrete for posts, braces or anchors shall be included in the cost of the fence and gates.

170 The cost of removal, storage, re-installation, and the replacement of damaged or missing parts shall be included in the cost of the resetting fence.

SECTION 604 – SIDEWALKS, CURB RAMPS, STEPS, AND HANDRAILS

604.01 Description

This work shall consist of constructing HMA or PCC sidewalks, curb ramps, concrete steps, or the reconstruction of PCC sidewalks in accordance with 105.03.

MATERIALS

604.02 Materials

10 Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher, Size No. 53	904.03
Concrete, Class A	702
Detectable Warning Surfaces	905.05
Fine Aggregate, Size No. 23, No. 24, or No. 15.....	904.02
Joint Filler.....	906.01
Joint Sealing Materials	906.02
Reinforcing Bars.....	910.01
Silica Sand.....	ASTM C778

20

Hand railing shall be aluminum pipe in accordance with ASTM B221, alloy 6063, temper T52 or galvanized steel pipe in accordance with ASTM A53, grade B, all as specified.

The detectable warning surface in concrete curb ramps shall be selected from the QPL of Detectable Warning Surfaces in accordance with 905.05.

The mortar bed material shall be high-strength mortar in accordance with ASTM C387. Part of the mix water shall be replaced with a Type II polymer modifier meeting

604.03

- 30 the requirements of ASTM C1438. The proportioning of water and polymer modifier shall be as recommended by the manufacturer of the polymer modifier.

A type C certification in accordance with 916 shall be provided for the masonry mortar and polymer modifier.

A type C certification in accordance with 916 shall be provided for the silica sand.

CONSTRUCTION REQUIREMENTS

40 **604.03 Portland Cement Concrete Sidewalks and Curb Ramps**

(a) General Requirements

- The location of curb ramps shall take precedence over the location of drainage structures and signal, utility, or light poles. Drainage structures and poles shall not be located within the limits of the curb ramp, exclusive of flared sides. Poles located within a sidewalk shall not reduce the clear width to less than 4.0 ft. Crosswalk markings shall be located such that the curb ramps and curb ramp clear spaces are contained within the markings unless otherwise specified. The flared sides need not fall within the crosswalk lines. The normal gutter flow line shall be maintained throughout the curb ramp area, and appropriate drainage structures shall be used, as needed, to intercept the flow prior to the curb ramp area. Positive drainage shall also be provided to carry water away from the intersection of the curb ramp and the gutter line.
- 50

The bottom edge of curb ramps and the top of curb shall be flush with the edge of the adjacent pavement or the gutter line. Vertical surface discontinuities shall be a maximum of 1/2 in. Vertical surface discontinuities greater than 1/4 in. up to 1/2 in. shall be beveled at a slope no steeper than 1V:2H.

- 60 The curb ramp running slope shall not exceed 8.33%. Curb ramp and sidewalk cross slope shall not exceed 2.00%. The slope of the turning space shall not exceed 2.00% in any direction. A running slope or cross slope that exceeds the maximum shall be as shown on the plans.

Construction tolerance shall not apply to running slope and cross slope percentages.

(b) Excavation

- Excavation shall be made to the required depth and to a width that will enable the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface in accordance with the section shown on the plans. All soft and yielding material shall be removed and replaced with acceptable material.
- 70

(c) Forms

Forms shall be of wood, metal, or other approved material and shall extend for the full depth of the concrete. Forms shall be straight, free from warp, and of sufficient

strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

80

(d) Placing Concrete

The foundation shall be thoroughly moistened immediately prior to the placing of the concrete. The proportioning, mixing, and placing of the concrete shall be in accordance with 702. The thickness of the concrete in the curb ramp, including flared sides, shall be as shown on the plans.

(e) Finishing

90 Immediately after striking off, the grade, running slopes and cross slopes shall be checked with a 2 ft level and a long handled straightedge of light construction that can completely span the surface. The level and straightedge shall be laid parallel and perpendicular to the grade or running slope at intervals of no more than 2 ft on curb ramps and 10 ft along sidewalks. All high spots shall be removed and depressions filled with fresh concrete and then leveled. Checking and leveling shall continue until the surface has the required grade, running slope and cross slope and is free of voids.

The surface shall be finished with a wooden float. No plastering of the surface will be allowed. The final surface shall be free from porous spots caused by the disturbance of coarse aggregate particles. Curb ramp surfaces shall be coarse broomed transverse to the running slope as shown on the plans.

100

All exposed edges shall be finished with a 1/4 in. radius.

(f) Joints

The type and location of joints and the size of preformed joint filler shall be as shown on the plans.

All concrete joints shall be finished with a 1/4 in. radius.

110 Preformed 1/2 in. joint filler shall be placed around all appurtenances, such as manholes and utility poles which extend into and through the sidewalk, and between the sidewalk and any fixed structure, such as a building or bridge. The preformed joint filler shall extend for the full depth of the sidewalk or curb ramp, and shall be flush with the surface of the adjacent concrete.

(g) Detectable Warning Surfaces

Detectable warning surfaces shall be placed the full width of the curb ramp. Where forming is required for installation of the detectable warning surfaces, the border width shall not exceed 2 in. within the ramp width, as shown on the plans.

120 Detectable warning surfaces shall contrast visually from the adjacent surfaces. The surface shall consist of truncated domes aligned in a square or radial grid pattern as shown on the plans.

Surfaces shall be installed to be level across joints or seams and shall be flush with the edges of adjoining concrete. Surfaces from various manufacturers shall not be mixed in any individual curb ramp.

1. Brick Surfaces

130 Brick surfaces shall be placed in a mortar setting bed within the hardened concrete block out. The concrete base of the block out shall have a rough textured finish, such as would be produced by a screed or wood float. The depth of the block out shall be such that a mortar bed thickness of 3/8 to 3/4 in. is achieved for the nominal depth of the brick. The hardened concrete base shall be free of all material which might prevent the mortar setting bed from adhering. The concrete base shall be dampened with water but the surface dry immediately prior to the placing the mortar setting bed. The mortar setting bed shall be placed at the desired thickness, and no more than 2 ft ahead of laying the bricks. The bricks shall be buttered with mortar on the bottom before placement into the setting bed.

140 Brick surfaces shall be installed in a running or stacked bond pattern with a 1/16 in average joint width. The joint width shall not exceed 1/8 in. Whole bricks should be laid first, followed by bricks cut to size, keeping the number of joints to a minimum. A masonry saw shall be used to produce a clean, accurate, straight cut. The joint between bricks shall be completely filled with a dry fine aggregate. The fine aggregate may be obtained from a non-Certified Aggregate Producer, but it shall be natural sand having a gradation where at least 95% of the material passes the No. 4 sieve. Excess fine aggregate shall be removed from the surface of the bricks.

2. Cast Surfaces

150 Cast iron surfaces shall be installed in accordance with the manufacturer's recommendations. When required, cutting of the cast iron shall be in accordance with the manufacturer's recommendations. Cut edges shall be ground to a smooth shape consistent with the manufactured edges.

(h) Curing

Concrete shall be cured for at least 72 h. Curing shall be in accordance with 504.04 except curing compound shall not be used in the area where detectable warning surfaces are to be installed.

160 604.04 PCC Steps

PCC steps shall be in accordance with the applicable provisions of 604.03.

604.05 Reconstructed PCC Sidewalk and Curb Ramp

Where existing concrete sidewalk is to be reconstructed, all disintegrated concrete, brick, stone, or other material shall be completely removed and replaced with new concrete sidewalk in accordance with 604.03.

Such sidewalk shall be constructed to a minimum depth of 4 in. unless another

170 depth is designated, and to the width of the adjoining walk, or to a width of no less than 48 in. from the back face of curb, or to such other width as directed.

The removal of concrete sidewalk shall be to uniform lines as directed. The sidewalk to be removed shall be cut in a straight line with an approved power driven concrete saw. The sawing shall be such that the portion of sidewalk to remain in place shall not be damaged. All portions which are damaged or removed beyond the established line shall be replaced.

180 Unless otherwise directed, sidewalk to be removed shall be removed between tool marks or joints. At locations where the sidewalk and curb are adjacent and the curb is deteriorated, the curb shall also be replaced as directed.

The new sidewalk shall have a joint pattern similar to the surrounding sidewalk. Sidewalk placed at drives shall be 6 in. thick, or the same depth of the existing drive, whichever is greater.

Where existing curb ramp is to be reconstructed for placement of detectable warning surfaces, all concrete, brick, stone, or other material shall be completely removed and replaced in accordance with 604.03.

190 **604.06 Re-Laid Sidewalk**

This work consists of the removal and re-laying of concrete, stone-slab, or brick sidewalk at the locations shown on the plans or as directed. In the operations of removing and re-laying, care shall be taken not to damage any of the sidewalk. Before re-laying, a cushion of fine aggregate shall be spread on the prepared subgrade to a depth of no less than 2 in. Cracked or damaged sections shall not be re-laid but shall be disposed of as directed. The cross slope of the re-laid sidewalk shall be checked with a 2 ft level in accordance with 604.03(e).

200 **604.07 HMA Sidewalk**

(a) Excavation and Forms

Excavation and forms, when required, shall be in accordance with 604.03(b) and 604.03(c).

(b) Bed Course

Bed course material shall be coarse aggregate No. 53 and shall be placed in lifts not exceeding 4 in. in depth. Each lift shall be thoroughly compacted.

(c) Placing HMA Sidewalk

210 HMA sidewalk material shall be placed on a compacted bed course in one or more courses. The mixture shall consist of HMA base, intermediate, or surface, type B in accordance with 402, except the 9.5 mm surface gradation can go above or below the PCS control point in accordance with 401.05. An MAF, in accordance with 402.05, will not apply. Aggregate requirements of 904.03(d) do not apply. Compaction shall be accomplished by means of a hand operated or power roller of an acceptable type

604.08

and weight in accordance with 402.15. In areas inaccessible to the roller, hand tamping will be allowed. In any case, the HMA sidewalk material shall be uniformly compacted. The grade and cross slope shall be checked with a 2 ft level in accordance with 604.03(e).

220

If the finished compacted surface is too open or remains sticky, the surface shall be given a coating of fine aggregate, well broomed over the surface, leaving no excess.

604.08 Backfilling and Finishing Shoulders and Slopes

After forms have been removed, the space on each side of the sidewalks shall be filled to the required elevation with suitable material which shall be firmly compacted and neatly graded. Adjacent shoulders and slopes shall be finished to the required grade and cross section.

230

604.09 Hand Rails

This railing shall be erected in a workmanlike manner, straight and true to grade. Posts shall be vertical and railings shall be parallel to the walk surface or the plane of the steps and spaced as shown on the plans. Fastenings shall be as indicated on the plans. Railing posts on masonry shall be held in place in a manner that develops the full strength of the railing post in bending.

240

Fabrication and placement of railings shall be completed in accordance with the applicable requirements of 711. Ends of tube sections shall be milled or sawed. Cut ends shall be true, smooth, and free from burrs and ragged edges. Welds shall be ground smooth. The rail system shall be continuous except as shown on the plans. Joints shall be spliced as detailed on the plans. Welding of steel shall be in accordance with 711.32 and welding of aluminum shall be in accordance with the applicable requirements of 803. Radiographic, magnetic particle, and dye penetrant inspection will not be required.

250

All aluminum surfaces in contact with concrete shall be coated with an aluminum impregnated caulking compound prior to installation. After installation and alignment, openings between metal surfaces and concrete shall be sealed in a watertight manner with the caulking compound.

Steel pipe railing not designated to be painted shall be galvanized after fabrication and prior to installation. Railing designated to be painted shall receive one shop coat of paint after fabrication and two field coats after installation. The type and color of paint shall be as specified on the plans. Cleaning and painting shall be in accordance with 619.

604.10 Method of Measurement

260

Concrete sidewalk, reconstructed concrete sidewalk, and re-laid concrete sidewalk will be measured by the square yard of finished surface. HMA for sidewalk will be measured by the ton of mixture placed. Bed course material will be measured by the ton.

Concrete curb ramps will be measured by the square yard and will include the ramp, turning space, flared side, and setback. Turning spaces shared by more than one curb ramp will be measured only once. Detectable warning surfaces and retrofitted detectable warning surfaces will be measured by the square yard.

Concrete steps will be measured by the cubic yard based on the neat lines shown on the plans.

270

Hand rails will be measured by the linear foot in accordance with the dimensions shown on the plans or as directed. Measurements will be made from end to end of the railing along the centerline.

Curb and curb and gutter will be measured in accordance with 605.09. Reinforcing bars, if used, will be measured in accordance with 703.07.

Joint material will not be measured.

280

604.11 Basis of Payment

The accepted quantities of concrete sidewalk will be paid for at the contract unit price per square yard for sidewalk, concrete. HMA for sidewalk will be paid for at the contract unit price per ton, complete in place. Bed course material will be paid for at the contract unit price per ton. Concrete steps will be paid for at the contract unit price per cubic yard for steps, concrete. Reconstructed sidewalk and re-laid sidewalk will be paid for at the contract unit price per square yard for sidewalk, reconstruct, or sidewalk, re-lay. Detectable warning surfaces and retrofitted detectable warning surfaces will be paid for at the contract unit price per square yard.

290

The accepted quantities of curb ramps will be paid for at the contract unit price per square yard for curb ramp, concrete, complete in place.

Hand rails will be paid for at the contract unit price per linear foot.

Curb and curb and gutter will be paid for in accordance with 605.10.

Reinforcing bars, if used, will be paid for in accordance with 703.08. Curb, if directed to be replaced, will be paid for in accordance with 605.10.

300

Payment will be made under:

Pay Item	Pay Unit Symbol
Bed Course Material.....	TON
Curb Ramp, Concrete	SYS
Detectable Warning Surfaces	SYS
Detectable Warning Surfaces, Retrofit	SYS

605.01

	Hand Rail, _____	LFT
	type	
310	HMA for Sidewalk	TON
	Sidewalk, Concrete.....	SYS
	Sidewalk, Concrete, Reconstruct.....	SYS
	Sidewalk, Concrete, Re-Lay.....	SYS
	Steps, Concrete.....	CYS

The cost of the ramp, including border, turning space, flared side, return curb, and setback shall be included in the cost of the curb ramp.

320 The cost of excavation, backfill, joint material, and necessary incidentals shall be included in the cost of the pay items in this section.

The removal and disposal of concrete sidewalk which is unsuitable for re-laying and which has not been damaged due to negligence will be paid for in accordance with 202.14. Concrete sidewalk which is specified to be re-laid or to remain in place and which is damaged shall be removed and disposed of and replaced with no additional payment.

330 If directed, concrete sidewalk shall be constructed to a depth greater than that shown on the plans. Such additional thickness will be converted into the equivalent square yards quantity of concrete sidewalk of the thickness shown on the plans and will be paid for as such.

The cost of furnishing and applying sand to finished compacted surfaces shall be included in the cost of HMA for sidewalk.

The cost of the detectable warning surfaces, thin set mortar, and fine aggregate for filling joints shall be included in the cost of the detectable warning surfaces.

340 The cost of removal, disposal, and replacement of portions of the concrete curb ramp, concrete base, including border, detectable warning surfaces, thin set mortar, and fine aggregate for filling joints shall be included in the cost of the detectable warning surfaces, retrofit.

The cost of aluminum impregnated caulking compound and the painting of steel hand railing shall be included in the cost of the hand rail.

SECTION 605 – CURBING

605.01 Description

This work shall consist of the construction of curb or curb turnouts, combination curb and gutter, combined curb and gutter turnouts, or resetting curb in accordance with 105.03.

MATERIALS

10 **605.02 Materials**

Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher, Size No. 53	904.03
Concrete	502
Joint Materials	906
Joint Mortar	907.12
Precast Concrete Curbing	905.04
Reinforcing Bars.....	910.01

20 **605.03 Precast Cement Concrete Curbing**

(a) Excavation

Excavation shall be made to the required depth and the base upon which the curb is to be set shall be compacted to a firm even surface. All soft and unsuitable material shall be removed and replaced with suitable material which shall be thoroughly compacted.

(b) Installation

30 The curb shall be set in accordance with the line and grade required. The face and top of the curb shall be checked with a 10 ft straightedge. Portions showing irregularities of 1/4 in. or more shall be removed and replaced with no additional payment. All spaces under the curbing shall be filled with bed course material. The bed course material shall be coarse aggregate No. 53 and shall be thoroughly tamped.

(c) Joints

40 Curbing shall be laid with joints as indicated on the plans. These joints shall be filled with mortar as specified. Where a portland cement concrete pavement is to be constructed contiguous to a curbing, joints shall be constructed in the curbing directly in line with pavement expansion joints. The joint in the curbing shall be the same width as the pavement joint and shall be filled with an expansion joint filler of the nominal thickness as the pavement joint. Any voids between the joint filler and the curb shall be filled with mortar.

(d) Backfilling

After the curb has set, any remaining excavated areas shall be filled with approved material. This material shall be placed and thoroughly tamped in layers not exceeding 6 in. in depth.

50 **605.04 Cast in Place Cement Concrete Curbing**

(a) Excavation

Excavation and bedding shall be in accordance with 605.03(a).

(b) Forms

Forms shall be of wood or metal, straight, free from warp, and of such construction that there will be no interference to the inspection of grade or alignment. All forms shall extend for the entire depth of the curb and shall be braced and secured sufficiently so that no deflection from alignment or grade shall occur during the placing of the concrete.

60

(c) Proportioning and Placing

Concrete shall be proportioned, mixed, and placed in accordance with 502, except utilization of the Department provided spreadsheet is not required for the CMDS. Where integral curb and gutter is specified, that portion of the curb below the upper surface elevation of the adjoining pavement shall be constructed by extending the pavement to the outer vertical plane of the curb at the time the pavement is placed. The concrete used in this extension shall be the same composition as that of the pavement.

70 As an option, an integral curb and gutter may be placed at the same time as the PCCP pavement by the slip form method. The slip form machine shall have an attachment to place, consolidate, and shape the concrete to the required shape and dimensions. The reinforcing tie bars or stirrups between the pavement and the curb shall be omitted.

After the concrete for the upper portion is placed in the forms, it shall be tamped and spaded or vibrated until mortar entirely covers the surface. The top shall be floated smooth and the outer upper corner rounded to a 1/4 in. radius.

80 The face and top of the curb, integral curb, and gutter shall be checked with a 10 ft straightedge. Portions showing irregularities of 1/4 in. or more shall be removed and replaced.

90 Consolidation of concrete placed in the forms shall be by vibration or other acceptable methods. Forms shall be left in place for 24 h or until the concrete has set sufficiently so that they can be removed without injury to the curbing. Upon removal of the forms, the exposed curbing face shall be rubbed immediately to a uniform surface. Rubbing shall be accomplished by the use of water and a carborundum brick. For the purpose of matching adjacent concrete finishes or for other reasons, other methods of finishing may be allowed. No plastering will be allowed.

(d) Curb Turnouts and Combined Concrete Curb and Gutter Turnouts

Turnouts will be required with specified inlets or with concrete gutter and paved side ditch in accordance with 607 and as shown on the plans. Concrete gutter and paved side ditch shall be constructed monolithically with the curb turnout.

(e) Joints

Joints in integral curbs shall be located at joints in adjoining PCCP. The joints

100 shall be saw cut or formed with 1/4 in. thick preformed joint material. Joint sealant is not required for joints in integral curbs.

Curbing not constructed integral with adjacent pavement shall be constructed with intermediate joints located at 10 ft intervals. These joints may be sawed or formed with metal separator plates, and the depth and width shall be in accordance with the plans.

Preformed expansion joints, 1/4 in. thick, shall be placed at the beginning and end of all curb returns and also at castings.

(f) Curing

110 Immediately upon completion of the rubbing, the curbing shall be moistened and kept moist for three days, or cured by the use of membrane forming material. The method and details of curing shall be subject to approval.

(g) Backfilling

After the concrete has set sufficiently, the spaces in front and back of the curb shall be refilled with suitable material to the required elevations in layers of not more than 6 in. and be tamped thoroughly.

(h) Curb Machine

120 Curb machines may be used to construct curb provided the curb can be constructed to the requirements of the specifications.

605.05 Reflecting Cement Concrete Curbing

Construction methods for this item shall be in accordance with 605.03 and the following requirements.

130 The reflecting surface of the curbing shall be a mortar mix consisting of 1 part white portland cement to 1 3/4 parts of light colored, washed, mortar sand. This mortar mix shall have a thickness of approximately 1 in. Alternately, the entire curbing may be constructed of concrete made with white portland cement.

Washed mortar sand shall meet all the requirements for mortar sand and shall be of a light satisfactory color. The reflecting surface mortar shall be placed immediately after the placing of the base concrete. No more than 20 minutes shall elapse between the placing of the base concrete and the placing of the reflecting surface.

Scoring or surface deformation and finish of the reflecting surface shall be in accordance with the details shown on the plans.

140 **605.06 Concrete Center Curbing**

The subgrade shall be prepared the same as for the adjoining pavement. If subbase is provided for the adjoining pavement, it shall be carried through for the full width of the curb and at the same thickness as that for the pavement.

The temperature limitations of 502.11 shall apply to placing the concrete. The surface shall be troweled smooth with a metal trowel. Curing shall be in accordance with 504.04.

150 Forms shall be removed within 24 h after the concrete has been placed. Plane surfaces and exposed sides of the curb shall be checked with a 10 ft straightedge. Portions showing irregularities of 1/4 in. or more shall be removed and replaced in compliance with these specifications.

Joints in center curbs adjacent to PCCP shall be aligned with joints in adjoining PCCP. Joints in center curbs adjacent to asphalt shall be spaced at 18 ft maximum. The joints shall be saw cut or formed with 1/4 in. thick preformed joint material. Joint sealant is not required for joints in center curbs.

160 Where an expansion joint is constructed in PCCP adjacent to concrete center curb, the expansion joint shall be carried through the center curb in accordance with applicable requirements of 503.03(f).

605.07 HMA Curbing

(a) Excavation

Excavation shall be in accordance with 605.03(a).

(b) Preparation of Bed

170 When curbing is to be constructed on a fresh laid HMA surface, the curb may be laid only after the surface has been cleaned.

When curbing is to be constructed on a cured or aged portland cement concrete base, asphalt pavement, or asphalt treated base, the bed shall be thoroughly swept and cleaned with compressed air. The surface shall be thoroughly dried and, immediately prior to placing of the HMA mixture, shall receive a tack coat in accordance with 406. During application, the spread of this tack coat to areas outside of the area to be occupied by the curb shall be prevented.

(c) Mixture

180 The mixture shall be in accordance with 402.07(d).

A type D certification in accordance with 916 shall be provided for the HMA curbing mixture. The test results shown on the certification shall be the quality control tests representing the material supplied and include gradation and binder content. The gradation tolerances shall be $\pm 2.5\%$ on the No. 200 (75 μm) sieve, $\pm 4.0\%$ on the No. 4 (4.75 mm) sieve, and binder content tolerance shall be $\pm 0.5\%$ from DMF.

(d) Placing

190 HMA curbing shall be constructed by use of a self-propelled automatic curber, curb machine or paver with curbing attachments. The curbing shall be in accordance

with the section shown on the plans. The automatic curber or machine shall meet the following requirements and shall be approved prior to use.

1. The weight of the machine shall be such that required compaction is obtained without the machine riding above the bed on which curbing is being constructed.
2. The machine shall form curbing that is uniform in texture, shape, and density.

200

The construction of curbing by means other than the automatic curber or machine may be allowed when short sections or sections with short radii are required, or for such other reasons as may seem warranted. The resulting curbing shall conform in all respects to the curbing produced by the use of the machine. The face and top of the HMA curb shall be checked with a 10 ft straightedge. Portions showing irregularities of 1/4 in. or more shall be removed and replaced.

Weather limitations shall be in accordance with 402.12.

210

(e) Painting and Sealing

When sealing or painting is required, it shall be performed only on a curbing which is clean and dry and which has reached the ambient temperature.

605.08 Resetting Curbing

(a) Salvage of Curbing

Curbing specified for resetting shall be cleaned, removed, and stored. Any existing curbing that is to be reset which is lost, damaged, or destroyed as a result of operations or because of failure to store and protect it in a manner that would eliminate its loss or damage, shall be replaced.

220

(b) Curb Removal

Curbing, which is unsuitable for resetting and which has not been damaged due to negligence, shall be removed and disposed of as directed.

(c) Excavation

Excavation and bedding shall be in accordance with 605.03(a).

(d) Resetting

The curb shall be set on a firm bed in accordance with the required line and grade. All sections of curbing shall be set so that the maximum opening between adjacent sections is 3/4 in. wide for the entire exposed top and face. Any dressing of the ends of the curbing necessary to meet this requirement shall be done as needed. Cutting or fitting may be necessary in order to install the curbing at the locations as directed.

230

After the curb has been set, the joints shall be completely filled with mortar as specified.

(e) Backfilling

240 The spaces in front and back of the curb shall be refilled to the required elevation with suitable material. This material shall be tamped thoroughly in layers of not over 6 in. in depth.

605.09 Method of Measurement

Curbing, both new and reset, and curb removal will be measured by the linear foot along the front face of the section at the finished grade elevation. Combined curb and gutter will be measured along the face of the curb. Curb turnout will be measured longitudinally by the linear foot as curb of the type specified, from the ends of the radii which touch the front face of the longitudinal curb portion. Combined curb and gutter turnout will be measured longitudinally by the linear foot as curb and gutter of the type specified, from the ends of the radii which touch the front face of the longitudinal curb portion. No deduction in length will be made for drainage structures installed in the curbing such as catch basins or drop inlets. Concrete center curb will be measured by the linear foot, unless it is of variable width, in which case measurement will be by the square yard.

250

Bed course material will be measured by the ton.

605.10 Basis of Payment

260 The accepted quantities of curb work will be paid for at the contract unit price per linear foot for curb; curb and gutter; curb, reset; or center curb, of the type specified. Variable width center curb will be paid for at the contract unit price per square yard for center curb, of the width specified. Bed course material will be paid for at the contract unit price per ton, complete in place.

Curb turnout will be paid for at the contract unit price per linear foot of the type of curb specified. Combined curb and gutter will be paid for at the contract unit price per linear foot for curb and gutter of the type specified.

270 Payment will be made under:

	Pay Item	Pay Unit Symbol
	Bed Course Material.....	TON
	Center Curb, _____	SYS
	type	LFT
	Curb and Gutter, _____	LFT
	type	
	Curb, _____	LFT
	type	
280	Curb, Remove.....	LFT
	Curb, Reset, _____	LFT
	type	

The cost of tack coat, reinforcing bars or welded wire reinforcement for curb, curb and gutter, or center curb shall be included in the cost of the pay items. The cost of replacement curb portions for those which show irregularities or 1/4 in. or more shall be included in the cost of curb.

SECTION 606 – PAVEMENT CORRUGATIONS

606.01 Description

This work shall consist of placing corrugations in the pavement in accordance with 105.03.

Corrugations shall not be constructed within the limits of reinforced concrete bridge approaches or on bridge decks.

- 10 The operation shall be coordinated such that milled materials do not encroach on pavement lanes carrying traffic and all milled materials are disposed of in accordance with 104.07. When corrugations are installed, milled materials shall be swept and vacuumed following the milling operation.

The corrugations shall be constructed by cutting smooth strips in existing or newly constructed pavement. The operation shall be conducted by means of a cutting machine that provides a series of smooth cuts without tearing or snagging. The equipment shall include guides to maintain uniformity and consistency in the alignment of the strips.

20

Longitudinal rumble stripes are the combination of either the center line pavement marking placed in the center line corrugation or the edge line pavement marking placed in the edge line corrugation. They shall be installed as shown on the plans and as specified herein.

Longitudinal rumble stripes are corrugations placed in the shoulder near the travel lane. They shall be installed as shown on the plans and as specified herein.

- 30 When corrugations are installed, control points are required as a guide for milling corrugations and shall be spotted with paint for the full length of the road to be milled. Control points along tangent sections shall be spaced at a maximum interval of 100 ft. Control points along curve sections shall be spaced to ensure the accurate location of the milled corrugations. The location of control points shall be as approved prior to the milling operations.

If snowplowable raised pavement markers exist where center line corrugations are being placed into the existing surface, the prismatic reflectors in these markers shall be temporarily covered and corrugations gapped a maximum of 5 ft and not within 6 in. of the markers.

606.02

40

Milled HMA corrugations shall be the type designated in the contract documents, Conventional or Sinusoidal. Milled PCCP corrugations shall be Conventional.

MATERIALS

606.02 Materials

Materials shall be in accordance with the following:

	Pavement Markings	808
50	Liquid Asphalt Sealant	902.01

CONSTRUCTION REQUIREMENTS

606.03 General Requirements

In the presence of D-1 pavement joints or castings which conflict with the location of the corrugations, the corrugations shall be gapped a maximum of 5 ft and not within 6 in. of the joint or casting.

60 Corrugations installed on HMA shall be sealed using liquid asphalt sealant in accordance with 401.15.

Corrugations shall not be installed on PCCP until the PCCP has cured for a minimum of 14 days. The milling operations for installing corrugations on PCCP shall not exceed 12 mph.

(a) Installation Tolerances

Lateral deviation of milled corrugations shall not exceed 1 in. in 100 ft. The alignment of all pavement markings placed within rumble stripes shall be ±1/2 in. of its specified location.

70

(b) Maintenance of Traffic

The rumble stripe traffic control procedures shall be submitted to the Engineer and shall be in accordance with 808.08. Vehicles used in performing the milling, sweeping, vacuuming, or sealing operations shall have a rear escort vehicle that follows at a distance of 100 to 500 ft.

606.04 Method of Measurement

80 HMA and PCC pavement corrugations will be measured by the linear foot, measured parallel to the center line of the roadway. Gaps longer than 20 ft will not be included in the measurement for milled corrugations.

606.05 Basis of Payment

HMA and PCC pavement corrugations will be paid for at the contract unit price per linear foot, for the type specified.

30 Reinforcement will be required for all paved side ditch, cut-off-walls, and lugs as shown on the plans.

Paved side ditch transitions will be required at intersections with earth ditches and pipe culverts.

Transitions of 10 ft or less will be required between two different types of paved side ditches.

40 Cut-off wall and lug details shall be as shown on the plans. A cut-off wall shall be constructed at the beginning and end of any paved side ditch. Lugs shall be poured monolithic with paved side ditch on steep grades. Their locations shall be as shown on the plans or as otherwise directed. Backfilling shall be in accordance with 605.04(g).

607.04 Cement Concrete Gutter and Turnout

Concrete gutter and concrete gutter turnout shall be constructed as shown on the plans or where directed. Construction shall be in accordance with all applicable requirements set out herein for paved side ditch.

607.05 Method of Measurement

50 Paved side ditch or cement concrete gutter will be measured by the linear foot along the centerline of the ditch per each type specified. Each cutoff wall or lug will be measured as 8 lft of paved side ditch or cement concrete gutter. Paved side ditch transitions at earth ditches and pipe culverts will be measured as equivalent lengths in linear feet of the paved side ditch specified at each location. Transitions at the intersection of two different types of paved side ditch will be converted to equivalent lengths in linear feet of the larger type of paved side ditch specified at each site.

Reinforced concrete gutter turnout will be measured as 50 lft of concrete gutter. Additional length, if required, will be measured by the linear foot of concrete gutter.

60 **607.06 Basis of Payment**

The accepted quantities of paved side ditch or cement concrete gutter of the type specified, including cutoff walls and lugs measured in accordance with 607.05, will be paid for at the contract unit price per linear foot complete in place. Concrete gutter turnout will be paid for at the contract unit price per linear foot for gutter, concrete, of the type specified.

Payment will be made under:

Pay Item	Pay Unit Symbol
Gutter, Concrete, _____ type	LFT
Paved Side Ditch, _____ type	LFT

The cost of reinforcing bars or welded wire reinforcement, excavation, joints, and necessary incidentals shall be included in the cost of the pay items.

SECTION 608 – SHOULDER DRAINS

608.01 Description

This work shall consist of constructing shoulder drains in accordance with these specifications and in accordance with 105.03.

MATERIALS

608.02 Materials

10 Materials shall be in accordance with the following:

Coarse Aggregates, Class D or Higher, Size No. 8904.03

CONSTRUCTION REQUIREMENTS

608.03 General Requirements

20 Unless otherwise designated, shoulder drains shall be installed on both sides of the pavement by trenching from the edges of the pavement through the shoulders and backfilling with aggregate at low points in the grade and at other locations when so directed. This work shall precede the finishing of the shoulders.

The width of the trench shall be approximately 12 in. unless otherwise directed. Other dimensions shall be as shown on the plans.

After the trench has been prepared, it shall be backfilled to the required elevation with aggregate, and then be well compacted. After this, any remaining unfilled trench area shall be filled with material approved for shoulders and compacted by rolling or tamping or both. The finished shoulder elevation shall conform with that required at that point.

30

608.04 Method of Measurement

Shoulder drains will be measured by the ton of aggregate placed.

608.05 Basis of Payment

The accepted quantities of aggregate for shoulder drains will be paid for at the contract unit price per ton for aggregate for shoulder drains complete in place.

Payment will be made under:

40	Pay Item	Pay Unit Symbol
	Aggregate for Shoulder Drains.....	TON

Excavation, trenching, backfilling, and other related miscellaneous items will not be paid for separately, but the cost thereof shall be included in the cost of the pay item.

SECTION 609 – REINFORCED CONCRETE BRIDGE APPROACHES

609.01 Description

This work shall consist of constructing reinforced concrete bridge approaches, RCBA, and extensions required for bridge railing transitions in accordance with 105.03.

MATERIALS

10 **609.02 Materials**

Materials shall be in accordance with the following:

	Coarse Aggregate, Class B or Higher, Size No. 8	904.03
	Coarse Aggregate, Class D or Higher, Size No. 53	904.03
	Concrete, Class A	702
	Curing Materials	912.01
	Geotextile for Pavement and Subgrade	918.02
	Joint Materials	906.02(a)1
	Reinforcing Bars, Epoxy Coated	910.01
20	Support Devices	910.01(b)9
	Threaded Tie Bar Assembly	910.01(b)2

CONSTRUCTION REQUIREMENTS

609.03 General Requirements

Subgrade shall be prepared in accordance with 207. Subbase shall be prepared in accordance with 302. Geotextile shall be installed in accordance with 214.

30 The RCBA extension shall be placed only where a concrete bridge-railing transition shall be located on the RCBA. If the transition shall be placed on the bridge, the RCBA shall be placed as shown on the plans.

609.04 Forms

Forms shall be either steel or wood and shall be in accordance with 508.04(c)1 or 508.04(c)2.

609.05 Joints

40 Longitudinal construction joints will only be allowed as shown on the plans. The type I-A joint shall be constructed as shown on the plans.

Type I-A joints shall be created by sawing slots using sawing equipment in

accordance with 508.07. The joint shall be cut in two operations. The initial saw cut shall commence as soon as the concrete has hardened sufficiently to enable sawing without raveling, usually 2 to 12 h after placement.

The second saw cut shall be made after the concrete has sufficiently cured, but before opening the RCBA to all traffic. Slurry or saw residue remaining in the slot shall be immediately flushed. Construction traffic shall not be on the RCBA after the second saw cut until the joint is sealed.

50

The sawed slot shall be cleaned to remove all foreign matter from the entire depth of cut. Joint sealing shall be in accordance with 503.05.

609.06 Reinforcing Bars

Furnishing and placement of reinforcing bars shall be in accordance with 703.

609.07 Thickness

The depth of the RCBA will be checked by the Engineer prior to pouring, by making stringline measurements every 3 ft across the width of the approach. Any location deficient in depth by 1/2 in. or more shall be corrected prior to placing the concrete.

60

609.08 Concrete Placement

The subbase shall be uniformly moist at the time of concrete placement. Delivery and placement of concrete shall be in accordance with 702.

609.09 Finishing

The RCBA shall be finished with equipment in accordance with 508.04(c)3 and 508.04(c)4. The operations shall be controlled so that an excess of mortar and water is not worked to the top. Long handled floats may be used to smooth and fill in open textured areas. The edges of formed RCBA shall be tooled or chamfered.

70

The finished RCBA surface shall be textured with a double thickness burlap drag or a minimum 4 ft wide turf drag. Immediately after the finishing operation is complete and before the surface film has formed, the surface of the RCBA shall be textured by transverse grooving in accordance with 504.03. The grooves may be formed by mechanized equipment using a vibrating beam roller, a series of discs or other approved device. Manual tools such as fluted floats, spring steel tined rakes, or finned floats with a single row of fins may be used. The grooves shall be relatively uniform and smooth and shall be formed without tearing the surface or bringing coarse aggregate to the top.

80

All areas of hardened RCBA which do not conform to the requirements due to either a deficiency in the grooving or a rough open textured surface shall be corrected. Corrections shall be made by cutting transverse grooves in the hardened surface with an approved cutting machine and retexturing to a satisfactory finish as directed.

609.10 Curing

- 90 RCBA shall be wet cured in accordance with 702 or shall have liquid membrane forming curing compound applied to exposed surfaces within 30 minutes after the finishing operations have been completed. The edges of the RCBA shall be cured immediately upon removal of the forms. The edge shall be covered with curing materials equal to the material used on the surface or banked with soil 12 in. wide or greater.

When conditions arise which prevent timely application of curing materials the surfaces shall be kept wet with a fine spray of water. The fine spray of water shall continue until application of curing materials is resumed.

- 100 Liquid membrane forming curing compound shall be applied in a continuous uniform film at a rate not less than 1 gal./150 sq ft of concrete surface and shall be applied to provide a uniform, solid, white opaque coverage on all surfaces, similar to a white sheet of paper. Additional applications, if needed, shall follow the previous application within 30 minutes. The curing compound may be warmed in a water bath during cold weather at a temperature not exceeding 100°F. Thinning with solvents will not be allowed. Non-uniform film rates will result in the discontinuance of that application method.

- 110 A new coat of curing compound shall be applied to areas damaged by rain or other means during the curing period. The recoating shall be applied as soon as possible and at a rate equal to that specified for the original coat.

609.11 Smoothness

The smoothness of the surface of the RCBA will be measured by means of a 10 ft long straightedge as soon as practical following curing or completion of adjoining roadway or structure sections. All surface variations shall be corrected to 1/8 in. or less.

- 120 Smoothness variations outside specified tolerances shall be corrected in accordance with 502.20.

609.12 Opening to Traffic

The RCBA may be opened to equipment and traffic when the flexural strength of the test beams indicates the concrete has attained a modulus of rupture of 550 psi or greater.

The Contractor and Engineer will conduct an inspection of the new RCBA for any damage. The inspection and all necessary repairs shall be completed prior to opening to traffic.

130

609.13 Method of Measurement

Reinforced concrete bridge approaches, including extensions required for bridge railing transitions, will be measured by the square yard. Subbase for PCCP will be

	Aggregate Base.....	301.02
	HMA.....	402.03
	PCCP	502.02
	Prime Coat.....	405.02
	Seal Coat	404
20	Subbase.....	302.02
	Tack Coat	406.02

CONSTRUCTION REQUIREMENTS

610.03 General Requirements

Subgrade for approaches shall be prepared in accordance with 207. Aggregate base shall be constructed in accordance with 301. HMA for approaches shall be constructed in accordance with 402. HMA mixture for approaches shall be HMA surface or intermediate, type B, C, or D in accordance with 402.04. An MAF, in accordance with 402.05, will not apply.

Dense graded subbase shall be constructed in accordance with 302. PCCP for approaches shall be constructed in accordance with 502. The CMDS shall be submitted to the Engineer for approval. Utilization of the Department provided spreadsheet is not required.

610.04 Existing Approaches and Crossovers

If an existing surface is to be left in place as an approach pavement or crossover, the surface shall be patched in accordance with 304.04 or 305.04, or as directed.

Existing approaches or crossovers that have been rubblized shall be primed in accordance with 405 prior to being paved.

610.05 Method of Measurement

Compacted aggregate base will be measured in accordance with 301.09. HMA mixture for approaches will be measured by the ton of the type specified, in accordance with 109.01(b). Dense graded subbase will be measured in accordance with 302.08. PCCP for approaches will be measured by the square yard of the thickness specified. Subgrade treatment will be measured in accordance with 207.05.

HMA patching in accordance with 610.04, will be measured by the ton in accordance with 304.06. PCCP patching in accordance with 610.04, will be measured by the square yard in accordance with 305.06.

Prime coat will be measured in accordance with 405.09. Tack coat will be measured in accordance with 406.06. Seal coat will be measured in accordance with 404.13.

610.06 Basis of Payment

The accepted quantities of HMA mixture for approaches will be paid for at the

60 contract unit price per ton of the type specified, complete in place. Compacted aggregate base will be paid for in accordance with 301.10. PCCP for approaches will be paid for at the contract unit price per square yard of the thickness specified, complete in place. Dense graded subbase will be paid for in accordance with 302.09. Subgrade treatment will be paid for in accordance with 207.06.

HMA patching will be paid for in accordance with 304.07. PCCP patching will be paid for in accordance with 305.07.

70 Prime coat will be paid for in accordance with 405.10. Tack coat will be paid for in accordance with 406.07. Seal coat will be paid for in accordance with 404.14.

The quantities of materials placed on the 3 ft wedge on approaches, when placed with the mainline pavement shall be included in the mainline HMA items and paid for in accordance with 401.22 or 402.20. The quantities, when placed separately from the mainline pavement, shall be included in the quantities for HMA for approaches and paid for in accordance with 610.06.

80 The quantities of materials for the paving or resurfacing of turn lanes, passing lanes, acceleration lanes, deceleration lanes, and recovery lanes greater than 100 ft, excluding tapers, shall be included in the mainline quantities and paid for in accordance with 401.22, 402.20, 501.31, or 502.23 whichever is applicable.

The accepted quantities of HMA material for mailbox approaches will be included with quantities required to construct the shoulder section when the shoulder is to be paved. If the shoulder is not to be paved, the HMA material for mailbox approaches will be paid for as HMA mixture for approaches of the type specified.

Payment will be made under:

90	Pay Item	Pay Unit Symbol
	HMA for Approaches, Type <u> * </u>	TON
	PCCP for Approaches, <u> </u>	SYS
	thickness	

* Mixture type in accordance with 402.04.

The cost of excavation, shaping, leveling, forming, compaction, placing, and all necessary incidentals shall be included in the cost of the pay items in this section.

100 The cost for curbing placed monolithically with the PCCP on approaches shall be included in the cost of PCCP for approaches.

SECTION 611 – MAILBOX INSTALLATIONS

611.01 Description

This work shall consist of the construction of mailbox installations, or the removal and resetting of existing mailboxes and assemblies, in accordance with 105.03.

MATERIALS

611.02 Materials

10 Materials shall be in accordance with the following:

Mailbox Support Galvanized Hardware	ASTM A153
Nominal Standard Galvanized Pipe.....	ASTM A53
Treated Wood Posts.....	911.02(e)

611.03 Mailbox Assembly

Existing mailboxes and assemblies shall be removed without damage from the highway right-of-way.

20 Mailboxes, which must remain in service between removal and erection of the new assembly, shall be securely mounted to an empty 55 gal. metal drum. The temporary assembly shall be located where it is accessible for mail delivery but placed as far as possible from the traveled roadway. The apparent owner of the existing mailbox shall be contacted and allowed to take possession of the existing mailbox and assembly. If the owner refuses to take possession, the existing mailbox and assemblies shall be removed.

30 Mailbox assemblies shall be furnished and installed as shown on the plans. Alternate mailbox assemblies which have been crash tested and approved in accordance with NCHRP 350 requirements may be considered upon receipt of a written request. Alternate mailbox assemblies approved for use shall be furnished and installed in conformance with the manufacturer's recommendations.

40 Mailboxes complying with the requirements of the United States Postal Service, including markings and sizes, shall be furnished and installed with the mailbox assembly. The mailbox shall be of comparable size to the existing mailbox previously removed from the highway right-of-way. The markings shall include "approved by U.S. Postmaster" stamped on the mailbox by the manufacturer and the address number, box number, or house number, in 2 in. or larger reflective material placed on the side of the mailbox in view of motorists in the nearest travel lane.

Existing mailboxes and assemblies that are to be reset shall be removed and reinstalled without damage. If the existing mailboxes and assemblies are damaged during removing and resetting, they shall be replaced in kind at no additional cost.

611.04 Method of Measurement

Mailbox assemblies will be measured by the number of units of the type installed. Resetting of mailbox assemblies will be measured by the number of units of the type reinstalled.

50

611.05 Basis of Payment

Mailbox assemblies will be paid for at the contract unit price per each per type, complete in place. Resetting of mailbox assemblies will be paid for at the contract unit price per each per type, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
60	Mailbox Assembly, Double.....	EACH
	Mailbox Assembly, Single	EACH
	Mailbox Assembly, Reset, Double	EACH
	Mailbox Assembly, Reset, Single.....	EACH

The cost of wood or pipe posts, support hardware, mailbox, and removal of existing mailbox and its assembly shall be included in the cost of the mailbox assembly.

70 The cost of all materials, labor, equipment and incidentals required to remove and reset the existing mailboxes shall be included in the cost of mailbox assembly, reset.

SECTION 612 – UNDERSEALING

612.01 Description

This work shall consist of drilling holes and furnishing and pumping an asphalt material under cement concrete pavement in accordance with 105.03.

MATERIALS

612.02 Materials

10 Asphalt material shall be in accordance with the following:

Utility asphalt, UA-III 902.01(d)

CONSTRUCTION REQUIREMENTS

612.03 Weather Limitations

Undersealing shall not be performed when pavement surface temperatures are below 40°F, or when the subgrade or subbase is frozen. If proper undersealing cannot

612.04

20 be achieved due to excessive temperatures or direct sunlight, work shall be performed at night.

612.04 Shoulders

All holes, low areas, or displaced areas in the shoulders immediately adjacent to the pavement edge shall be filled with loam, clay, or other approved material and compacted to the elevation of the pavement. Such areas, including all other shoulder areas immediately adjacent to the pavement edge, shall be compacted with a roller or another approved method.

612.05 Drilled Holes

30 Where the existing pavement has transverse joints, holes not to exceed 1 1/2 in. in diameter shall be drilled on the centerlines of the pavement lane to be treated. Such holes, unless otherwise directed, shall be located longitudinally between transverse joints or cracks at approximately 30 to 36 in. from the joints or cracks. Intermediate holes, if necessary, shall be spaced as directed.

If the existing pavement does not have transverse joints, holes not to exceed 1 1/2 in. in diameter shall, unless otherwise specified, be located on the centerline of the pavement lane to be treated and be spaced as directed.

40 An approved method shall be used to prevent the drill from entering the subgrade after penetrating the pavement. Automatic stops on mechanical equipment and marked drill bits on hand operated jackhammers may be approved subject to satisfactory operation.

Just prior to pumping operations, the surface of the pavement around each hole for an area of at least 1/2 the width of the lane being treated shall be thoroughly sprinkled with water to prevent the undersealing material from adhering to the pavement surface.

50 **612.06 Pumping**

All storage tanks, pipes, retorts, booster tanks, and distributors used for storing or handling the materials shall be kept clean and in good operating condition at all times so there is no contamination of the materials.

Where undersealing operations are being performed under traffic, necessary signs, barricades, watchers, and flaggers shall be used to maintain one lane of traffic in the immediate vicinity of pumping operations. Traffic may be allowed to use the pumped areas upon removal of the original plugs and after the hardwood plugs are driven.

60 When directed, certain portions may be required to be undersealed a second time. The number of holes involved in this second undersealing shall not exceed 5% of the number of holes indicated in the Schedule of Pay Items.

(a) Asphalt Material

The asphalt shall be pumped through the drilled holes and under the pavement

with an approved type of self-propelled pressure distributor, the pressure to be as directed. A metallic hose shall connect the asphalt tank through an asphalt pump to a 1 in. nozzle and a return metallic hose shall connect the nozzle to the asphalt distributor tank.

70

The nozzle shall be equipped with a 3-way valve that allows the asphalt to circulate back to the distributor tank when pumping operations are not in progress. The nozzle shall be inserted in the hole, driven to a snug fit, and pumping of the asphalt continued until the undersealing is complete, or to such other amount as directed. In case of an existing asphalt resurface on concrete, holes shall be drilled through the resurface and the underlying concrete and the nozzle shall be of sufficient length that it can be driven to a snug fit into the concrete without the upper part of the nozzle being below the elevation of the existing asphalt resurface.

80 The asphalt shall not be heated above 500°F at any time and, when pumped under the pavement, the temperature shall be no less than 350°F. All material heated beyond 500°F shall be rejected.

(b) Wood Plugs

Upon completion of the pumping operation, the nozzle shall be removed and a wood plug driven into the hole. After the pumped material has hardened, the original plug shall be removed and a 4 in. or longer hardwood plug a minimum of 1/16 in. larger than the diameter of the drilled hole shall be driven flush with the surface of the pavement. All material extruded during the pumping operations shall be immediately cleaned from the pavement surface and removed from the limits of the contract within a period of 24 h.

90

The hardwood plugs shall be inspected after any milling operation in the case where a resurface exists on the concrete. Damaged or missing plugs shall be replaced prior to overlaying with a new surface.

612.07 Method of Measurement

Asphalt material will be measured by the ton. Drilled holes for underseal will be measured per each hole drilled.

100

612.08 Basis of Payment

This work will be paid for at the contract unit price per ton for material for underseal. Drilled holes for underseal will be paid for at the contract unit price per each, complete in place.

Additional holes and materials required for a second undersealing operation will be paid for at the contract unit prices for the quantities involved.

Payment will be made under:

110

Pay Item	Pay Unit Symbol
Drilled Hole for Underseal	EACH
Material for Underseal.....	TON

The cost of shoulder material, wood and hardwood plugs, and necessary incidentals shall be included in the cost of the pay items.

SECTION 613 – SALVAGED ROAD MATERIALS

613.01 Description

This work shall consist of removing approved material from an existing road within the limits of the contract, including intersecting approaches, and using it in reconstruction of the road in accordance with these specifications or as directed.

613.02 Materials

10 Approved materials may be asphalt treated or untreated gravel, stone, slag, or all combinations of these or other materials which are suitable for salvaging.

613.03 Construction Requirements

Before any filling or further work is done at locations where material is to be salvaged, such material shall be removed and stored in stockpiles outside the construction limits and adjacent thereto, or it may be incorporated directly into the work without stockpiling if conditions allow.

20 The quantities removed, if available, shall be sufficient to complete the item of work or certain portions thereof for which it is intended. The depth of excavation shall be as directed.

The incorporation of the salvaged material into the work shall be in accordance with applicable provisions of the specifications for which the material is to be used or in accordance with the special provisions, depending on the nature of the material and the use to which it is put.

613.04 Method of Measurement

30 Salvaged road material will be measured by the cubic yard in stockpiles after removal from its original position or, if the Contractor prefers, it will be measured by the cubic yard in its original position. All measurements will be made by means of cross sections. The volumes will be computed by the average end area method.

If salvaged road material is used as subbase, the combined pay quantities of subbase and salvaged road material for subbase shall equal but shall not exceed the total theoretical volume as calculated to the neat lines shown on the plans for subbase. If the volume of salvaged road material used as subbase determined by the cross

section method does exceed the total theoretical volume of subbase, the final pay quantity for salvaged road material for subbase shall be the total theoretical volume.

40 The final pay quantity of subbase will be determined by deducting the final pay quantity of salvaged road material for subbase from the total theoretical volume of subbase.

If salvaged road material is obtained from within the pay limits of the new construction, such cubic yardage of salvaged material will be deducted from the excavation quantities to be measured for payment.

613.05 Basis of Payment

50 The accepted quantities of salvaged road material for the use shown in the Schedule of Pay Items will be paid for at the contract unit price per cubic yard, complete in place.

Payment will be made under:

Pay Item	Pay Unit Symbol
Salvaged Road Material for _____	CY

60 The cost of removal of the material, storage, incorporating it into the work, and necessary incidentals shall be included in the cost of the pay item.

SECTION 614 – CONCRETE HEADER

614.01 Description

This work shall consist of the construction or reconstruction of PCC headers adjacent to railroad tracks, bridges, and similar locations in accordance with 105.03.

MATERIALS

614.02 Materials

10 Materials shall be in accordance with the following:

Concrete	702
Reinforcing Bars.....	910.01

If the header is adjacent to cement concrete base or pavement, the header concrete shall be the same composition as that of the base or pavement header constructed monolithic with the base or pavement. If the adjacent base or pavement is thickened, that portion forming the thickening shall be considered as part of the header.

20 If the header is adjacent to asphalt pavement, the concrete shall be class A in accordance with 702 using class AP coarse aggregate.

CONSTRUCTION REQUIREMENTS

614.03 PCC Header

Construction shall be in accordance with the applicable provisions of 702 and with these requirements.

30

Welding shall be in accordance with 711.32.

Headers at railroad crossings shall be as shown on the plans.

614.04 Reconstructed Cement Concrete Header

This work shall be in accordance with the plans. Round plug welds or rectangular shaped plug welds may be used to weld the steel angle to the existing steel edge protection. Round plug welds shall be a minimum of 1 in. diameter.

Welding shall be in accordance with 711.32.

40

614.05 Method of Measurement

Cement concrete header and reconstructed cement concrete header will be measured by the linear foot.

614.06 Basis of Payment

The accepted quantities of this work will be paid for at the contract unit price per linear foot for header, cement concrete, of the type specified, or header, cement concrete, reconstruct, complete in place.

50

Payment will be made under:

Pay Item	Pay Unit Symbol
Header, Cement Concrete, _____ type	LFT
Header, Cement Concrete, Reconstruct.....	LFT

The cost of edge protection, metal chairs, excavation, and necessary incidentals shall be included in the cost of the pay items.

SECTION 615 – MONUMENTS, MARKERS, AND PARKING BARRIERS

615.01 Description

This work shall consist of furnishing and setting, setting only, or resetting right-of-way markers, monuments for marking section or other lines, benchmark posts and tablets, and parking barriers in accordance with 105.03.

MATERIALS

10 **615.02 Materials**

Materials shall be in accordance with the following:

Coarse Aggregate, Class A or Higher, Size No. 8 or 91	904.03
Fine Aggregate, Size No. 23.....	904.02
Portland Cement.....	901.01(b)
Post.....	911.02(f)
Reinforcing Bars.....	910.01

20 **615.03 Reinforced Cement Concrete Right-of-Way Markers**

These markers shall conform with the dimensions and lettering shown on the plans. The reinforcement shall be securely held in place by at least four spacers of an approved design. The concrete ingredients shall be graded and proportioned to produce a strong dense concrete.

When tested as hereinafter described, a specimen shall support a total load of at least 2,400 lb before the first crack appears. The specimen will be tested as a simple beam. The distance between supports shall be exactly 24 in. with the load applied at the rate of approximately 1,200 lb per minute in the center of the span. Loading will continue until the first crack appears.

The cement concrete shall absorb no more than 8% water. Specimens for absorption may be taken from the markers tested for strength. The absorption test shall be as described in accordance with AASHTO T 280 except the specimen tested shall be the full cross section marker.

The markers shall have a smooth workmanlike finish free from cracks, patches, honeycomb, exposed reinforcement, and excessive bubble holes. Each marker shall be plainly marked near the bottom with the trademark or initials of the manufacturer and the date of manufacture. These letters and figures shall be no less than 1 in. in height and shall be indented 1/8 in.

A type C certification in accordance with 916 shall be provided for the right-of-way markers.

615.04 Monuments

Monuments shall be of the type specified in the Proposal book, the details of which are shown on the plans. Any portion extending above the ground shall be finished in accordance with 702.21.

Where concrete is required, it shall be class A in accordance with 702. When placed in the forms it shall be tamped in layers until mortar covers the outer surface.

615.05

The tops of the monument shall be floated smooth. Monuments may be precast or cast-in-place.

The pin shall be set perpendicular to and flush with the top of the monument while the concrete is plastic and left undisturbed until the concrete has set. The pin shall be steel and shall be 1 in. in diameter and 5 in. long. If for type D monuments, the hole shall be drilled in the center with a 1/8 in. drill for a depth of 1 1/2 in. The hole shall
60 be filled with lead flush with the end of the pin. Castings for protected monuments shall be in accordance with 910.05(b).

615.05 Benchmark Posts

Benchmark posts shall be of the dimensions shown on the plans and cast in accordance with applicable provisions of 615.03, except the strength shall be determined by concrete cores taken from the finished product. At least two concrete cores will be taken from each unit and the average strength of the unit shall be at least 4,000 psi with no individual core strength less than 3,600 psi. Tablets will be furnished by the Department and shall be set in the posts as indicated on the plans.

70

615.06 Parking Barriers

Parking barriers shall be of the dimensions shown on the plans.

Placement of parking barriers shall be at the locations and in accordance with the details shown on the plans, or as otherwise directed.

Existing parking barriers to be removed and reset shall be removed without damage, stored and reinstalled as shown on the plans.

80

(a) Concrete

The concrete barriers shall be cast and tested in accordance with the applicable requirements of 615.03, except the strength shall be determined by concrete cores taken from the finished product. At least two concrete cores will be taken from each unit and the average strength of the unit shall be at least 4,000 psi with no individual core strength less than 3,600 psi.

(b) Timber Post

Vertical timber posts as parking barriers shall be round, roofed on top, and be dimensioned as shown on the plans. The posts shall be in accordance with the
90 applicable requirements of 911.02(f).

CONSTRUCTION REQUIREMENTS

615.07 Setting Right-of-Way Markers

The back face of these markers shall be set on the right-of-way lines approximately 1,000 ft apart as hereinafter provided. They shall be set at all corners of irregular right-of-way lines, opposite each P.C. and P.T. of curves, and not to exceed

500 ft apart on the inside and outside of curves. Care shall be used in locating markers on tangents so that a marker is plainly visible from each of those adjacent.

100

Markers shall be set plumb, to the depth required on the plans, and with the letters facing the pavement. Portions of the holes not occupied by markers shall be backfilled and compacted in layers with suitable material up to the level of the original ground. The markers shall not be displaced during backfilling.

615.08 Resetting Right-of-Way Markers

When the proposal provides that existing right-of-way markers be reset, the existing markers shall be removed and reset at designated locations in accordance with 615.07.

110

615.09 Setting Monuments

If the location of a monument falls within the limits of a cement concrete pavement, a steel pin, the details of which are shown on the plans, shall be set perpendicular to and flush with the top of the finished pavement. It shall be placed just before the concrete takes initial set and then left undisturbed until the concrete has set. Other monuments shall be of the type shown on the plans, depending on the type or surface of the pavement in which they are to be placed or if they are to be placed outside of pavement. Necessary excavation shall be to the required depth. The bottom of the excavation shall be firm and true to line and grades given. After a monument is in place, the remaining excavated areas shall be backfilled with suitable material firmly tamped in layers. The monument shall not be disturbed.

120

Existing monuments which are not required to be disturbed or re-established, but which are disturbed during construction operations, shall be re-established.

615.10 Re-Established Monuments

It may be necessary to re-establish existing monuments in pavements or bases which are disturbed unavoidably or covered by operations embraced in the contract.

130

If the existing monument is, or contains a brass, copper, or steel pin, the pin shall be extended to the surface of the new pavement by attaching a pin of the same metal with at least a 1 in. diameter and of the length required. Such extensions shall be attached by tapping the original pin and providing a necessary screw attachment such that the extension can be fastened securely to the original pin. The tapped hole shall be at least 1/4 in. in diameter and no less than 1 in. deep. The screw attachment shall have the same diameter as for the hole in the original pin and shall be no less than 1 in. in length.

140

Where an existing monument of the type specified above has not been re-established on a previous contract, the monument shall be re-established in the same manner as set out above.

Where existing monuments are protected and encased in cast iron, such castings shall be adjusted to meet the elevation of the proposed surface by means of an asphalt coated, cast iron, adjustment casting. The size shall be the same as the original casting and of the depth necessary to meet the elevation of the proposed new surface.

615.11 Setting Benchmark Posts and Tablets

Benchmark posts shall be set at locations marked on the plans or as directed.
 150 Excavation shall be to the depth indicated and to dimensions sufficient to provide for the concrete backfilling. This concrete shall be class A and shall extend for 6 in. around and below the post. The bottom shall be monolithic with the sides. The remainder of the excavation up to the original ground line shall be backfilled with suitable material well tamped in layers. Care shall be taken not to disturb the post. When specified on the plans, or directed, benchmark tablets furnished by the Department shall be placed in newly constructed or existing drainage structures located within the limits of the contracts.

615.12 Reset Benchmark Posts

160 When the Proposal book provides that existing benchmark posts be reset, the existing benchmark posts shall be removed and reset at designated locations in accordance with 615.11.

615.13 Method of Measurement

Right-of-way markers, reset right-of-way markers, monuments, re-established monuments, castings adjusted to grade monuments, benchmark posts, reset benchmark posts, parking barriers, and reset parking barriers will be measured by the number of units installed.

170 **615.14 Basis of Payment**

The acceptable quantities of right-of-way markers, reset right-of-way markers, monuments, re-established monuments, castings adjusted to grade monuments, benchmark posts, and reset benchmark posts, parking barriers, and reset parking barriers will be paid for at the contract unit price per each, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
180	Benchmark Post.....	EACH
	Benchmark Post, Reset.....	EACH
	Casting Adjusted to Grade, Monument	EACH
	Monument, _____	EACH
	type	
	Monument, Re-Establish	EACH
	Parking Barrier, Concrete.....	EACH
	Parking Barrier, Reset	EACH
	Parking Barrier, Timber Post.....	EACH

190	Right-of-Way Marker	EACH
	Right-of-Way Marker, Reset	EACH

The cost of extensions for monuments, adjustment castings, backfill, disposal of surplus materials, re-establishing disturbed existing monuments, and all other necessary incidentals shall be included in the cost of the pay items in this section. The cost of setting tablets in benchmark posts or structures shall be included in the cost of Construction Engineering.

200 The cost of existing parking barrier removal, storage, resetting, and all other necessary incidentals needed for resetting shall be included in the cost of parking barrier, reset. Existing barriers that are damaged by the Contractor shall be replaced with no additional payment.

SECTION 616 – RIPRAP AND SLOPEWALL

616.01 Description

This work shall consist of placing broken stone or concrete which may or may not be grouted, precast slabs, or slope wall in accordance with these specifications and in accordance with 105.03.

MATERIALS

10 **616.02 Materials**

Materials shall be in accordance with the following:

20	Asphalt Joint Filler	906.01
	Clay	903.01
	Concrete, Class A	702
	Fine Aggregate, Size No. 23.....	904.02
	Geotextile for Riprap.....	918.02
	Portland Cement.....	901.01(b)
	Precast Concrete Riprap	904.04(e)
	Riprap	904.04
	WWR, Smooth	910.01(b)5
	Water	913.01

CONSTRUCTION REQUIREMENTS

616.03 Placing Dumped Riprap

30 Dumped riprap shall be placed to produce a surface of approximate regularity but need not necessarily be hand placed. The finished surface shall vary no more than 9 in. from a true plane. The thickness perpendicular to its surface shall be no more than 2 ft nor less than 1 ft unless otherwise directed.

616.04 Placing Grouted Riprap

The aggregate, preparation of the slope, and the depth of riprap aggregate for grouted riprap shall be in accordance with 616.05. After the aggregate has been placed and accepted, all openings shall be filled with cement grout. The finished surface shall be approximately smooth, solid, and true to line, grade, and section.

40 Grout shall be composed of 1 part portland cement and 4 parts fine aggregate. The portland cement and fine aggregate shall be dry-mixed to a uniform mixture. Water shall be added as the mixing continues until the grout attains a consistency that will enable it to flow into the openings.

616.05 Placing Revetment, Class 1, and Class 2 Riprap

Revetment, class 1 and class 2 riprap may be placed by dumping and shall be placed to the required thickness. The finished surface shall be free from clusters of small stones or of large ones. The finished surface shall vary from a true plane no more than 9 in. for revetment riprap or 18 in. for class 1 or class 2 riprap but shall not be less than the minimum depth specified.

50 **616.06 Placing Uniform Riprap**

Uniform riprap shall be placed to produce a surface of approximate regularity with edges having projections no more than 3 in. above the required cross section. The material shall be hand laid or placed by other approved means.

616.07 Blank**616.08 Placing Precast Cement Concrete Riprap**

60 The slope on which the riprap is to be placed shall be in accordance with that shown on the plans unless otherwise designated. Laying shall begin in a trench below the toe of the slope and progress upward. Each piece shall be laid by hand perpendicular to the slope. It shall be firmly embedded against the slope in such a manner that the vertical joint space between individual units does not exceed 3/8 in., unless otherwise specified. Half blocks, odd shaped blocks, or class A concrete shall be used to fill the voids at the ends of sections to be placed or on curved shaped sections. The top course shall conform, as nearly as practicable, with the prescribed berm or shoulder elevation. Any adjustment necessary to achieve this shall be obtained by constructing a wedge course near the top of the slope as directed. This wedge course, when required, shall consist of class A concrete. If the thickness of the course does not allow class A concrete, it shall be constructed of a 1:2 mortar proportioned
70 by volume. Toewalls, when required, shall consist of class A concrete.

616.09 Slopewall

The slope on which slopewall is to be placed shall be in accordance with that shown on the plans unless a different slope is designated.

The concrete mixture shall be class A. Where paved slopewall abuts or surrounds columns, piers, or other structures, 5/8 in. of asphalt joint filler shall be used between

80 the slopewall and such structure. Welded steel wire reinforcement shall be placed within the middle 1/3 of the slopewall thickness unless otherwise directed. The fabric shall extend through all construction joints. The surface of the slopewall shall be cured for 48 h in accordance with 501.20. Construction joints may be either butt or keyway type.

Inspection holes shall be provided at the locations shown on the plans or as directed. The holes shall be approximately 3 ft by 3 ft in size.

Precast concrete riprap, type B, as shown on the plans, may be used in lieu of slopewall of 4 in. thickness.

90 **616.10 Undermined Paved Side Ditch**

Treatment of undermined existing paved side ditch and placement of revetment riprap shall be as shown on the plans or as otherwise directed.

Undermined paved side ditch shall be broken up and left in place. If it is determined that erosion is excessive, the eroded area shall be backfilled with a cohesive material, compacted, regraded, and lined with revetment or uniform riprap.

616.11 Installation of Geotextile Under Riprap

100 Storage and handling of geotextiles shall be in accordance with the manufacturer's recommendations, except that the geotextile shall not be exposed to direct sunlight, ultraviolet rays, water, temperature greater than 140°F, mud, dirt, dust, and debris, to the extent that its strength, toughness, or permeability requirements are diminished. Each geotextile roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days. At the time of installation, the geotextile shall be rejected and replaced with no additional payment if defects, rips, flaws, deterioration or damage incurred during manufacture, transportation, storage, or construction is evident.

110 The surface to receive the geotextile shall be prepared to a relatively smooth condition free of obstructions, depressions, and debris within the limits indicated on the plans.

Geotextiles used along channels shall be placed with the machine direction of the geotextile parallel to the channel. Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the downstream sheet and the upslope sheet over the downslope sheet.

120 Geotextiles used for 2:1 slopes or greater shall be placed with the machine direction of the geotextile sheets perpendicular to the toe of slope. The geotextile sheets shall be overlapped in the direction of the anticipated movement of water.

Adjacent pieces of geotextile may be joined by sewing if approved, or by

overlapping and pinning. The minimum overlap shall be 18 in. except when placed under water. When placed under water, the overlap shall be a minimum of 3 ft. Securing pins shall be steel, 3/16 in. in diameter, 18 in. long, pointed at one end and fabricated with a head to retain a steel washer having an outside diameter of no less than 1 1/2 in. Securing pins with washers shall be inserted through both strips of overlapped geotextile at spacing intervals in Table 1 along a line through the midpoint of the overlap. The geotextile strip shall be placed so that the lower strip will be overlapped by the next higher strip. Pins shall be driven until the washer bears against the geotextile and secures it firmly to the ground.

Whether the fabric is joined by sewing or pinning, additional pins shall be installed as necessary to prevent any slippage of the fabric regardless of location.

Slope	Pin Spacing
steeper than 3:1	2 ft
3:1 to 4:1	3 ft
4:1 or flatter	5 ft

Table 1

The geotextile shall be placed in such a manner that placement of the overlying materials will not excessively stretch or tear the geotextile and will not pull the required overlap or seam apart. Construction equipment shall not be on the exposed geotextile. Placement of riprap or stone shall start from the base of the slope, moving upslope and from the center outward. Riprap shall not roll downslope and the height of drop for riprap shall be kept to less than 2 ft.

616.12 Method of Measurement

Dumped, revetment, class 1 and class 2 riprap obtained from outside the right-of-way will be measured by the ton. If obtained from inside the right-of-way, no measurement will be made if placed as shown on the plans unless direct payment is specified. If placed at locations not shown on the plans, measurement will be made by the square yard.

Grouted riprap and precast concrete riprap, including the area occupied by the wedge course, will be measured by the square yard, parallel to the slope. Slopewall will be measured by the square yard. Holes for inspecting slopewalls will be measured per each. Geotextiles used under riprap will be measured by the square yard by the type specified, complete in place. Uniform riprap will be measured by the ton.

Treatment of undermined paved side ditch will be measured by the linear foot of paved side ditch, broken and left in place.

616.13 Basis of Payment

The accepted quantities of dumped, revetment, class 1, and class 2 riprap obtained from outside the right-of-way will be paid for at the contract unit price per ton. Dumped, revetment, class 1, and class 2 riprap obtained from within the project limits

will be paid for at the contract unit price per square yard. Uniform riprap will be paid for at the contract unit price per ton. Grouted riprap will be paid for at the contract unit price per square yard of the specified depth. Precast concrete riprap, and concrete slopewall will be paid for at the contract unit price per square yard, all complete in place. If slag is used as dumped riprap and payment will be made per ton, the pay quantity will be adjusted in accordance with 904.01.

The accepted quantities of geotextiles used under riprap will be paid for at the contract unit price per square yard, complete in place.

Inspection holes will be paid for at the contract unit price per each.

The treatment of undermined paved side ditch will be paid for at the contract unit price per linear foot for paved side ditch, break. Backfill required for treatment of paved side ditch will be paid for at the contract unit price per cubic yard for borrow, cohesive.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Borrow, Cohesive.....	CYS
	Geotextiles for Riprap, _____ type	SYS
190	Inspection Hole.....	EACH
	Paved Side Ditch, Break.....	LFT
	Riprap, Class _____	TON
		SYS
	Riprap, Dumped	TON
		SYS
	Riprap, Grouted, _____ in. depth	SYS
	Riprap, Precast Concrete	SYS
	Riprap, Revetment.....	TON
200		SYS
	Riprap, Uniform	TON
	Slopewall.....	SYS
	Slopewall, Concrete, _____ in. depth	SYS

If the contract includes a pay item for removing materials from within the project limits which are used as grouted riprap, the cost of such removal shall be included in the cost of the pay item for the removal work. The cost of placing such material shall be included in the cost of the riprap pay item.

210

619.01

The cost of paved side ditch required at the top of riprap and along the edge of riprap will be paid for in accordance with 607.06.

The cost of welded steel wire reinforcement shall be included in the cost of the slopewall.

The cost of excavation below the finished riprap or slopewall shall be included in the cost of the riprap and slopewall pay items.

220 The cost of excavation, grading, sewing, pinning, and necessary incidentals shall be included in the cost of geotextiles.

SECTION 617 – BLANK

SECTION 618 – BLANK

SECTION 619 – PAINTING BRIDGE STEEL

619.01 Description

This work shall consist of preparing surfaces, disposing of waste, and applying paint or another coating to steel bridges, steel piling, bearing assemblies, or other steel items in accordance with 105.03.

MATERIALS

10 **619.02 Materials**

Materials shall be in accordance with the following:

Epoxy Intermediate Paint	909.02(b)
Finish Coat for Weathering Steel	909.02(e)
Multi-Component Inorganic Zinc Silicate Primer	909.02(a)1
Organic Zinc Primer	909.02(a)2
Polyurethane Finish Coat	909.02(c)
Structural Steel Coating Systems	909.03
Waterborne Finish Paint	909.02(d)

20

Safety data sheets shall be provided in the QCP for all materials to be delivered to the project site.

Caulk used to form the drip bead on weathering steel shall be a clear, 100% silicone caulk.

Caulk used on joints of lapping members shall be compatible with either the

structural steel paint system or the partial paint system, and in accordance with the paint manufacturer's recommendations.

30

CONSTRUCTION REQUIREMENTS

619.03 Quality Control and Quality Assurance

The Contractor shall be responsible for the quality of work on the contract and shall ensure that all work has been performed by accepted quality control methods. A QCP shall be prepared and submitted by the Contractor in accordance with ITM 803. No work may begin until written notice has been received that the QCP was accepted by the Engineer. The QC manager shall furnish the current referenced SSPC Standards at the project site.

40

Cleaning and painting shall be done by a Contractor certified as SSPC-QP 2 for cleaning and painting existing bridge steel on steel structures shown in the contract documents as being built before 1995. Cleaning and painting shall be done by a Contractor that at a minimum is certified as SSPC-QP 1 for cleaning and painting new bridge steel or for cleaning and painting existing bridge steel on steel structures shown in the contract documents as being built after 1994.

The Department will accept work performed on the project through quality assurance inspections and testing. Acceptance testing will be performed and will be the basis for which acceptance will be made.

50

(a) Test Methods and Procedures

The current version of the following test methods and procedures shall be performed as a minimum for quality control by the Contractor. These and other tests may be performed for acceptance testing by the Engineer. The results of the following tests and procedures shall be compiled and submitted to the Engineer on a daily basis.

Test/Procedure	Method and Procedure
Clean Compressed Air	ASTM D4285
Cleaning of Steel	SSPC-Vis 1, Vis 3
Cleanliness of Recycled Ferrous Metallic Abrasives	SSPC-AB 2
Dry Film Thickness	SSPC-PA 2
Relative Humidity	ASTM E337
State of Cure of Inorganic Zinc Primers	ASTM D4752
Surface Profile	ASTM D4417, Method B or C

Relative humidity, dew point, and surface temperature shall be recorded before the application of any coating and at least once per hour during the application of any coating.

60

Air compressor output and blasting abrasives shall be inspected at least once every four hours for contamination.

Visual inspections for cleaning shall be performed after each phase of the applicable cleaning operations for compliance with the specified requirements for each lot. The surface shall be wiped with a white glove or white rag to ensure the surface is free of dust and other contaminants.

70

The blast cleaned surface shall be inspected for surface profile, oil contamination, dust, and blasting residue, and accepted prior to the application of the primer.

The required number of surface profile measurements and dry film thickness measurements shall be in accordance with SSPC-PA 2.

If a lot is non-conforming, corrective action shall be taken to make the lot acceptable. Corrective action shall be submitted in writing and performed as approved. A phase shall not be covered until the whole lot has been accepted.

80

(b) Acceptance Testing

Acceptance testing of painting steel bridge work will be in accordance with ITM 803. The results of the acceptance testing will be compared to the specific requirements for that phase of work. The Contractor shall not proceed to the next phase of work until written approval has been received from the Engineer that the current phase is accepted.

619.04 Prosecution of Work

Prosecution of work shall be in accordance with the applicable requirements of 108.04. Once the cleaning and painting operations have begun, it shall be performed on all work days without stoppage until all work has been completed. If the contract contains more than one bridge, a schedule shall be included in the QCP which provides the sequence of work on the bridges. Once work has begun on a bridge, it shall be performed until complete, including all cleanup.

Permission shall be obtained in writing to start or continue work at the hold points as follows:

- (a) prior to the acceptance of the QCP and start of work;
- (b) immediately following each phase of surface preparation;
- (c) immediately before the application of the first coat;
- (d) prior to the application of each succeeding coat; and
- (e) after the final coat has cured.

100

A minimum of one day's notice shall be given in advance of each of the hold points.

619.05 Inspection Access to Bridges

Safe and reasonable access to all points of the bridge shall be provided for the Engineer's inspections immediately upon request.

110

619.06 Maintaining Traffic

The traffic lanes may be restricted when surface preparation or painting phases are being performed on a portion of the bridge over the traveled roadway, or as directed, when the need exists.

Construction signs in accordance with 801.04 shall be furnished and placement at each project site shall be as shown in the QCP. However, a “Bridge Painting Ahead” sign may be used in place of the “Road Construction Ahead” sign.

120

The traffic maintenance plan shall include a type of barrier system which shall protect against blasting of vehicles or pedestrians, eliminate abrasive materials and debris from falling onto the traveled portion of the pavement, and prevent the spreading of abrasive materials and debris in the area which may create a traffic hazard. If the intended purpose of the protective devices has not been accomplished, work shall stop until adequate corrections have been made. All abrasive material or debris shall be removed by the end of each day’s work in accordance with 619.07.

619.07 Safety and Environmental Requirements

130

Safety requirements, pollution control, and disposal of existing paint waste and debris shall be in accordance with the following requirements.

(a) Safety Requirements

The containment system shall be in accordance with 619.07(b)1a or 619.07(b)1b, as applicable, based on the year the structure was built as shown in the contract.

140

The Contractor shall follow OSHA rules and regulations and be responsible for determining the level of hazards that are present in the containment during the removal of the existing bridge coating operation. Once the Contractor establishes the level of hazard present, the Contractor shall be responsible for furnishing personal protective equipment to provide the degree of protection necessary for the established level of hazard. All Contractor and Department personnel on the project site shall wear personal protective equipment to the level of hazard as determined by the sampling and monitoring requirements performed by the Contractor. The protective equipment shall be furnished by the Contractor, including to Department personnel. Training shall be given to all personnel who are provided with personal protective equipment. Personal protective equipment shall include, but not be limited to, clean air supplied respirators, air purifying respirators, conventional hood as applicable, eye protection, and protective clothing.

150

(b) Pollution Control

Pollution control shall consist of two different operations. One shall be controlling and containing the atmosphere generated during the coating removal operation. The other shall be controlling and containing the solid waste stream generated as a result of the coating removal operation.

1. Pollution Control during Existing Coating Removal Operations

160 During existing coating removal operations, the Contractor shall recognize that the environment created by removal of the existing coating from the structure may create an atmosphere in which hazards to personnel on the jobsite are likely to be generated, and thus the Contractor shall be responsible for controlling and protecting the exposure of all workers and the surrounding environment from the hazards.

The characterization of the level of hazard of the existing coating that the Department considers to be present on the structure will be dictated by the year the structure was built as described below. The characterization of the level of hazard of the existing coating is not related to the results of the TCLP.

a. Containment for Structures Built Before 1995

170 For structures shown in the contract documents as being built before 1995, the Contractor shall provide a containment system in order to contain all blasting materials, scrapings, wire brushings, and paint particles in accordance with SSPC-Guide 6, Class 2A or greater with method A, level 1 emission control capability. The Contractor shall take samples and monitor the work environment in accordance with IOSHA requirements and shall provide personal protective equipment appropriate to the conditions present within the work environment.

b. Containment for Structures Built After 1994

180 For structures shown in the contract documents as being built after 1994, the Contractor shall provide a containment system in order to contain all blasting materials, scrapings, wire brushings, and paint particles in accordance with SSPC-Guide 6, Class 2A or greater with method A, level 3 emission control capability. The Contractor shall take samples and monitor the work environment in accordance with IOSHA requirements and shall provide personal protective equipment appropriate to the conditions present within the work environment.

190 Regardless of the level of containment as listed above, if a spill, as defined in IDEM Regulation 327 IAC 2-6.1 does occur, all work shall stop and immediate action shall be taken to clean up the site. Spills of material, that enter or threaten to enter the water, shall be handled in accordance with IDEM Regulation 327 IAC 2-6.1. The IDEM Emergency Response Branch, the local health department, and all water intake users within 500 ft of the bridge shall be immediately contacted and advised of the spill. Written documentation of all such contacts and actions shall be kept. All applicable Federal, State, and local rules and regulations described in 619.07(b)2b(1) shall be observed.

2. Pollution Control of the Generated Waste Stream

a. Waste Stream Sampling

200 Each bridge shall generate a separate waste stream and shall not be commingled with other materials. A sample of the waste stream from the bridge shall be obtained at the conclusion of the first day of the coating removal operation for that bridge. The

sample will be shipped to be tested within 24 h in a manner agreed to by the Department and as described in the QCP. The Engineer will witness the extraction of the waste stream sample. The Department will maintain custody of the waste residue sample until it is shipped. The waste stream sample shall be taken by random method as described in the QCP which reflects representation of the entire bridge. The samples shall be analyzed for all contaminants listed in ITM 803 by the TCLP. The remaining waste shall be placed in an approved container. Such containers shall be labeled and
 210 maintained to comply with 40 CFR 264.

None of the waste shall remain on the booms or on any water surface overnight. All blasting debris shall be cleaned up after each day's work. All waste material shall be properly stored at the project site to prevent loss or pollution.

If the waste stream sample analysis is returned with one or more of the contaminants meeting or exceeding the regulatory level for the respective contaminant, the entire waste stream for that bridge shall be considered to exhibit the characteristic of toxicity and thus shall be characterized as and considered to be
 220 hazardous.

If the waste stream sample characterization is returned with none of the contaminants meeting or exceeding the regulatory level for the respective contaminant, the entire waste stream for that bridge shall be considered to not exhibit the characteristic of toxicity and thus shall be characterized as and considered to be non-hazardous.

Waste stream characterization as either hazardous or non-hazardous for disposal shall be based only on the results of the TCLP. The results of the TCLP do not dictate
 230 the level of the containment system required in accordance with 619.07(b)1.

If hazardous materials are found to be present in the waste sample of a structure shown in the contract documents as being built after 1994, the Contractor shall immediately notify the Engineer that hazardous materials have been found and, if not addressed in the QCP, the Contractor shall submit revisions to the QCP that detail the necessary changes due to the presence of hazardous materials. The Contractor shall not return to work until the revised QCP is approved in writing.

b. Waste Disposal

240 Regardless of the waste characterization obtained from the waste stream sample, disposal of existing paint and debris shall be in accordance with SSPC-Guide 7 and the following requirements.

(1) Laws to be Observed

Federal and State laws and regulations regulate the disposal of bridge painting debris. Bridge paint debris shall be manifested or certified and shall be disposed of at an appropriate disposal facility.

250 The Contractor shall have direct knowledge regarding compliance with laws pertaining to pollution control and waste management such as, but not limited to, the following.

- a. subtitle C of the RCRA, 40 CFR 261, 262, 263, 265, and 268;
- b. the Solid Waste Rule, 329 IAC 10;
- c. the Hazardous Waste Rule, 329 IAC 3.1;
- 260 d. the Air Pollution Rule 329 IAC 6-4;
- e. the Water Pollution Rule, 327 IAC 2-6.1;
- f. the United States Department of Transportation regulations 49 CFR 172.300; and
- g. OSHA worker safety regulations 29 CFR 1926.

(2) Time Limitations

270 The maximum time limit from the date the generated waste is placed in a container and the date the material is transported to a permitted treatment, storage, and disposal facility shall be 90 calendar days.

(3) Marking of Spent Material Containers

Spent material containers shall be marked with the date that waste is first placed in the container. Until laboratory results described in 619.07(b)2a are received concerning the category of the waste stream, the containers shall be labeled "LEAD PAINT WASTE DEBRIS" or "ZINC PAINT WASTE DEBRIS", as appropriate. The labeling shall include the contract number, bridge number, sample number, and sample date. Labeling of containers as hazardous waste will not be required until the appropriate laboratory analysis determines the waste stream to be hazardous in accordance with the current RCRA hazardous waste definitions. Immediately upon notice that the waste is hazardous, the containers shall be marked in accordance with 49 CFR 172, Subpart D.

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(4) Instruction for Disposal of Paint Waste

If the waste stream is found to be hazardous, the Engineer will obtain an EPA identification number from IDEM. This number will be provided to the Contractor within 30 days of the start of waste generation for bridges having hazardous waste paint debris. The waste from different bridges shall not be commingled. The Contractor shall be responsible for:

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- a. determining the location for disposal, treatment, or recycling of the waste, obtaining the Engineer's

- approval of the site, and arranging with the approved site for acceptance of the materials;
- 300 b. preparing a hazardous waste manifest, as required by Federal and State requirements, for signature;
- c. scheduling the shipment of waste to the permitted disposal site;
- d. ensuring that the hazardous waste manifest is carried in the transportation vehicle;
- e. ensuring that all required hazardous materials placards are properly displayed on the vehicle;
- 310 f. ensuring prompt movement of the vehicle to the disposal site; and
- g. returning one copy of signed manifest documents to the Engineer. A copy of the chemical and physical analysis of the waste stream, all deposit receipts, manifests, and required paperwork for disposal shall be given to the Engineer and all waste disposed of before the waste disposal item will be paid.

320 If the waste stream is found to be non-hazardous in accordance with current RCRA hazardous waste definitions, the waste shall be disposed of at an appropriate disposal facility.

(5) Instructions for Disposal of Other Project Generated Waste

Other wastes that may be generated on the project include, but are not limited to, spent solvents from cleaning of equipment and empty or partially empty containers of paint, paint thinners, spent abrasives, and solvents. The Contractor shall recycle or dispose of all project generated waste materials.

330 If the waste stream is defined as a hazardous waste in accordance with the current RCRA definitions, the waste shall be recycled or disposed of in accordance with 619.07(b)2b(4). All project generated waste and the method of recycling or disposal shall be identified in the QCP.

619.08 Surface Preparation of Concrete and Steel

The tops of all concrete and steel pier caps, concrete abutment caps, and 2 ft down all sides of concrete pier and abutment caps shall be washed. The washing shall be accomplished by means of a pressure washer with potable water. The pressure shall

619.08

340 be between 800 and 1,500 psi. If detergents or other additives are added to the water, the surface shall be rinsed with potable water before the detergents dry.

Cleaning of steel surfaces shall be performed by an SSPC certified contractor. This requirement will not apply to the following:

- (1) shop cleaning; or
 - (2) sections of beams or other structural members less than 180 sq ft of total area to be painted for the contract where heat-straightening or similar repairs have taken place.
- 350

Surfaces to be painted shall be cleaned in accordance with the SSPC classification, unless otherwise specified. Compressed air shall pass through an oil and water extractor before entering another apparatus.

Solvent cleaning in accordance with 619.08(a) shall be performed to remove all oils, soluble salts, visible grease, and any other surface contaminants before all other cleaning methods are started.

360 Field cleaned steel surfaces shall be primed the same day as cleaned, except for areas requiring a second abrasive blast cleaning. Those areas shall be primed the same day as the second cleaning. If rust forms after cleaning, the surface shall be cleaned again before painting. Work shall be stopped when there is disagreement about whether a surface has been adequately cleaned. Written notification shall be provided specifically identifying the problem.

Cleaning shall be scheduled so that dust or other contaminants do not fall on wet, newly painted surfaces.

370 A dust collector suitable for the containment type and size shall be used during all blast cleaning operations in preparation for all structural steel paint systems and as directed for a partial paint system.

On existing bridges when abrasive blast cleaning is used, clean dry media in accordance with SSPC-AB 1 or SSPC-AB 3 shall be used. The media shall produce a profile that is free of oil, soluble salts, greases, and other similar substances which can contaminate the blasted surface. If ferrous metallic media is chosen and the Contractor elects to recycle the media by running the media through recycling equipment, the recycling equipment shall be capable of separating the blasting media from the paint debris and the cleanliness of the recycled ferrous metallic media shall be in accordance with SSPC-AB 2.

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The surface profile of cleaned new steel surfaces and cleaned existing steel surfaces shall not be less than 1 mil and not greater than 3 mil.

For structures shown in the contract documents as being built before 1995, the Contractor shall assume that mill scale is present on the existing steel. All mill scale shall be removed as a part of the cleaning operations.

390 **(a) Solvent Cleaning**

Solvent cleaning shall be performed in accordance with SSPC-SP 1.

After the hold point for solvent cleaning has been released, one or more of the following cleaning methods shall be performed.

(b) Hand Tool Cleaning

Hand tool cleaning shall be in accordance with SSPC-SP 2.

(c) Brush-Off Blast Cleaning

400 Brush-off blast cleaning shall be in accordance with SSPC-SP 7/NACE No. 4.

(d) Commercial Blast Cleaning

Commercial blast cleaning shall be in accordance with SSPC-SP 6/NACE No. 3.

(e) Near-White Blast Cleaning

Near-white blast cleaning shall be in accordance with SSPC-SP 10/NACE No. 2.

410 In addition, all steel within a cross-sectional area measuring 5 ft longitudinally, on both sides of a bridge deck joint, as well as all areas of visible corrosion pitting, as determined by the Engineer, shall be abrasive blast-cleaned two times. After the first cleaning, all dust shall be removed from the cleaned surfaces and the surfaces shall be wetted with potable water either by hand wiping or atomized low volume spray. The volume of water used shall be low enough to preclude runoff. The surfaces shall be left undisturbed for a minimum of 24 h then cleaned a second time to the specified standard.

(f) White Metal Blast Cleaning

White metal blast cleaning shall be in accordance with SSPC-SP 5/NACE No. 1.

420 **(g) Power Tool Cleaning**

Power tool cleaning shall be in accordance with SSPC-SP 3.

(h) Commercial Grade Power Tool Cleaning

Commercial grade power tool cleaning shall be in accordance with SSPC-SP 15.

(i) Power Tool Cleaning to Bare Metal

Power tool cleaning to bare metal shall be in accordance with SSPC-SP 11.

430 Upon completion of cleaning operations, the Contractor shall vacuum or blow off under full containment any residual dust remaining from the cleaning operation.

619.09

The Engineer will check the prepared surface for dust prior to the Contractor beginning painting operations.

619.09 Paint Systems

Paint systems shall be applied in accordance with the manufacturer's recommendations. The dry film thickness of a paint coating will be measured with a calibrated film thickness gauge in accordance with SSPC PA 2. All paint coatings shall have a dry film thickness not less than 80% of the required dry film thickness.

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(a) Structural Steel Paint System

The coating system shall consist of an inorganic zinc primer with a dry film thickness of 3 mil, an epoxy intermediate coat with a dry film thickness of 4 mil, and a polyurethane finish coat with a dry film thickness of 3 mil for the painting of steel bridges and other structural steel.

(b) Partial Paint System

The coating system shall consist of organic zinc primer with a dry film thickness of 3 mil and a waterborne finish coat with a dry film thickness of 3 mil for partial painting of steel bridges and other structural steel.

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619.10 Painting

Painting shall be performed by a SSPC certified contractor, except as noted in 619.08.

Concrete at all junction points of concrete and steel shall be adequately shielded or otherwise protected so the application of paint on steel is full and complete, and that spraying onto the concrete is minimized.

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If a blasted or painted surface is unsatisfactory, removal of the paint, thorough cleaning of the surface, and repainting or other correction will be required as directed. Where defects or damages occur in a film of any coating, all defective areas shall be removed to soundly bonded paint or bare steel and painted to the specified thickness.

No lettering shall be painted on bare or painted steel surfaces, except marks required for erection and project information stenciled in accordance with 619.10(g).

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Joints of all lapping members shall be caulked after either the application of the epoxy intermediate coat of the structural steel paint system or the application of the organic zinc primer of the partial paint system. The intermediate or primer coat shall be cured to the manufacturer's recommended coating cure time prior to caulking.

1. All vertical and diagonal lapping members shall be caulked along the top and sides. The bottom shall remain open for drainage.

- 480
2. All horizontal lapping members shall be caulked along the leading edge and sides of steel members facing toward oncoming traffic or facing toward the prevailing wind direction.
 3. All horizontal members shall remain uncaulked along the side of steel members facing away from oncoming traffic or prevailing wind direction.

(a) Weather Limitations

490 Field painting will not be allowed between November 15 and the following April 1 unless different date ranges are requested in the QCP and approved in writing. Painting shall begin only when the 24 h ambient temperature is to remain above 50°F after paint application, and the steel surface temperature is between 50°F and 100°F unless different temperature ranges are requested in the QCP and approved in writing. Coating, painting, and curing shall be done only when the relative humidity is to remain between 30% and 80%. The pot life and induction time shall be in accordance with the manufacturer's recommendations for the existing temperature and humidity.

500 Paint shall not be applied when the air is misty, or when conditions are otherwise unsuitable. The surface temperature of the steel to be painted shall not be within 5°F of the dew point. When painting in a protected area to eliminate the above conditions, the steel shall remain under cover until the paint is dry. All wet paint which has been exposed to excessive humidity, rain, snow, or condensation shall be allowed to dry. Damaged paint shall then be removed. The surface shall be re-cleaned and repainted as directed. The Engineer will be the sole authority to decide when work may begin or shall stop due to weather conditions.

(b) Storage

510 Paint shall be stored in accordance with the manufacturer's recommendations. If paint is allowed to remain in storage, the containers shall be turned end for end at least once per week. The paint shall be used within the manufacturer's recommended shelf life.

(c) Mixing

Paint shall be thoroughly mixed so that the pigment is completely in suspension and the consistency is uniform. Mechanical mixers shall be used in accordance with the manufacturer's instructions. The paint shall remain in this condition during application to the steel surface. After initial mixing and before application, zinc primer shall be strained through a metal screen not coarser than the No. 30 (600 μm) sieve.

520 Partially empty containers of paint shall not be used. Partial mixing of containers will not be allowed. All paint containers shall remain closed until needed for mixing.

(d) Thinning

When required for proper application, the thinning of field paint will be allowed.

Only thinners recommended by the manufacturer and as approved shall be used. Thinners shall be added to paint in accordance with the manufacturer's recommendations. The maximum quantity added shall not exceed the manufacturer's recommendations. The thinned paint shall not exceed IDEM regulations for volatile organic compounds.

530 The Contractor shall contact IDEM and the local air pollution control board for information about any volatile organic compound regulations or restrictions.

(e) Application of Paint

All paint coatings shall be of colors to produce a distinct contrast with adjacent coatings, including the color of a clean steel surface.

540 Paint shall be applied by either an airless or conventional spray method which has been recommended by the paint manufacturer. The compressed air used for painting shall pass through an oil and water extractor before entering the paint pot. However, areas to be painted which are inaccessible to spray application or areas requiring touchup may be painted with brush or daubers. Epoxy intermediate and polyurethane finish paints may also be applied by brushes or rollers provided the coating cures to a smooth and uniform finish. Spray shall be adjusted to produce a uniform coating.

1. Stripe Coat

550 If using the structural steel paint system in accordance with 619.09(a), a stripe coat in accordance with SSPC-PA Guide 11 shall be applied. All sharp edges, welds, outside corners, bolt heads, nuts, threads, crevices, plate seams, back-to-back angle seams, pitted steel, rivet heads, and other sharp discontinuities shall be striped on the second and third coats, and then repainted with the remaining steel surfaces. Striping shall extend at least 1 in. from edges. If specified, the stripe coat shall be allowed to dry to the manufacturer's recommended recoat dry time prior to painting the second and third coats on the remaining steel surfaces.

560 If using the partial paint system in accordance with 619.09(b), a stripe coat in accordance with SSPC-PA Guide 11 shall be applied. All sharp edges, welds, outside corners, bolt heads, nuts, threads, crevices, plate seams, back-to-back angle seams, pitted steel, rivet heads, and other sharp discontinuities shall be striped on each of the coats, and then repainted with the remaining steel surfaces. Striping shall extend at least 1 in. from edges. If specified, the stripe coat shall be allowed to dry to the manufacturer's recommended recoat dry time prior to painting the remaining steel surfaces. Painting techniques shall minimize dry overspray. Dry overspray shall be removed prior to application of other coatings and after application of the finish coat.

For both paint systems, the stripe coat may be applied with either a brush or a sprayer. If the Contractor-chosen method of applying the stripe coat is not producing results acceptable to the Engineer, the Engineer will require the stripe coat application method to be changed.

2. Blank

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(f) Curing Time

The minimum curing time between coatings shall be 24 h for inorganic zinc primers and 8 h for the epoxy intermediate coat. The curing time will vary depending on the temperature and humidity. The inorganic zinc primer shall be cured to a minimum solvent resistance rating of 4 in accordance with ASTM D4752 prior to the application of the epoxy intermediate coat. It shall be demonstrated that the inorganic zinc primer is in accordance with this requirement. The epoxy intermediate coat shall be cured in accordance with the manufacturer's recommendations prior to the application of the polyurethane finish coat. The polyurethane finish coat shall be applied within 12 calendar days of application of the epoxy intermediate coat.

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The curing time of all other paint systems or coatings shall be in accordance with the manufacturer's recommendations.

(g) Stencil Identification

After the hold point for the finish coat has been released, project identification information shall be painted with a stencil in 2 in. black capital letters onto the outside of both fascia beams, at the right end of the beam and near the end bent, which reads as follows:

590

bridge number

contract number

PAINTED _____

date

619.11 Shop Prime Coating

The shop performing the cleaning and the application of the prime coat for structural steel shall have a valid AISC-420-10/SSPC-QP 3 certification. Abrasive used for cleaning steel in the shop shall be an abrasive that produces a surface profile in accordance with 619.08. The inorganic zinc primer coat shall be applied to all structural steel in the shop. The remaining two coats shall be applied in the field after final erection. A structural steel paint system in accordance with 619.09(a) shall be used. When shear connectors have been specified, the top of the top flange shall not be primed. Erection marks may be painted on zinc painted surfaces. Machine finished surfaces for sliding contact shall be coated with heavy grease as soon as practicable after being accepted, but before removal from the shop.

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Shop primed beams shall not be loaded for shipment until the primer has been allowed to cure for a minimum of 48 h.

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(a) Non-Weathering Steel

All structural steel shall be cleaned in accordance with 619.08(e).

620 All structural steel shall receive an inorganic zinc primer, including faying surfaces of high strength bolted connections and areas in contact with concrete. Surfaces, other than the contact surfaces described above, which are inaccessible after erection shall be painted in the shop with the full paint system required on the completed bridge.

(b) Weathering Steel

All structural steel shall be left unpainted, except as shown on the plans. All diaphragms, stiffeners, and other appurtenances located within the limits shown on the plans shall be included in the painting area. Surfaces to be painted shall be cleaned in accordance with 619.08(e). Surfaces shall be painted in accordance with 619.09(a), except the finish coat shall be in accordance with 909.02(e).

619.12 Field Painting New Steel Bridge

630 All structural steel surfaces which are accessible after final erection shall be painted with the remaining coatings specified for structural steel paint system in accordance with 619.09(a) in the field after final erection.

If application of inorganic zinc primer on a steel surface is not performed in the shop before erection of the bridge, the surfaces which are exposed shall be cleaned in accordance with 619.08(a), and 619.08(e). These surfaces shall then be painted with the structural steel paint system after final erection.

640 Surface areas where the inorganic zinc primer was damaged during shipping, handling, and erection shall be cleaned in accordance with 619.08(a) and either 619.08(d) or 619.08(i). Likewise, all bolt and field connections shall be cleaned in the same manner. All the damaged areas, and bolt and field connections shall then be painted with the inorganic zinc primer applied in the shop. This requirement will not apply to temporary steel bridges.

Where steel surfaces have been painted with the full paint system and the paint coatings have been damaged, the affected steel surface areas shall be cleaned in accordance with 619.08(i). Structural steel paint system shall then be re-applied.

650 For weathering steel girders, caulk shall be applied to act as a drip bead as shown on the plans.

619.13 Painting Existing Steel Bridges

The surfaces to be cleaned and painted shall include the surfaces of all steel members of the superstructure, substructure, floor beams, stringers, plates, castings, bearing assemblies, ornamental handrails, lattice work, and other steel appurtenances. When shear connectors have been specified, the top of the top flange shall not be painted.

660 If the contract specifies clean steel bridge, the bridge steel shall be cleaned in

accordance with 619.08(a) and either 619.08(e) or 619.08(i). The structural steel paint system in accordance with 619.09(a) shall be used for painting.

If the contract specifies clean steel bridge, partial, the bridge steel shall be cleaned in accordance with 619.08(a) and either 619.08(e), or 619.08(h). The partial paint system in accordance with 619.09(b) shall be then used for painting.

619.14 Handling of Steel Bridge Superstructure to be Removed

670 If the Contractor elects to take ownership of the steel in accordance with 202.03, a QCP shall be submitted in accordance with 619.03. The entire surface area of the steel shall be cleaned in accordance with 619.08(d) prior to the steel leaving the construction limits and becoming the property of the Contractor. Mill scale shall be assumed to be present on the existing steel. Cleaning in accordance with 619.08(a) shall not be performed. A level of containment in accordance with 619.07(a) shall be used.

Testing of the waste stream and disposal of the waste produced by this cleaning shall be in accordance with 619.07.

680 **619.15 Drain Castings Treatment**

Roadway drain castings located in a bridge deck shall be satisfactorily cleaned in accordance with 619.08(c) or 619.08(g). The castings shall not be shot-blasted.

The roadway drain castings shall be painted with a black finish coat in accordance with 909.02(c).

If a roadway drain casting extension pipe is damaged or missing, it shall be replaced. The extension pipe shall be in accordance with 715.

690 **619.16 Clean and Paint Bearing Assemblies**

When shown on the plans or a pay item is included in the schedule of pay items, all bearing assemblies including top and bottom plates of each assembly shall be cleaned in accordance with 619.08(a) and 619.08(d). Pollution control shall be in accordance with 619.07.

If the pay item clean and paint bearing assemblies is listed in the schedule of pay items for a particular structure, the entire bearing assembly shall be painted with the structural steel paint system in accordance with 619.09(a).

700 If the pay item, paint steel bridge, or paint steel bridge, partial, is listed in the schedule of pay items for a particular structure, the entire bearing assembly shall be painted with the structural steel paint system that is being used on the rest of the bridge.

619.16.1 Clean and Paint Steel Piling

All exposed steel piling shall be cleaned in accordance with 619.08(a) and either 619.08(e) or 619.08(i). The structural steel paint system in accordance with 619.09(a)

619.17

shall be applied. The color of the top coat shall be SAE-AMS-STD-595, color No. 13711.

710 **619.17 Responsibility for Damage**

Unless otherwise specified by the Engineer in writing, full containment shall be provided when performing the surface preparation operation and when applying all coats of paint, except primer coats, with spray equipment. All persons and property shall be protected from damage or injury from the surface preparation operations and painting operations by providing containment as described in the QCP. Persons and property shall include, but not be limited to, pedestrians, vehicles, and other traffic upon or underneath a bridge, all portions of the bridge superstructure and substructure, and all adjacent property. The Contractor shall be responsible for damages in accordance with 107.17.

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619.18 Top of Top Flange of Steel Structural Members

When shown on the plans or a pay item is included in the schedule of pay items, the top of the top flange of steel structural members shall be cleaned in accordance with 619.08 by a contractor certified as SSPC-QP 2. The Contractor shall assume the existing coating on the top of the top flange contains hazardous materials and mill scale and shall use pollution control and containment in accordance with 619.07(b)1. A QCP shall be prepared and submitted in accordance with 619.03. The steel shall be cleaned to a level of cleanliness in accordance with 619.08(e) or 619.08(h), however solvent cleaning in accordance with 619.08(a) shall not be performed.

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Each bridge shall generate a separate waste stream and shall not be commingled with other materials. The waste stream shall be sampled in accordance with 619.07 and all other requirements of 619.07 shall be followed. Once the result from the waste stream sampling is known and the waste stream is appropriately characterized as hazardous or non-hazardous, all waste shall be disposed of in accordance with 619.07(b).

619.19 Method of Measurement

740 Cleaning and painting of steel structural members, cleaning the top of the top flange of steel structural members, cleaning and painting of bearing assemblies, and cleaning and painting of steel piling will not be measured for payment. Cleaning areas around bridge joints and other areas with visible corrosion pitting a second time will not be measured for payment. Disposal of the waste generated by the cleaning operation will not be measured for payment.

Cleaning roadway drain castings, caulking joints of lapping members, and caulking on weathering steel will not be measured for payment.

750 For steel that will become the property of the Contractor, cleaning existing steel, removal of mill scale, testing, disposal of the waste, containment, and all other items involved with this work will not be measured as per 202.13.

If a structure is shown in the contract documents as being built before 1995, no measurement will be made of the area covered by mill scale. Otherwise, the area of structural steel covered by mill scale will be measured for payment after a proper cleaning of the entire containment area or an agreed large portion thereof and removing all other existing materials, including all paint and rust. The percentage of the area of structural steel covered by existing mill scale will be representative of this entire area. The pre-established remedies for this changed condition apply in accordance with
760 104.02(d) and 619.20.

Roadway drain casting extension pipe will be measured in accordance with 715.13.

The estimated weight, length, number of steel spans, surface area of steel, and type of primer shown on the plans or in the Proposal book is incidental information. Such information is approximate only. The Department will not guarantee its accuracy.

770 **619.20 Basis of Payment**

Existing steel bridges to be cleaned, or partially cleaned, whichever is specified, will be paid for at the contract lump sum price for clean steel bridge or clean steel bridge, partial, at the bridge number specified. Cleaning the top of the top flange of existing steel bridges will be paid for at the contract lump sum price for clean steel bridge, top flanges, at the bridge number specified. Existing steel bridges to be painted, or partially painted, whichever is specified, will be paid for at the contract lump sum price for paint steel bridge or paint steel bridge, partial, at the bridge number specified.

780 When specified as a separate pay item in the contract, cleaning and painting bearing assemblies will be paid for at the contract lump sum price for clean and paint bearing assemblies, at the bridge number specified.

When specified as a separate pay item in the contract, cleaning and painting steel piling will be paid for at the contract lump sum price for clean and paint steel piling, at the bridge number specified.

(a) Pre-Established Remedies for Changed Conditions

790 **1. Discovery of Hazardous Materials but No Mill Scale on a Structure Shown in the Contract Documents as Being Built After 1994**

The payment will be an additional 25% of the clean steel bridge item as computed in 619.20(b)1 in accordance with 109.05 as payment for all additional costs incurred.

2. Discovery of Mill Scale but No Hazardous Materials on a Structure Shown in the Contract Documents as Being Built After 1994

If, on a structure shown in the contract documents as being built after 1994 and the presence of hazardous materials has not been confirmed by laboratory analysis, the area of structural steel covered by mill scale comprises greater than 25% of the area of

800 structural steel in accordance with 619.19, additional compensation for the removal of the mill scale will be made as an adjustment to the clean steel bridge item. The adjustment will be an additional payment of 30% of the clean steel bridge item as computed in accordance with 619.20(b)1 will be made.

3. Discovery of Hazardous Materials and Mill Scale on a Structure Shown in the Contract Documents as Being Built After 1994

810 If the laboratory analysis of a waste stream sample on a structure shown in the contract documents as being built after 1994 yields results indicating the presence of hazardous materials, the entire bridge shall be considered as having mill scale and the following pre-established remedy for this changed condition in accordance with 104.02(d) shall apply. If agreed to in writing between the Contractor and the Department, the work shall proceed with the Contractor assuming all risks for removal of mill scale. An additional 55% of the clean steel bridge item as computed in 619.20(b)1 in accordance with 109.05 will be paid as additional compensation for the removal and disposal of the hazardous materials, the removal of the mill scale, the additional containment required, and all other incidental items associated with the removal of the hazardous materials and mill scale.

(b) Prices used in Pre-Established Remedies to Changed Conditions

820 The following prices will be computed and used as the price for the pay item identified below in all pre-established remedies to changed conditions referenced in this section.

The price for the clean steel bridge item, per bridge, used in all pre-established remedies to changed conditions referenced in this section will be limited to the lesser of the following:

1. 70% of the sum of the clean steel bridge item and paint steel bridge item for that bridge; or
- 830 2. the actual amount for the clean steel bridge item for that bridge shown in the Schedule of Pay Items.

Roadway drain casting extension pipe will be paid for in accordance with 715.14.

For steel that will become the property of the Contractor, payment for cleaning existing steel, removal of mill scale, testing, disposal of the waste, containment, and all other costs involved this work will be in accordance with 202.14.

840 The cost of transportation and disposal of waste materials, waste, waste containers, and all other debris generated from pollution control and cleaning that is disposed of will be paid for at the contract lump sum price for disposal of cleaning waste, hazardous or non-hazardous, at the bridge number specified.

Payment will be made under:

Pay Item	Pay Unit Symbol
Clean and Paint Bearing Assemblies, Br. No. ____	LS
Clean and Paint Steel Piling, Br. No. ____	LS
Clean Steel Bridge, Partial, QP- ____, Br. No. ____	LS
850 Clean Steel Bridge, QP- ____, Br. No. ____	LS
Clean Steel Bridge, Top Flanges, QP-2, Br. No. ____	LS
Disposal of Cleaning Waste, _____, Br. No. ____	LS
waste type	
Paint Steel Bridge, Br. No. ____	LS
Paint Steel Bridge, Partial, Br. No. ____	LS

860 The cost to prepare a QCP shall be included in the cost of the pay items of this section. The cost of providing the Department with access to the bridge and seasonal or weather limitations shall be included in the cost of the pay items of this section.

If a structure is shown in the contract documents as being built before 1995, no additional payment will be made for the removal of mill scale. The cost of the removal of mill scale shall be included in the cost of clean steel bridge, clean steel bridge, partial, clean and paint bearing assemblies, clean and paint steel piling, or clean steel bridge, top flanges.

870 If a structure is shown in the contract documents as being built after 1994 and the percentage of the area covered by mill scale is less than or equal to 25% of the total structural steel surface area of a bridge measured in accordance with 619.19 no additional payment will be made for the removal of mill scale. The cost of the removal of mill scale shall be included in the cost of clean steel bridge or clean steel bridge, partial.

880 The cost of furnishing all materials, equipment, and labor required for solvent cleaning, scraping, steel brushing, or other acceptable methods for removing paint in the locations directed shall be included in the cost of clean steel bridge, clean steel bridge, partial, clean and paint bearing assemblies, clean and paint steel piling, or clean steel bridge, top flanges. The cost of cleaning roadway drain castings shall be included in the cost of clean steel bridge or clean steel bridge, partial.

The cost of providing containment in accordance with 619.07 and 619.17 and personal protective equipment shall be included in the cost of the pay items of this section.

The cost of furnishing all materials, equipment, and labor required to perform the quality control tasks outlined in 619.03 shall be included in the cost of clean steel bridge or clean steel bridge, partial, clean and paint bearing assemblies, clean and paint steel piling, or clean steel bridge, top flanges.

621.01

890 The cost of furnishing all materials including caulk, equipment, and labor to perform caulking and painting, including the stripe coats, with the structural steel paint system or the partial paint system shall be included in the cost of paint steel bridge or paint steel bridge, partial. The cost of switching stripe coat application methods shall be included in the cost of paint steel bridge or paint steel bridge, partial. The cost of furnishing all materials, equipment, and labor to perform painting of the roadway drain castings shall be included in the cost of paint steel bridge or paint steel bridge, partial.

900 The cost of all equipment, material, labor, testing, use of special cleaning methods, and shipping of waste stream samples shall be included in the cost of the clean steel bridge or clean steel bridge, partial, clean and paint bearing assemblies, clean and paint steel piling, or clean steel bridge, top flanges, pay items.

The cost of dust removal, wetting, and within the cross-sectional area measuring 5 ft longitudinally on both sides of a bridge deck joint as well as all areas of visible corrosion pitting, a second time shall be included in the clean steel bridge, clean steel bridge, partial, clean and paint bearing assemblies, or clean steel bridge, top flanges, pay items.

910 When a pay item is included in the schedule of pay items for clean and paint bearing assemblies, all costs associated with cleaning and painting bearing assemblies, except disposal of cleaning waste, shall be included in the cost of the pay item. If clean steel bridge, clean steel bridge, partial, paint steel bridge, or paint steel bridge, partial, are included as pay items in the schedule of pay items, no separate payment will be made for cleaning and painting bearing assemblies on that bridge number. The cost of cleaning and painting bearing assemblies shall be included in the cost of the respective clean steel bridge, clean steel bridge, partial, paint steel bridge, or paint steel bridge, partial, pay items for that bridge number.

920 When a pay item is included in the schedule of pay items for clean and paint steel piling, all costs associated with cleaning and painting steel piling, except disposal of cleaning waste, shall be included in the cost of the pay item.

SECTION 620 – BLANK

SECTION 621 – SEEDING AND SODDING

621.01 Description

This work shall consist of either or both plain and mulched seeding or placing approved sod. It includes furnishing and placing seed, fertilizer, inoculants, top soil, and mulch, if required, in a prepared seed bed or furnishing and placing sod at locations in accordance with 105.03.

MATERIALS

10

621.02 Materials

Materials shall be in accordance with the following:

	Fertilizer	914.03
	Grass Seed	914.04
	Grass Seed, Temporary	914.02
	Leguminous Inoculants	914.06
	Mulch	914.05(a)
	Plastic Net.....	914.09(g)
20	Sod, including Nursery Sod.....	914.07
	Top Soil	914.01
	Water	914.09(a)
	Staples	914.09(f)

Seed that has passed the expiration date shown on the bag tag shall not be installed.

CONSTRUCTION REQUIREMENTS

30 621.03 Preparation of Ground Before Seeding

The area to be seeded shall be made smooth and uniform and shall be in accordance with the finished grade and cross section shown on the plans or as otherwise designated and shall be trimmed in accordance with 210.

40 The seed bed, if not loose, shall be loosened to a minimum depth of 3 in. before fertilizer or seed is applied. In areas of excessive vehicular traffic, such as parking of construction equipment near a bridge repair, the soil shall be loosened to a minimum depth of 6 in. Areas to be covered with topsoil shall be milled or disked slightly before the topsoil is placed. A disk, spike-toothed harrow, or other similar device may be used for this purpose. Such loosening will be required to ensure bond of the topsoil with the surface on which it is put and to form a uniform surface. The topsoil shall then be spread to a sufficient depth to produce the thickness specified after it has been compacted lightly with an approved roller, tamping device, or other method.

621.04 Preparation of Ground Before Applying Erosion Control Blankets

Prior to placing the blankets, the area to be covered shall be relatively free of all rocks or clods over 1 1/2 in. in diameter, and all sticks or other foreign material, which prevent the close contact of the blanket with the seed bed.

50 If as a result of a rain, prepared seed bed becomes crusted or eroded, or if eroded places, ruts, or depressions exist, the soil shall be reworked until it is smooth. Such areas which are reworked shall be re-seeded.

621.05 Applying Fertilizer, Seed, and Mulch

(a) Fertilizer

Fertilizer as specified shall be spread uniformly over the area to be seeded. Fertilizer shall be spread at the rate of 800 lb/ac unless otherwise specified.

60 (b) Seed

Seed may be drilled in or mixed with water. The mixture shall be sprayed over the area to be seeded. An approved mechanical method which shall place the seed in direct contact with the soil may be used. In places inaccessible to mechanical equipment, or where the area to be seeded is small, a hand operated cyclone seeder or other approved equipment may be used. Seed of warm season grasses, forbs, or aquatic species shall not be covered more than 1/8 in. All other seed shall not be covered more than 1/2 in.

70 Leguminous seeds, unless otherwise specified, shall be inoculated with a culture in accordance with 914.06. The culture shall be mixed with sufficient water to distribute it thoroughly. The seed shall be wetted thoroughly with the solution and allowed to dry sufficiently to be in condition for sowing. Inoculated seed shall be sown within 30 h after treatment. Where seeding is to be done by hydraulic methods, the inoculate may be added to the water in the spray tank.

(c) Mulch

80 Mulching material, when specified, shall be applied uniformly in a continuous blanket at the rate of 2 t/ac. Mulch shall be placed within 24 h after seeding. The percent of moisture in the mulch shall be determined in accordance with 621.14(c).

Mulching material shall be punched into the soil so that it is partially covered. The punching operation shall be performed longitudinally with the mulch tiller. The tools used for punching purposes shall be disks that are notched and have a minimum diameter of 16 in. The disks shall be flat or uncupped such as notched coulters commonly used on moldboard plows. Disks shall be placed a minimum of 8 in. apart along the axle or shaft. Shaft or axle sections of disks shall not exceed 8 ft in length.

90 The mulch tiller for punching shall be constructed so that weight may be added or hydraulic force from the tractor may push the puncher into the ground. If heavy weights are not used, several trips over the area may be necessary to work part of the mulch into the soil. Care shall be exercised to obtain a reasonably even distribution of mulch incorporated into the soil.

After procedures for holding the mulch in place have been completed, mulch, other than when applied by hydroseeder, shall be watered thoroughly. The seed or soil beneath it shall not be displaced. The mulching material shall be maintained in place satisfactorily until final completion and acceptance of the contract except as provided in 107.18. When seeding is performed between June 1 and August 15, a second thorough watering shall be applied approximately 21 days after seeding.

100

On slopes steeper than 3:1, or when specified, the following methods will be allowed.

1. Method A

The mulch may be held in place by means of a commercially produced mulch binder which is in accordance with all applicable State and Federal regulations. Such product shall be applied in accordance with the manufacturer's written instructions. A copy of the written instructions shall be supplied to the Engineer prior to the seeding work. The product shall contain a coverage indicator to facilitate visual inspection for evenness of application. If the mulch fails to stay in place, the Contractor shall repair all damaged areas. A change in the mulch binder may be requested by the Engineer.

110

2. Method B

The mulch may be held in place by spraying it with a satisfactory liquid asphalt or asphalt emulsion. The bituminous material may be applied immediately after the mulch is in place or it may be injected into the mulch as it leaves a power-driven mulch spreader. If applied to the surface, the amount shall be approximately 0.06 gal./sq yd. If applied as the mulch comes from the spreader, the amount shall be approximately 60 gal./t of mulch material. The exact amount shall be as directed.

120

3. Method C

The mulch may be held in place with binder twine fastened down with wooden pegs not less than 6 in. long spaced 4 ft apart. The twine shall be placed parallel to and also at 60° with the pavement edge in both directions. The distance between the intersections of the diagonal strands measured along the strands shall be 12 ft. The strand parallel to the pavement shall cross the diagonal strands at their intersections to form equilateral triangles 12 ft on a side.

4. Method D

The mulch may be held in place with a polymeric plastic net. The plastic net shall be unrolled such that it lays out flat, evenly, and smoothly, without stretching the material. The plastic net shall be held in place by means of staples. The wire staples shall be driven at a 90° angle to the plane of the soil slope. Staples shall be spaced not more than 4 ft apart with rows alternately spaced. The plastic net shall be secured along the top and bottom of the soil slope with staples spaced not more than 1 ft on center. The ends and edges of the plastic net shall be overlapped approximately 4 in. and stapled. Overlaps running parallel to the slope shall be stapled 1 ft on center and overlaps running perpendicular to the slope shall be stapled at least 3 ft on center. The plastic net shall be placed with the length running from top of slope to toe of slope, or the plastic net shall be placed with the length running horizontally or parallel to the contour.

140

5. Method E

The area may be covered with erosion control blankets. The Contractor will be allowed to use excelsior blanket, paper mat, or straw mat.

(d) Excelsior Blankets

Excelsior blankets may be used where mulched seeding is specified or where erosion control blanket is specified. Excelsior blankets shall be placed within 24 h after seeding operations have been completed. The ground shall be prepared in accordance with 621.04. After the area has been properly shaped, fertilized, and seeded, the blanket shall be laid out flat, evenly, and smoothly, without stretching the material. Excelsior blankets shall be held in place by means of staples. The staples shall be driven at a 90° angle to the plane of the soil slope. Staples shall be spaced not more than 5 ft apart in three rows for each strip, with a row along each edge and one row alternately spaced in the middle. The upslope edge shall be fastened by staples spaced 12 in. apart. The ends and edges of the blankets shall be tightly butted together, but not lapped. When excelsior blanket is used, the blanket shall be placed with the length running from top of slope to toe of slope, or the blanket shall be placed with the length running horizontally or parallel to the contour. The staples used for stapling shall be in accordance with 914.09(f).

(e) Paper Mat

Paper mat may be used for mulch for seeding where mulched seeding is specified or where erosion control blanket is specified. Paper mat shall be placed within 24 h after seeding operations have been completed. The ground shall be prepared in accordance with 621.04.

After the area has been properly shaped, fertilized, and seeded, two anchor trenches shall be dug, one along the foot of the slope and the other 1 ft back from the crown of the slope. These anchor trenches shall be 4 in. deep and at least 6 in. wide. One edge of the paper mat shall be placed into the top trench and stapled 9 in. on center. The trench shall then be filled with soil. The paper mat shall then be unrolled such that it lays out flat, evenly, and smoothly, without stretching the material. Paper mat shall be held in place by means of staples. The staples shall be driven at a 90° angle to the plane of the soil slope. Staples shall be placed not more than 3 ft apart with rows alternately spaced. The paper mat shall be secured in the bottom anchor trench in the same manner as it was secured in the upper anchor trench. The ends and edges of the mat shall be overlapped at least 4 in. and stapled.

Overlaps running parallel to the slope shall be stapled 18 in. on center and overlaps running perpendicular to the slope shall be stapled at least 9 in. on center. When paper mat is used, the mat shall be placed with the length running from top of slope to toe of slope, or the mat shall be placed with the length running horizontally or parallel to the contour.

(f) Straw Mat

Straw mat may be used for mulch for seeding on projects where mulched seeding is specified or where erosion control blanket is specified. Straw mat shall be placed within 24 h after seeding. The ground shall be prepared in accordance with 621.04. After the area has been properly shaped, fertilized, and seeded, the straw mat shall be

unrolled over the designated area so that the plastic mesh is on top and the straw fibers are snugly and uniformly in contact with the soil surface without stretching the material. The rolls shall be butted snugly together and stapled in place. The staples shall be driven through the blanket at a 90° angle to the plane of the ground surface. Each staple shall anchor the plastic mesh. The staples shall be spaced at approximately 3 ft increments, both longitudinally and transversely.

200 For placement on slopes, the straw mat shall be placed with the length running from the top of slope to the toe of slope and shall extend a minimum of 3 ft over the crown of the slope. On slope applications, six staples shall be installed across the uphill end of the roll. The downhill ends of the lowermost rolls across the slope shall also be anchored with six staples, placed on uniform spacing.

For placement in ditch lines, the straw mat shall be unrolled parallel to the centerline of the ditch. The mat shall be placed so that there are no longitudinal seams within 24 in. of the bottom centerline of the ditch. In ditch lines, six staples shall be placed at uniform spacing across the upstream end of each roll.

210 **(g) Wood Cellulose Fiber Mulch**

Wood cellulose fiber may be used where mulched seeding is specified. Wood cellulose fiber mulch shall be placed at the rate of 1 ton/ac within 24 h after seeding operations have been completed. Application shall be by hydraulic mulching and consist of mixing wood cellulose fiber mulch and grass seed with water. It shall be mixed in standard hydraulic mulching equipment to form a homogeneous slurry. The slurry shall be sprayed, under pressure, uniformly over the soil surface. The hydraulic mulching equipment shall contain a continuous agitation system that keeps all materials in uniform suspension throughout the mixing and distribution cycles. Fertilizer shall be applied in accordance with 621.05(a).

220

621.06 Seed Mixtures

Seed mixtures are classified as follows. Mixes including warm season grasses, forbs, or aquatic species will be specified in the plans.

(a) Seed Mixture R

230 This seed mixture shall be applied at the rate of 202.5 lb/ac consisting of 100 lb/ac of low endophyte Tall Fescue, 50 lb/ac of turf type Perennial Ryegrass, 50 lb/ac of Creeping Red Fescue, and 2.5 lb/ac of White Dutch Clover. Seed used in this mixture shall be drought tolerant. Fertilizer and mulching material, where specified or directed, shall be applied in accordance with 621.05.

(b) Seed Mixture U

This seed mixture shall be applied at the rate of 196.5 lb/ac consisting of 100 lb/ac of a 4-way blend of turf type Tall Fescue, 50 lb/ac Creeping Red Fescue, 45 lb/ac Perennial Ryegrass, and 1.5 lb/ac White Dutch Clover. Fertilizer and mulching material, where specified or directed, shall be applied in accordance with 621.05.

(c) Seed Mixture P

240 This seed mixture shall be applied at the rate of 130 lb/ac consisting of 35 lb/ac of Weeping Alkaligrass, 35 lb/ac of Creeping Red Fescue, 35 lb/ac of Slender Creeping Red Fescue, and 25 lb/ac of Perennial Ryegrass. Seed used for this mixture shall be salt tolerant. Fertilizer shall be applied at the rate of 400 lb/ac. Fertilizer and mulching material, where specified or directed, shall be applied in accordance with 621.05.

(d) Seed Mixture Shade

250 This seed mixture shall be applied at the rate of 145 lb/ac consisting of 35 lb/ac of Fine Fescue, 40 lb/ac of Perennial Ryegrass, 40 lb/ac of Tall Fescue, 10 lb/ac of Kentucky Bluegrass, 15 lb/ac of Timothy, 3 lb/ac of Redtop, and 2 lb/ac of Alsike Clover. Seed used for this mixture shall be shade tolerant varieties or cultivars. Fertilizer and mulching material, where specified or directed, shall be applied in accordance with 621.05.

(e) Seed Mixture Floodplain

260 This seed mixture is intended for areas that require natural habitat restoration below the 100 year floodplain in conjunction with IDNR Construction in a Floodway permit. If certain species in this mix are unavailable, substitutions may be allowed when approved by the Engineer. This mix quantity shall be measured in pure live seed, PLS, pounds per acre. This mixture shall be applied at a rate of 20 PLS lb/ac. This seed mix shall include seasonal cover crop. Fertilizer shall not be applied with this seed mixture.

Common Name	Botanical Name	Application Rate, PLS
Virginia Wild Rye	<i>Elymus virginicus</i>	2 lb/ac
Canada Wildrye	<i>Elymus canadensis</i>	2 lb/ac
Rough Dropseed	<i>Sporobolus asper</i>	2.5 lb/ac
Little Bluestem	<i>Schizachyrium scoparium</i>	8.4 lb/ac
Purpletop	<i>Tridens flavus</i>	0.4 lb/ac
Upland Bentgrass	<i>Agrostis perennans</i>	0.2 lb/ac
Partridge Pea	<i>Chamaecrista fasciculata</i>	0.8 lb/ac
Illinois Bundleflower	<i>Desmanthus illinoensis</i>	0.6 lb/ac
Black-eyed Susan	<i>Rudbeckia hirta</i>	0.6 lb/ac
Showy Tick Trefoil	<i>Desmodium canadense</i>	0.4 lb/ac
Foxtail Barley	<i>Hordeum jubatum</i>	0.6 lb/ac
Purple Coneflower	<i>Echinacea purpurea</i>	0.6 lb/ac
False Sunflower	<i>Heliopsis helianthoides</i>	0.4 lb/ac
Common Milkweed	<i>Asclepias syriaca</i>	0.2 lb/ac
Yellow Coneflower	<i>Ratibida pinnata</i>	0.2 lb/ac
Wild Bergamot	<i>Monarda fistulosa</i>	0.1 lb/ac

A seasonal cover crop shall be applied with seed mixture Floodplain. The Spring Summer Cover Crop mix shall be applied during spring and summer months and no later than July 31 of the current year. The Fall Cover Crop mix shall be applied in fall

months and no earlier than August 1 of the current year. Cover crops shall be applied at 50 PLS lb/ac.

270

1. Spring Summer Cover Crop

Common Name	Botanical Name	Application Rate, PLS
Common Oat	<i>Avena sativa</i>	35 lb/ac
Annual Ryegrass	<i>Lolium multiflorum</i>	15 lb/ac

2. Fall Cover Crop

Common Name	Botanical Name	Application Rate, PLS
Cereal Rye	<i>Secale cereal</i>	35 lb/ac
Austrian Winter Pea	<i>Pisum sativum</i>	10 lb/ac
Crimson Clover	<i>Trifolium incarnatum</i>	5 lb/ac

“Do Not Spray” signs shall be placed near the beginning and end of this work, at 200 ft intervals, or as otherwise directed. The sign shall be 16 gauge aluminum. The size and message arrangement shall be as shown on the plans. The sign background shall be white. The sign lettering shall be black. The sign shall not be reflectorized. Paint and primer shall be in accordance with 909.04. The sign post shall be placed as shown on the plans. The post shall otherwise be in accordance with 910.15.

280

621.07 Mulched Seeding

Mulched seeding, when specified, shall consist of applying the seed mixtures in accordance with 621.06(a), 621.06(b), 621.06(c), and 621.06(d) as specified. This mixture shall include fertilizer and mulching material in the amounts set out herein. If erosion control blanket is specified, the Contractor will be allowed to use excelsior blanket, paper mat, or straw mat in accordance with 621.05(d), 621.05(e), or 621.05(f), respectively.

290

621.08 Preparation of Ground Before Sodding

The area to be sodded shall be smooth, uniform, and shall be in accordance with the required cross section. Surfaces prepared for sod shall be of sufficient depth below unseated areas that newly laid sod shall be in accordance with the surrounding surface.

For those areas which shall be covered with topsoil, the procedure for the application of topsoil shall be in accordance with 621.03.

After the area has been prepared for sod, fertilizer shall be applied at the rate of 400 lb/ac. The surface shall be loosened to a depth of 1 to 2 in. and then raked before the sod is placed. All clods, lumps, boulders, or waste material shall be removed satisfactorily.

300

In areas where the above method of preparation is impracticable, a different method may be approved.

621.09 Laying Sod

Sod strips shall be laid in the designated direction. The sod shall be fitted to the surrounding grade and fixed objects. The sod strips shall be butted together closely to avoid open joints. Overlapping of sod will not be allowed. After laying and initial watering, the sod shall be tamped or rolled as directed to ensure contact with the soil underneath and shall be in accordance with the surrounding surface. After compaction, the sod shall present a smooth even surface free from lumps and depressions. On slopes of 3:1 or flatter, the use of broken sod strips will be allowed. Where broken pieces are laid, no overlaps will be allowed.

Sod placed in ditches with grades steeper than 1% and on slopes 3:1 and steeper shall be pegged. The pegs shall be spaced not over 2 ft apart in each strip measured lengthwise of the strip. Pegs shall be driven down until no more than 1 in. protrudes above the surface of the sod. Grades and slopes flatter than specified herein shall be pegged as directed.

Pegs shall be wood at least 1/2 in. by 3/4 in. by 12 in. In lieu of pegs, T-shaped wire pins may be used. The pins shall be machine bent from 8 gauge low carbon steel with a minimum of an 8 in. leg, a 4 in. head, and a 1 in. secondary drive. Pins shall be driven flush with the top of the sod.

621.10 Watering Sod

Sod shall be watered immediately after laying. The amount of watering shall be sufficient to saturate the sod and the upper few inches of the underlying soil. The sod shall be watered once every day of the first week, once every second day of the second week, once every third day of the third week, and once a week thereafter. Sod shall be maintained for a minimum of four weeks from the time it is laid before being accepted. During periods of ample rainfall, watering may be modified to simulate the above schedule. The requirements of 107.19 shall apply.

621.11 Seeding or Sodding Disturbed Areas Outside Construction Limits

Areas outside shown construction limits which are disturbed by the Contractor shall be repaired to their original condition or better. The areas shall be seeded with seed mixture R, U, P, Shade, or Floodplain as directed. If the contract contains seed mixtures other than the mixes listed here, the Contractor may seed the disturbed area with the mixture contained in the contract provided the area is less than 1 ac in size. If the area disturbed is well maintained and part of a residential or commercial lot, it shall be sodded unless the Engineer determines otherwise.

621.12 Seasonal Limitations

The Contractor shall post a warranty bond for all permanent seeding done from October 16 through January 31. Only completed seeding with seed mixtures R, U, P, or Shade will satisfy the requirements of the warranty bond. Seeding without mulch shall not be done between May 1 and August 15.

Sod placed during the months of June, July, and August shall be subject to the following conditions:

- (a) sod shall be in good, live, growing condition; and
- (b) sod shall be placed within 36 h after cutting and protected from damage during that period.

360 Winter sodding will be allowed when the temperature is above 35°F. No frozen sod shall be laid and no sod shall be laid on frozen soil. Sod shall be properly protected from drying out and shall be laid within 48 h after cutting.

621.13 Method of Measurement

370 Fertilizer and mulching material will be measured by the ton. Seed mixtures will be measured by the pound. Spring Summer Cover Crop and Fall Cover Crop seed mixtures used in conjunction with seed mixture Floodplain will not be measured for payment. Topsoil will be measured by the cubic yard in accordance with 211.09. Mulched seeding and sodding will be measured by the square yard. Water will be measured by the 1,000 gal. Mobilization and demobilization for seeding will be measured per each trip, when directed, to the project site. "Do Not Spray" signs will be measured by the number of signs installed.

621.14 Basis of Payment

380 The accepted quantities of fertilizer and mulching material, furnished and delivered complete in place, will be paid for at the contract unit price per ton, except as set out below for sodding. Seed mixtures will be paid for at the contract unit price per pound for the class and type specified. Mulched seeding will be paid for at the contract unit price per square yard for the class and type specified, complete in place. Topsoil will be paid for at the contract unit price per cubic yard. Sodding and nursery sodding will be paid for at the contract unit price per square yard, complete in place. "Do Not Spray" signs will be paid for at the contract unit price per each.

Payment for mobilization and demobilization for seeding will be made for the initial movement to the project site so that permanent or mulching work, as specified, is performed. When one or more operations are completed within the same mobilization, payment will be made for one mobilization. Payment will be for all work necessary to move personnel and equipment to and from the project site. Payment will also be made for additional mobilization, when directed.

390 Payment will be made under:

Pay Item	Pay Unit Symbol
Erosion Control Blanket.....	SYS
Fertilizer	TON
Mobilization and Demobilization for Seeding.....	EACH
Mulched Seeding _____, _____	SYS
class type	

621.14

	Mulching Material.....	TON
400	Seed Mixture _____, _____ class type	LBS
	Sign, "Do Not Spray".....	EACH
	Sodding.....	SYS
	Sodding, Nursery.....	SYS
	Topsoil.....	CYS
	Water	kGAL.

410 The cost of leguminous inoculants, preparing seed beds, sowing, raking, and all other necessary incidentals shall be included in the cost of seed mixtures. The cost of Spring Summer Cover Crop and Fall Cover Crop used in conjunction with seed mixture Floodplain shall be included in the cost of seed mixture Floodplain. The cost of furnishing and placing fertilizer, water, seed mixtures, and mulching material, in addition to the incidentals listed above for seed mixtures shall be included in the cost of mulched seeding.

The cost of furnishing, hauling, and placing the material, including material used as tie-down, repair of areas for which mulch fails to stay in place, all labor, equipment, and necessary incidentals shall be included in the cost of mulching material.

420 Repair of areas outside the construction limits which must be disturbed to construct the work required by the contract will be paid for in accordance with 201.07(e).

Water will be paid for only when ordered after the 30 day period, in accordance with 621.10.

Payment will not be made for topsoil which is obtained from within the right-of-way.

430 The cost of fertilizer, water, excavation of earth bed, disposal of surplus material, and all necessary incidentals shall be included in the cost of sodding or nursery sodding.

(a) Warranty Bond

440 Permanent seeding that requires a warranty bond to meet the requirements of 621.12 shall be warranted against failure resulting from lack of germination or method of application. The seeding shall be warranted to germinate and shall be free of obvious erosion occurrences. The intent of the warranty bond shall be to enable the final acceptance of the contract and payment of the retainage. All seeding which has significantly failed to attain approximately 70% germination shall be replaced with no additional payment. A properly executed maintenance bond with a surety shall be provided prior to the completion of the work. A warranty shall be made, with no additional payment, to replace all seeding in areas which has not effectively performed useful service as specified, as well as for the repair of designated erosion areas caused

by seeding failure. Such warranty shall be in writing with proper execution of the maintenance bond with a proper surety. The warranty shall be equivalent to 1 1/2 times the cost of the seeding work completed after October 15 with a minimum bond amount of \$25,000. All requirements for seeding work will still apply during the warranty period unless otherwise directed.

450

For the terms of the warranty, a reseeding unit shall be defined as an area equal to or larger than 2,000 sq ft in size. An erosion unit may be of an area of significance as determined.

The warranty shall cover work completed from October 16 through January 31. The Department will determine if the Contractor shall be released from the warranty. This determination will be made within 10 calendar days after documented request for inspection is made by the Contractor. Such determination will not be made prior to April 1. All replacement work shall be finished prior to June 15 with no additional payment. The requirements of 107.17 will apply to the warranty area only. The Engineer will certify in writing as to the completion of the work and will make proper notification for the releasing of the bond.

460

If the Contractor does not complete the necessary repairs before June 15, and there are no justifiable reasons for the Department to grant an extension, the Contractor shall forfeit the bond for the seeding work only. If a bond is forfeited, the Contractor will be required to explain to the Department why the Contractor's experience reduction factors do not warrant an increase.

470

(b) Changed Fertilizer

A fertilizer may be required with a higher nitrogen content than that specified, or the fertilizer specified may be required to be enriched by adding chemicals in order to be in accordance with such requirements. All additional cost incurred due to such procedure will be paid at the prices shown by certified vouchers. Such payment will include and will be full compensation for furnishing the required chemicals, or furnishing and processing the additional materials required.

(c) Mulching

The percent of moisture shall be determined at the time the mulching material is weighed. Facilities shall be provided for weighing in accordance with 109.01(b). Arrangements shall be made in advance so that the percent of moisture will be determined at the time of weighing and that the weight of the material will be checked. Moisture content of the mulch will be determined on the basis of air dry weight as follows:

480

$$\text{Moisture Content \%} = \frac{\text{Wet Weight of sample} - \text{Air Dry Weight of sample}}{\text{Air Dry Weight of Sample}} \times 100$$

622.01

490 The gross, or wet, weight of mulching material furnished and placed will be paid for if the moisture content does not exceed 10%. If the moisture content exceeds 10%, the weight to be paid for will be the gross, or wet, weight minus the weight of excess moisture computed as follows:

$$\text{Weight to be paid for} = G \times \frac{110}{(100 + M)}$$

where:

500 G = Gross, or wet, weight of mulching material
M = Moisture content, %, in the mulching material to the nearest 0.5%.

Mulching material which contains more than 50% moisture will be rejected. Wood cellulose fiber mulch containing more than 15% moisture will be rejected.

SECTION 622 – PLANTING TREES, SHRUBS, AND VINES

622.01 Description

This work shall consist of furnishing, delivering, and planting trees, shrubs, vines, and seedlings for wildlife habitat.

This work shall also consist of the performance of incidental planting procedures and plant establishment work to provide a complete operation in accordance with 105.03.

10

MATERIALS

622.02 Materials

Materials shall be in accordance with the following:

20	Backfill Material.....	914.01
	Fertilizer	914.03
	Mulch	914.05(b)
	Pipe.....	914.09(e)
	Plants	914.08
	Porous Material	914.09(d)
	Tree Wound Dressing.....	914.09(c)
	Water	914.09(a)

Soil conditioners such as peat moss or calcine clay may be added with written permission.

Guy wire shall be minimum No. 14 gauge galvanized wire.

30 **622.03 Care and Handling of Plants**

(a) Bare Rooted Plants

If the outside air temperature exceeds 35°F when the plants are delivered, the plants shall be planted immediately or placed in inside or outside storage. If they are stored outside, the roots shall first be puddled in a paste solution of backfill and water. The plants shall then be separated and their root systems heeled-in by completely covering with moist soil. If they are stored inside, the roots shall be puddled in a paste solution of backfill and water. Straw, peat moss, or corncobs shall be worked in and around the root system and kept moist.

40

Plants which are delivered in boxes, wrapped bundles, or other forms of closed containers, including trucks, and which are stored inside may remain in the container for 48 h from time of delivery, provided the containers are opened immediately and the plants are watered if necessary.

If the outside temperature is 35°F or less when plants are delivered, the plants shall be placed in inside storage immediately. Inside storage procedures shall be in accordance with the above requirements. Plants may be transferred to outside storage when the outside temperature exceeds 35°F provided they are puddled again and then heeled-in.

50

Temperature inside the storage building shall be maintained between 35°F and 55°F. Plants shall not remain in storage, either inside or outside, for more than seven days, unless otherwise specified because of unfavorable planting conditions.

Plants may be rejected on failure to comply with these specifications.

(b) Balled and Burlapped Plants and Container Grown Plants

Plants shall be planted or placed in storage before being exposed for 10 consecutive hours at temperatures less than 35°F. Storage of plants shall be in a moist storage building or they shall be placed outside in a compact group with balls or containers completely covered with corncobs and kept moist. Plants shall not remain in storage for more than 10 days, unless otherwise specified because of unfavorable planting conditions.

60

Plants may be rejected on failure to comply with these specifications.

622.04 Collected Plants

At least 24 h before starting to dig collected plants, notification shall be given of the time and place of digging so inspection of the work and of the plants can be made, if so desired.

70

Collected plants shall be dug carefully in a satisfactory manner. All operations of digging, transporting, and replanting collected plants shall be in accordance with all applicable laws and regulations of the State.

622.05 Excavation for Plant Holes

80 Stakes will be set to locate plant holes for each tree, shrub, or vine. The outline of each seeding bed will be staked and the planting on the required centers shall be as directed. Stakes for the staking operation shall be furnished. The location stakes shall be removed as directed. Excavation shall be such that the plant holes are cylindrical in shape with the sides approximately vertical. Material excavated from the holes may be used for backfill providing it is in accordance with 914.01. Otherwise, it shall be distributed uniformly within the construction area as directed. The excavated material shall not be stockpiled on turf or in ditches. Material unsuitable for the growth of vegetation, including rocks and boulders, shall be disposed of outside the right-of-way as directed and in accordance with 203.01 and 203.10. Plant holes shall be in accordance with the details and tables shown on the plans. If plants have not been planted within 10 days after excavation of the hole, the hole shall be refilled and re-
90 excavated at the time of planting. No additional payment will be made for this operation.

If, after staking or excavation of the plant holes at the locations shown on the plans, it becomes apparent that the location is unsuitable for planting due to accumulation of groundwater, possible flooding because of terrain conditions, or unsuitable soil conditions, plant holes shall be relocated as directed. Such relocation shall be done with no additional payment.

622.06 Planting Season

100 The planting season shall be from September 1 through the following May 25, with the exception that trees shall be planted from October 1 through the following April 15, provided that trees are dormant. Crown vetch plants and seedlings shall be planted only from April 15 through May 30, unless approved in writing. Bare rooted plants shall be planted only when the outside air temperature exceeds 35°F. Unless otherwise approved, deciduous plants, except those container grown, shall be dormant at the time they arrive at the work or storage site. Evergreens shall not have active terminal growth. At least 40% of the total number of balled and burlapped, and container grown plants, not including crown vetch plants, shall be planted from the beginning of the planting season through December 31. Bare root seedlings for
110 wildlife habitat shall be planted from October 1 through the following April 30. Container grown seedlings for wildlife habitat shall be planted at any time.

The initial planting and spring replacements, in accordance with 622.18, shall be completed satisfactorily within the planting season which expires prior to the completion date of the contract. The establishment period for these plants shall be from the end of the specified planting period to the fall inspection. If the initial planting and spring replacements are not completed within the specified time, the completion date may be extended one year to provide an establishment period. If the completion date is extended, all requirements of 622.18 shall apply until final inspection and
120 acceptance.

622.07 Pruning

Before the plant is placed in the plant hole, any bruised or broken parts of roots shall be cut off smoothly as approved unless otherwise specified or directed. All plants shall be pruned either before or after planting. Such pruning generally shall consist of thinning out or cutting back secondary branching to reduce the foliage by 1/3 to 1/2 in accordance with accepted horticultural practices. Pruning operations shall maintain the general crown outline and characteristic branching pattern for each species. Pruning or cutting back of terminal leaders which are over 3/8 in. in diameter at the point of cut will not be allowed. Broken or dead branches, or any other objectionable parts of the plant, shall be removed throughout the life of the contract. Pruning tools shall be kept sharp and shall be sterilized in denatured alcohol after each hour of use. All cut surfaces 3/8 in. or more in diameter shall be painted with a tree wound dressing.

Bare rooted shrubs shall be cut back to 1/2 their minimum specified height as shown on the plans. Pruning shall be performed after the shrubs have been sealed with Department seals and prior to the leaf buds breaking dormancy. At the time of the spring and fall inspections, bare rooted shrubs will be accepted at their original specified height provided they are healthy, in good growing condition, and are no less than 1/2 the minimum specified height.

622.08 Planting, Backfilling, and Watering

The plant shall be placed in the plant hole at the proper position for depth, alignment, final grade of the surrounding ground level, and vertical position of the trunk. The planting procedure shall be performed in such a manner that the top of the ball of the plant is as shown on the plans at the time of planting. The planting procedure shall be in accordance with the details as shown on the plans. Backfill material in accordance with 914.01 shall be placed around all plants except seedlings. The quantities of backfill material required per plant shall be as shown on the plans.

In areas which are designated on the plans as beds for group planting, the soil shall be tilled to a minimum depth of 6 in. in such a manner that all sod and vegetation is destroyed. These areas shall be tilled at least two times with an interval of 14 days between tilling operations. Planting may be done immediately after the second tilling. Additional tilling shall be performed if vegetation appears before mulch is applied. Sod and vegetation shall be removed in lieu of the tilling operation when the soil temperature or moisture conditions are such that the sod and vegetation would not be destroyed by tilling. At other times, sod and vegetation may be removed in lieu of tilling. If the excavation resulting from sod removal is greater than 1 in. deep, it shall be backfilled with topsoil to 1 in. above the original ground. After sod and vegetation removal and backfilling, the bed area shall be cultivated to a depth of 6 in. Large clods, rocks, and other debris encountered in the cultivation work and any excess soil shall be removed. The outline of beds for group plantings shall be no closer than 3 ft to the center of any of the outer plants in the area.

In addition to the water applied at the time of planting, unless excessive moisture prevails, a minimum of two supplemental waterings shall be applied between May 1

and June 15, and one every 14 days between June 15 and September 15. Sufficient water shall be applied to individual plants to saturate the backfill and the mulch area.

170 Plants in beds shall receive water equivalent to the quantity used for individual plants. Liquid fertilizer, in accordance with 622.09, may be applied with the supplemental watering and the method of application shall be approved. Lance watering will not be allowed.

Container grown seedlings for wildlife habitat which have been planted from June 1 through August 31 shall be maintained after installation for 30 days. Maintenance shall include watering the seedlings at the time of planting and once every seven days.

180 **(a) Plants with Bare Roots**

With the plant in its proper position, the plant hole shall be backfilled with material in accordance with 914.01. The backfill material shall be worked firmly around the roots as the hole is gradually filled. The plant shall be raised gently and lowered slightly as the soil is added to help eliminate air pockets around the roots. Soil shall be added in layers of about 6 in. and each layer tamped to make it firm and to hold the plant perpendicular. Water shall be used to settle the soil and to eliminate air pockets around the roots, unless otherwise directed. The top 4 in. of soil necessary to fill the plant hole completely shall be a very fine mixture and shall be placed on top of the firmed backfill and allowed to remain loose and untamped.

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(b) Balled and Burlapped Plants

Balled and burlapped plants shall be handled by the ball and placed in the holes in such a manner that the soil of the ball does not become loosened from the roots. The soil directly beneath the ball shall be firmed to minimize settling. Guy stakes shall be driven before backfilling operations begin. After the hole has been partially backfilled and the material firmed under and around the ball, the burlap shall be cut away and removed from the stem of the plant. Backfilling and firming shall then be completed in a manner to avoid loosening the soil from the root ball. Watering shall be done in accordance with 622.08(a). Backfill material shall be in accordance with 914.01.

200

(c) Seedlings for Wildlife Habitat

Seedlings shall be from 6 to 18 in. in height. Seedlings shall be planted as directed in the locations shown on the plans. Species shall be selected from the list as shown on the plans. Alternate species selection shall be subject to approval. Seedlings shall be planted no closer to each other than the distance shown on the plans. Seedlings shall not be planted in rows, but instead shall be planted in a natural appearing pattern. Failure to comply with this procedure will require the replanting of the seedlings as directed with no additional payment. All damaged seedlings shall be replaced with no additional payment if replanting is required.

210

622.09 Liquid Fertilizer Application

All plants shall be fertilized with a water soluble 5-10-10 fertilizer, or an equivalent amount of plant nutrients, at the rate of 0.75 lb/100 gal. of water. Fertilizer

shall be applied to each installed plant until the mulched area over the plant hole is saturated. Three applications shall be made: one on or about July 1; one about August 1; and one about September 1.

622.10 Mulching

220 Mulch, in accordance with 914.05(b), shall be placed as a top layer around each plant as soon as it has been installed. The mulch shall cover the entire area as described in 622.08 and shall be placed around individual plants in accordance with the plans.

622.11 Guying and Staking

230 Guying and staking shall be in accordance with the details shown on the plans. Guy wire shall be placed through rubber hose material around each tree then twisted to secure the tree in a relatively stable position. Three wood stakes shall be spaced equally about each tree. The guy wire shall be secured to each stake at an approximately right angle. Support of multi-stem trees of 4 to 6 ft in height shall consist of inner limb guying and bracing stakes. The securement point and placement of guy wire shall be so as to avoid abrasion of tree limbs. The guys and stakes shall be maintained for the duration of the contract. Prior to final inspection, all materials used to support trees shall be removed and disposed of, except as otherwise directed for trees requiring additional bracing time. However, supports for fall replacement shall remain in place. If approved, stakes may be left flush with the ground.

622.12 Plant Protection

(a) Borer Control Coatings

240 Within five days after planting and prior to wrapping, all trees, except evergreens, shall be protected against borer attack with an insecticide mixture applied to the tree trunk with a paint brush or a suitable hand sprayer. The application shall cover the trunk from the root crown to the first major branches. The mixture shall consist of enough powdered skim milk to form a smooth slurry when added to either dieldrin 18 at the rate of 2 qt to 50 gal. of water or thiodan 50 at the rate of 1 lb to 50 gal. of water.

(b) Wrapping for Rodent Protection

250 Within seven days after planting, all crabapple and shade trees with a 1/2 in. diameter or larger, except for multi-stem forms, shall be wrapped with a double layer of 18 by 14 mesh per in. aluminum mill finish screen wire mesh around the trunk of each tree as shown on the plans. The height of screen wire shall be from the existing grade to below the lowest branch. The screen wire shall be overlapped at the ends. The screen wire shall be secured to itself with hog rings or other approved methods, and to the rods by approved means.

Plastic coil type protective wrapping will be acceptable as an alternative to the screen wire and reinforcement rod method of tree protection or staked trees of less than 2 in. caliper. The wrapping shall be loosened twice each calendar year. The first adjustment shall be made between May 15 and June 15. The second adjustment shall

622.13

260 be made between September 1 and September 30. The plastic tree protective wrapping shall extend to the height of the bottom limb.

The Contractor may submit other proposed methods of rodent protection to the Department's landscape architect for approval prior to installation. The design of the protection shall ensure an average air space diameter of 2 in. greater than the tree's callipered size at installation. The protection shall enable air movement through its surface to dry the tree trunk following periods of precipitation. The protection shall not damage the tree nor hinder its growth.

270 Multi-stem trees shall be wrapped with commercially available wrapping paper wrapped tightly around the trunks from the ground to the lowest branch with a minimum of 1/2 in. overlap. The wrapping paper shall be tied securely with stout cord at top and bottom and at two intermediate intervals.

622.13 Retaining Walls and Tree Wells

280 Retaining walls around the roots of trees or shrubs, and tree wells around the trunks of trees or shrubs shall be constructed at the locations and to the shape and dimensions shown on the plans or as otherwise designated. They shall be of mortar and masonry, or other type as specified. Mortar shall not be used in any portion of the tree well extending below the top of contiguous porous material used for tree root protection. The inside face of a tree well shall be no less than 2 ft from the outside edge of the trunk of the tree or shrub.

No material shall be placed between the tree trunk and the wall of the tree well.

622.14 Tree Root Protection

290 Where tree root protection is specified, the entire area of the root spread shall be protected. The limits of this area shall be as designated, but in general this area corresponds to the area of the ground surface lying beneath the limb spread of the tree. The area shall be cleaned of all vegetation and debris. Porous material, in accordance with 914.09(d), shall be placed uniformly over the area to a depth in proportion to the height of fill, varying proportionally from 3 in. for fills of 1 ft or less to 12 in. for fills of 4 ft or more, or to such other depth as may be designated. A layer of No. 23 sand or other approved material shall then be placed in sufficient quantity to choke the top layer of porous material and will be measured and paid for as porous material.

300 Where the earth fill is less than 12 in. and tree root protection is specified without the construction of a tree well, the thickness of the porous material at the tree trunk shall be increased to the height of the fill and extend outward from the tree trunk in collar form for a distance of 12 in., unless otherwise shown on the plans.

No fill shall be placed over the root spread of any tree or shrub that is to be protected in the above manner until the required depth of porous material has been placed.

622.15 Pipe Underdrains

Pipe underdrains, when shown on the plans or directed, shall be placed to drain tree wells or porous material for tree root protection. These shall be placed in accordance with applicable provisions of 718.

310 **622.16 Damage to Plants**

During all operations of tree protection, care shall be used to prevent unnecessary cutting of roots and to prevent scarring or damage to selected trees or shrubs. Motorized equipment shall not be operated within the drip line of trees unless specified. Where trimming of branches or cutting of roots is necessary, all cuts shall be made cleanly with proper sharp tools in accordance with generally accepted horticultural practices. Scarred areas and cut surfaces 3/8 in. or more in diameter shall be covered completely with a tree wound dressing.

622.17 Grass and Weed Control

320 Weeding and mowing of grass in and around all group plantings, beds, and individual trees and shrubs shall be performed until final acceptance. The grass and weed control areas shall be the areas within 2 ft of the outer limits of all group plantings and shrub beds and within 2 ft of the outer limits of the mulch area of individual shrubs. For the care of individual trees, the area shall extend to a perimeter centered from the point itself to 2 ft beyond the stub stakes of the guy wires or 2 ft beyond the mulched area. In general, these areas shall be in accordance with the plans.

622.18 Care, Inspection, and Replacement

330 **(a) Care**

Watering, fertilizing, weeding, cultivating, spraying to control insect infestation and disease, and all other good horticultural practices necessary to maintain the plants in a living healthy condition shall be performed up to the time for termination of responsibility for care as set out herein. The plants shall be cared for throughout the life of the contract. All plants stolen, damaged, or destroyed by fire, automobiles, vandalism, or any other cause, with the exception of plants damaged or destroyed by Department maintenance operations, shall be replaced with no additional payment as soon as practicable. Plants damaged or destroyed by the Department will be replaced by the Department prior to the date of final acceptance.

340

(b) Inspection and Replacement

On or about May 1, a spring inspection of initial plantings will be made during and before the end of the planting season and prior to the beginning of the establishment period. Plants not living, unhealthy, in a poor growing condition, or otherwise not meeting the specifications shall be replaced with no additional payment, prior to May 15 for trees and prior to May 25 for other plants. These replacements shall be in accordance with all other requirements of the initial planting. All plants found to be not living or in an unhealthy condition between this replacement and final inspection shall be removed from the project immediately, as directed, and shall be replaced after September 15 as detailed below.

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A fall inspection will be made on or about September 15, at which time the condition of the materials planted within the specified planting season will be determined. At the time of this inspection, all plants which are found to be dead, unhealthy, in a poor growing condition, or otherwise not meeting the specifications will be rejected. Rejected plants shall be removed and disposed of as soon as practicable and replaced prior to November 15 with no additional payment. Replacement materials and operations shall be in accordance with the requirements of the initial planting.

360

A final inspection of the contract will be made as soon as possible after replacement. All plants shall be cared for and maintained until final inspection and acceptance.

All seedlings for wildlife habitat shall be in accordance with ASNS Seedling Trees and Shrubs and will be inspected by a landscape architect within one week of planting. Spring and fall inspections as described above will not be required. The inspection, planting, and maintenance of seedlings as required will constitute final acceptance.

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622.19 Crown Vetch Plants and Seedlings

The requirements of 622.09 and 622.18 will not apply to these items. Seedlings shall be fertilized as specified on the plans. Crown vetch plants and seedlings, including replacements, shall be watered as necessary to keep them in a living, healthy, and good growing condition.

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On or about June 5, these items will be inspected. If it is estimated that 90% or more of the plan quantity of any individual item in a specific area is living, healthy, and in a good growing condition, replacements will not be required. If less than 90% are alive, healthy, and in a good growing condition, all items not meeting these requirements shall be replaced. Replacements shall be marked in the same manner as the original planting, except the markers shall be yellow.

Replacement planting shall be accomplished prior to June 15.

390

A final inspection will be made on or about the following September 15. If it is estimated that 90% of the contract quantity of any individual item is living, healthy, and in a good growing condition, payment will be made for the contract quantity. If less than 90% meet these requirements, the pay quantity for the item will be established.

622.20 “Do Not Mow or Spray” Signs and “Do Not Disturb” Signs

These signs shall be placed at the boundaries of areas where seedlings for wildlife habitat have been placed. The locations and spacing of the signs shall be as shown on the plans or as directed. The sign shall otherwise be in accordance with 621.06(h).

622.21 Method of Measurement

400 Furnishing and planting trees, shrubs, and vines will be measured by the number of units of each type and size specified, installed, and accepted. Seedlings for wildlife habitat, “Do Not Mow or Spray” signs, and “Do Not Disturb” signs will be measured by the number installed and accepted. Retaining wall masonry, either mortared or not mortared as specified, will be measured by the cubic yard. Porous material for root protection will be measured by the ton.

622.22 Basis of Payment

410 The number of trees, shrubs, and vines of each variety planted, determined as provided above, will be paid for at the contract unit price per each for plant, of the type, form, and size shown in the Schedule of Pay Items. Seedlings for wildlife habitat, “Do Not Mow or Spray” signs, and “Do Not Disturb” signs will be paid for at the contract unit price per each.

Masonry wall and masonry tree well will be paid for at the contract unit price per cubic yard. Porous material for root protection will be paid for at the contract unit price per ton.

Payment will be made under:

	Pay Item	Pay Unit Symbol
420	Masonry Tree Well.....	CYS
	Masonry Wall.....	CYS
	Plant, Annual.....	EACH
	Plant, Aquatic.....	EACH
	Plant, Biannual.....	EACH
	Plant, Broadleaf Evergreen, Cone, Broad Upright, _____ size	EACH
	Plant, Broadleaf Evergreen, Globe, Dwarf, _____ size	EACH
	Plant, Broadleaf Evergreen, Spreading, Semispreading, _____ size	EACH
430	Plant, Coniferous Evergreen, Cone, Broad Upright, _____ size	EACH
	Plant, Coniferous Evergreen, Globe, Dwarf, _____ size	EACH
	Plant, Coniferous Evergreen, Prostrate Broad Spreading, Semispreading, _____ size	EACH
	Plant, Deciduous Shrub, _____ size	EACH
440	Plant, Deciduous Tree, Multi-Stem, _____ size	EACH
	Plant, Deciduous Tree, Single Stem, _____ size	EACH

628.01

	Plant, Ground Cover.....	EACH
	Plant, Perennial.....	EACH
	Plant, Root Tuber, Corm, Bulb.....	EACH
	Plant, Rose Grade.....	EACH
	Porous Material for Root Protection.....	TON
	Seedling.....	EACH
450	Sign, "Do Not Disturb".....	EACH
	Sign, "Do Not Mow or Spray".....	EACH

The cost of furnishing all materials, labor, and necessary incidentals shall be included in the cost of the pay items.

Progress payment for planting trees, shrubs, or vines will be based on the premise that 75% of the work has been completed when such trees, shrubs, or vines have been completely planted. The remaining portion of the payment will be for maintenance and plant replacement.

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SECTION 628 – FIELD OFFICE, COMPUTER SYSTEM, COMPUTER SYSTEM EQUIPMENT, OFFICE MACHINES AND COMMUNICATIONS

628.01 Description

This work shall consist of providing the specified facilities, equipment, supplies, and services in accordance with 105.03.

628.02 Field Office Requirements

10 When specified, the Contractor shall provide a field office, computer systems, computer system equipment, office machines, telephone service and equipment, services, equipment, and supplies for the Department’s exclusive use in accordance with the minimum requirements listed below.

All equipment shall be covered by normal manufacturer's warranties. All cellular telephone units, computer systems, telephones and voice mail systems, office machines and associated equipment provided by the Contractor will remain the property of the Contractor and will be returned to the Contractor upon completion of the contract.

20 **(a) Field Office**

The field office shall be located as mutually agreed by the Engineer and the Contractor. If a building exists within the limits of the right-of-way that is acceptable as a field office and the building is scheduled to be removed under the terms of the contract, the building may be equipped and furnished as the field office. A building within the right-of-way that is furnished under this specification shall be removed prior to the date of the last work and other acceptable facilities for the field office shall then be provided.

30 The field office may be a permanent building or a trailer and shall be of the type shown in the Schedule of Pay Items. The building or trailer furnished for the field office shall be in accordance with all applicable State and local codes and applicable IOSHA/OSHA requirements.

40 The field office shall be complete and ready for use by the Department, including all utility connections, office machines, internet service, equipment and supplies, prior to the start of work. If the Contractor is unable to provide the permanent field office prior to the start of the work, the Engineer shall be notified in writing and the Contractor and the Engineer will agree on temporary field office arrangements prior to the start of work. A temporary field office will not be accepted by the Department for more than two months, at which time a permanent field office shall be ready for the Department's use.

The field office shall, at a minimum, be the size listed below for the type field office specified.

1. Type A – 460 sq ft
2. Type C – 650 sq ft
3. Type D – 1,000 sq ft
4. Type E – 2,200 sq ft.

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Minimum dimensions shall be 8 ft wide and 7 ft in height, from floor to ceiling. For a trailer, the calculation of minimum area will be based on the exterior box dimensions.

The office shall have a solid and level floor with no holes, a weatherproof roof and shall be dust-proof, and wind-tight. The field office shall have at least two doors for ingress and egress and shall have a minimum of six windows for a Type A or Type C field office and eight windows for a Type D or Type E field office, not including any windows in the doors.

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Exterior doors shall have a satisfactory locking system. At least one door shall always be able to be unlocked and opened from inside the field office. If a padlock is used to secure a door, it shall be a high security type and shall be made inaccessible to bolt cutters, hacksaws, hammers, or prybars. The padlock shall be mounted in such a manner that locking and unlocking the door can be made with minimal effort. Installation of additional hardware to protect the lock or use of multiple padlocks on a door will not be allowed. Additional hardware to receive the padlock will be acceptable. The Contractor shall furnish the number of keys to the office as directed by the Engineer. The Department will maintain a list of all Department personnel who are given keys.

70

Windows shall be hinged or sliding and have a minimum area of 5 sq ft each. Windows shall be provided with satisfactory locks and screens. Windows, including windows in the doors, shall be provided with shades, blinds, or other approved coverings.

Type D and Type E field offices shall have at least one room with a minimum area of 196 sq ft for use as a conference or meeting room.

80

The field office shall have heating and air-conditioning equipment capable of maintaining a uniform temperature between 68°F and 80°F.

The field office shall have a minimum 100 amp, 120/240 volt electrical service, shall have sufficient receptacles to satisfactorily accommodate all required electrical equipment without the use of extension cords or splitters and shall be provided with satisfactory office type lighting.

90

If the field office is a trailer, the trailer shall be securely supported by adequate blocking. The blocking shall provide a foundation to prevent settlement. The trailer shall be secured to the ground with a trailer tie down system that is in accordance with all State and local requirements. Each trailer shall be furnished with steps meeting IOSHA/OSHA requirements at each doorway.

100

The field office location shall be selected in order to provide satisfactory parking and trash disposal facilities for Department use. Parking spaces shall be either paved or surfaced with compacted aggregate, size No. 53, or other acceptable materials suitable for all-weather usage and shall be maintained, including snow removal. Satisfactory parking for a Type A field office shall be a minimum of six separate parking spaces. Satisfactory parking for a Type C field office shall be a minimum of 10 separate parking spaces. Satisfactory parking for a Type D field office shall be a minimum of 12 separate parking spaces. Satisfactory parking for a Type E field office shall be a minimum of 16 separate parking spaces.

Any type of field office may be used by other Department personnel from other Department contracts.

(b) Field Office Equipment and Supplies

The following minimum equipment and supplies shall be furnished for each field office of the type specified.

110

Equipment and Supplies	Office Type		
	A and C	D	E
Bloodborne Pathogen Kit	1	1	1
Potable Water	Yes	Yes	Yes
Broom and Dust Pan	1	1	1
Calculators	1	2	4
Carbon Monoxide Detector	1	1	2
Chairs	8	12	20
Cleaning Supplies	Yes	Yes	Yes
Dry Erase Board	1	1	2
Electric Vacuum Sweeper	1	1	1
File Cabinet Drawers	4	8	12
Fire Extinguishers	2	2	3
First-Aid Kit	1	1	1
Folding Office Tables	4	6	10
Microwave Oven	1	1	2
Office Desks and Office Chairs	4	5	10
Paper Shredder	1	1	1
Plan Holder	1	1	2
Refrigerator/Freezer	1	1	2
Shelving	20 lft	24 lft	48 lft
Six-hook Coat Rack	1	1	2
Smoke Detector	1	2	3
Toilet Facilities	Yes	Yes	Yes
TV Monitor	0	1	1
USB Speakerphone Microphone	No	Yes	Yes
Waste Paper Baskets	4	6	10

The office and the equipment shall be furnished in a condition satisfactory to the Department.

120

Adequate quantities of basic hygiene and office cleaning supplies shall be provided. These supplies shall include, but are not limited to, antibacterial hand soap in a pump container, hand sanitizer, paper towels, trash bags, toilet paper, spray air freshener, window cleaner, all-surface cleaner, toilet disinfectant, toilet brush and a toilet plunger.

Potable water shall be provided separately for drinking and hand washing purposes.

The plan holder shall have a minimum number of five individual holders, capable of holding full size plans, 24 in. by 36 in., per plan holder.

130 Fire extinguishers shall be 5 lb, Class ABC or higher rated and shall be maintained in a fully charged and operable condition and shall meet all IOSHA/OSHA requirements.

140 The toilet facilities shall consist of, at a minimum, a toilet and hand washing location. For a Type A or Type C field office, the toilet can be a portable toilet and the hand washing location can be a portable hand washing station. For a Type D or Type E field office, the toilet facilities shall be provided indoors. Indoor toilet facilities shall have an exhaust fan. Hot water is not required for the toilet facilities. If a portable toilet is provided, it shall be provided with a lock and at least two keys for the lock. If a portable hand washing station is provided as the hand washing location, it shall always remain functional, including during freezing temperatures. The portable toilet or portable hand washing station shall be serviced a minimum of once per week and shall be maintained in such a manner as to provide consistent continual toilet facility service.

First-aid kits shall meet the requirements of ANSI Z308.1 current at the time of letting.

Shelving shall have a minimum width of 10 in.

150 Filing cabinets shall at a minimum be fire resistant steel filing cabinets with a class D or higher classification established by UL or Safe Manufacturers National Association. Cabinet drawers shall have a filing depth of 25 in. All cabinets shall have a lock and at least half of the drawers shall be fireproof.

Office desktops shall be at least 48 in. wide and 25 in. deep. All desks shall contain at least two drawers, one of which shall be provided with a lock.

Folding office tables shall be a minimum size of 30 in. by 72 in.

160 Office chairs shall be height adjustable and equipped with castors. Other required chairs may be stackable or folding chairs.

Supplies to be furnished shall include all items required for proper operation of the required equipment. This includes, but is not limited to, operating manuals and paper supplies.

Calculators shall be electric powered, have a printer, a minimum 12-digit capacity, and have a counting function.

The paper shredder shall have a minimum capacity of 12 sheets of 20 lb paper,

- 170 shall be capable of shredding paper clips and staples, and shall include a five-gallon capacity waste basket.

The dry erase board shall have a minimum size of 4 ft by 6 ft. Adequate quantities of dry erase markers and erasers shall be provided.

The TV monitor shall be at a minimum 55 in., LED, 4 series, 2160P, Smart, 4K UDH TV with HDR and shall work wirelessly with laptops. It shall be mounted on the wall of designated meeting or conference rooms as determined by the Engineer.

- 180 A USB speakerphone microphone shall be a Conference Speaker Omnidirectional Computer Mic, with 360° voice pickup, touch sensor buttons for mute/unmute, streaming and shall be provided for use in designated meeting or conference rooms as determined by the Engineer.

The microwave oven shall have a minimum 1 cu ft capacity with a minimum 1,100 watts and shall have digital controls.

- 190 The refrigerator/freezer shall have a minimum 20 cu ft. capacity for a Type D or Type E field office and shall have a minimum 10 cu ft capacity for a Type A or Type C field office.

The field office and all equipment and supplies shall be maintained and replenished in a satisfactory manner during the term of the contract or until released by the Engineer. If the field office or required equipment and supplies are not maintained by the Contractor, the Engineer may withhold partial payments until the field office is operational to the Department's satisfaction.

(c) Computer System and Computer System Equipment

- 200 When specified in the Schedule of Pay Items, the Contractor shall provide the computer system and computer system equipment in accordance with the minimum requirements listed below for the Department's exclusive use for each field office.

1. Computer System

- 210
- a. Laptop computer
 - b. Processor – Intel compatible, minimum dual-core 2.0 GHz
 - c. Memory – 8.0 GB, 1866 MHz
 - d. Hard Drive – 500 GB, 7,200 rpm or 256 GB SSD (Solid State Drive)
 - e. Ports – Two USB 2.0 compliant ports, one USB 3.0 compliant port
 - f. Network/Wireless – Ethernet or wireless card to be compatible with the selected internet and office network connections
 - g. Graphics – Integrated graphics card

- h. Display - Minimum 15 in. 1366 by 768 LCD panel
 - i. Battery - Minimum 3-cell Lithium ion
 - j. Miscellaneous - One laptop docking station compatible with the Monitor, with AC adapter, one additional AC adapter, one DC adapter and one padded carrying case.
- 220

The initial condition of the computer system shall be nearly pristine. All owner installed e-mail accounts, games, spyware, online services, applications, network or other profiles previously set up on the system shall be removed prior to placement in the field office. If the system was provided for a previous Department contract, all software not specified shall be removed prior to placement in the current field office.

The Contractor shall provide a minimum 900 J, six-outlet surge protector for each computer system specified in the contract.

230

2. Computer System Equipment

- a. Monitor – Minimum 22 in. digital panel that enables connectivity to DisplayPort and HDMI connections or an adapter
 - b. Keyboard – USB multimedia keyboard
 - c. Mouse – Optical USB 2-button scroll mouse
 - d. Miscellaneous - One laptop docking station compatible with the Monitor, with AC adapter, one additional AC adapter, one DC adapter that is compatible with the Department's provided laptop or mobile device, and one minimum 900 J six-outlet surge protector.
- 240

3. Computer Software

The Contractor shall provide software for the computer system in accordance with the minimum requirements listed below.

- a. Operating System Software – Windows 10 Professional.
 - b. Productivity Software – Microsoft Office 2013 Small Business and Adobe Acrobat Professional DC.
 - c. Security Software – McAfee Total Protection.
- 250

All software shall include the most current updates and patches at the time the computer system is provided to the Department. The Contractor shall provide for installation of updates and patches for the operating system, productivity and security software during the term of use of the computer system by the Department. Updates and patches shall be provided by an automatic update method.

- 260 The Department may install and maintain proprietary software on the computer in order to run the Department's construction management programs.

4. Miscellaneous Computer Requirements

The Contractor shall provide all cables, connections and software required to connect the computer system provided by the Contractor or by the Department to the printer and the scanner.

270 The Contractor shall provide an Ethernet and a wireless office network to enable all computer systems in the field office to access the field office internet service, the printer and the scanner.

The Contractor shall provide all manuals necessary for operation of the computer system, computer system equipment and software with the system and shall include all documentation normally furnished with the equipment and software when purchased.

280 The Department will be utilizing the computer system to run or access Department provided construction management software applications. These applications are known to run on Intel compatible equipment when using the Windows 10 Professional operating system. If the Department experiences problems running these applications due to hardware or software compatibility, the Contractor shall replace the equipment to ensure compatibility to the satisfaction of the Engineer within five business days.

290 The computer system shall be maintained in good working order. If a portion of the system becomes defective, inoperable, damaged, or stolen, that portion shall be repaired or replaced within five business days after the Contractor is notified by the Engineer. If the computer system and related accessories are not maintained by the Contractor as required, the Engineer may withhold partial payments until the computer system is operational to the Department's satisfaction.

(d) Field Office Internet Service

The Contractor shall provide broadband internet service for the field office. Broadband internet service shall be capable of a minimum average download speed of 50 Mbps and a minimum upload speed of 5 Mbps, unless otherwise approved by the Engineer.

(e) Field Office Machines

300 The Contractor shall provide a fully operational copier, printer, and document scanner for the Department's exclusive use in the field office in accordance with the minimum requirements listed herein.

In lieu of separate copier, printer, and scanner, the Contractor may provide an all-in-one unit that meets all the requirements for any combination of the individual machines being provided. Separate machines shall be provided for those machine functions that are not included in an all-in-one type machine. All machines shall be supplied with, and shall be maintained with, one additional set of ink cartridges.

1. Copier

310 The copier shall be compatible with, and shall be connected to, the computer system provided by the Contractor or the Department for use by the Department in the field office. The copier shall be capable of using plain paper and of making full size, black and white copies of letter, legal and ledger US paper size original documents. The copier shall be capable of reducing and increasing copy sizes. The copier shall have a self-feeding paper tray, an automatic document feeder and be capable of producing at least 20 copies per minute. The copier shall be capable of double-sided copying. The copier shall have at least two universal paper drawers; letter and ledger size.

2. Printer

320 The printer shall be compatible with, and shall be connected to, the computer system provided by the Contractor or by the Department for use by the Department in the field office. The printer shall be capable of printing single-sided and double-sided, black and white letter, legal and ledger US paper size documents at a rate of 20 pages per minute and capable of automatic duplex printing. More than one printer may be used to meet this requirement.

All printers shall be set to accommodate wireless printing from the Department's provided laptop or mobile device.

3. Document Scanner

330 The document scanner shall be compatible with, and shall be connected to, the computer system provided by the Contractor or the Department for use by the Department in the field office. The scanner shall be capable of scanning letter and ledger size documents and shall have an automatic document feeder and be capable of 200 to 600 dpi black and white resolution, preset to 200 dpi.

4. Miscellaneous Office Machine Requirements

340 The Contractor shall provide letter, legal and ledger size paper, ink cartridges and toner as required by the Engineer for the operation of each piece of equipment provided.

If any office machine becomes defective, inoperable, damaged, stolen or incompatible with the Department provided devices, that machine shall be repaired or replaced within five business days after the Contractor is notified by the Engineer. If any of the office machines are not maintained by the Contractor as required, the Engineer may withhold partial payments until the machine is operational to the Department's satisfaction.

(f) Telephone Service

350 When specified in the Schedule of Pay Items, the Contractor shall provide telephone services and equipment, as specified below, for use by the Department on the contract.

Telephone Service	Type A	Type B	Type C
Telephone line	1	2	2
Telephone	1	2	3
Telephone voice mail system	1	2	1

The telephone voice mail system shall be capable of providing both a minimum 1 minute outgoing message and 30 minutes total recording time for incoming messages. It shall have a remote operation feature, which may be used to retrieve, replay, erase, and save messages. An answering machine meeting these requirements may be substituted for the voice mail system.

360

At least one telephone shall be a cordless phone having a frequency of at least 900 MHz.

628.03 Mobile Internet Service

When specified, the Contractor shall provide mobile internet service for the Department's exclusive use.

The mobile broadband internet service access device will be used by the Department in a laptop computer provided by either the Contractor or the Department.

370

The device shall connect to the laptop via a USB 2.0 or USB 3.0 compliant port, or by wireless means. The device and service shall be capable of a minimum 4G speed. The internet service rate plan shall include unlimited data and time usage with no roaming charge for national domestic use. All software necessary for the operation of the device shall be provided to the Engineer.

The Contractor shall not purchase any device or enter into any service agreement until authorized by the Engineer. The Engineer will provide a minimum of 10 business days notice prior to the date the device will be required.

380

628.04 Cellular Telephones

The Contractor shall provide cellular telephone equipment and services, as specified below, for use by the Department on the contract.

Each cellular telephone unit shall have a service coverage area that includes the project limits. Each cellular telephone unit shall include a belt clip system, a 120V AC charger, a 12V DC mobile charger, and a hands-free kit consisting of a speaker and a microphone enabling the user to operate the unit with minimal need for the use of their hands. The hands-free kit shall be wireless.

390

All equipment shall be covered by normal manufacturer's warranties. All cellular telephone units and associated equipment will remain the property of the Contractor and will be returned to the Contractor upon completion of the contract.

Cellular telephone units shall meet the following minimum requirements:

(a) Type A

- 400
1. internet ready device with minimum 5 in. display, measured diagonally
 2. cellular telephone anytime minutes per month as shown in the Schedule of Pay Items
 3. unlimited nights and weekends service
 4. voice mail and caller ID
 5. protective case to prevent damage to the unit
 6. rear facing camera with a minimum 8 MP resolution
 7. minimum 1080p video capture
 8. 5 GB or higher data plan per unit
 9. internal memory of 64 GB or higher.
- 410

(b) Type B

1. a cellular telephone with anytime minutes per month as shown in the Schedule of Pay Items
2. unlimited nights and weekends service
3. voice mail and caller ID
4. built-in camera with a minimum 5 MP resolution.

420 The Department will be responsible for damage or loss of the units beyond that covered by normal manufacturer's warranties, while in use by the Department. The Contractor shall provide replacement cellular telephone units, batteries, chargers, and equipment within one business day of notification of need for the item.

The Contractor shall not enter into any agreement with any service provider or purchase any cellular telephone units for use by the Department until authorized by the Engineer. The Engineer will notify the Contractor a minimum of 10 business days prior to the need for the units.

628.05 Method of Measurement

430 Field office will be measured by the month for the specified type. Partial months will be rounded up to the next 1/2 or whole month. The Department will provide two weeks advanced notice prior to when the facility will be vacated.

Computer system and computer system equipment will be measured by the number of units specified.

440 Telephone service will be measured by the month for the specified type. Partial months will be rounded up to the next 1/2 or whole month. The Department will provide two weeks advanced notice prior to when the telephone service will be vacated.

Cellular telephones will be measured by the number of units required for the type specified.

Mobile internet service and cellular telephone service will be measured by the month for each system or service provided. Partial months will be rounded up to the next 1/2 or whole month. The Department will provide two weeks advanced notice prior to when mobile internet service and cellular telephone service will no longer be required.

450

628.06 Basis of Payment

Field office will be paid for at the contract unit price per month, complete in place until released.

Computer system and computer system equipment will be paid for at the contract unit price per each for the units provided.

Telephone service will be paid for at the contract unit price per month, complete in place until released.

460

Mobile internet service will be paid by the month for each system or service provided.

Cellular telephone units will be paid for at the contract unit price per each per each type specified. Cellular telephone service will be paid for at the contract unit price per month per each phone. Monthly charges for cellular telephone minutes and data in excess of those specified in the contract will be paid for by the dollar amount for the invoiced price per each occurrence as cellular telephone, additional charges.

470 Payment will be made under:

	Pay Item	Pay Unit Symbol
	Cellular Telephone Service, _____ anytime minutes	MOS
	Cellular Telephone, _____ type	EACH
	Cellular Telephone, Additional Data.....	DOL
	Cellular Telephone, Additional Minutes	DOL
480	Computer System Equipment.....	EACH
	Computer System	EACH
	Field Office, _____ type	MOS
	Mobile Internet Service, _____ quantity	MOS
	Telephone Service, _____ type	MOS

490 The cost of all heating, cooling, electrical service, and other miscellaneous utility bills required for the field office shall be included in the cost of the field office.

If a field office smaller than the specified type is approved by the Engineer, a new unit price will be established for the smaller field office. The new unit price will be equal to the original contract unit price multiplied by the smaller floor area and divided by the specified floor area.

500 All costs necessary to provide and maintain the telephone service, including monthly charges and installation of telephone lines, shall be included in the cost of the telephone service.

If a temporary field office is provided in accordance with 628.02, payment will be 65% of the unit price during the time the temporary field office is in use by the Department.

The cost of all materials and labor necessary to setup, secure, maintain, and remove the field office, including all required equipment and supplies and any material required to provide parking, shall be included in the cost of the respective pay item.

510 All costs necessary to provide and maintain the computer system, computer system equipment, including the required software, manuals, technical support, and miscellaneous computer requirements shall be included in the cost of the computer system or computer system equipment.

All costs necessary to establish, install, and maintain field office internet service, both wireless and Ethernet, field office network, including any required hardware, software, fees, monthly charges, setup, installation, and technical support shall be included in the cost of the field office.

520 All costs associated with providing the field office for any Type of field office for use by other Department personnel from other Department contracts shall be included in the cost of the field office.

All costs necessary to provide the copier, printer, and document scanner, including setup, installation, all required connections to computers, technical support, and miscellaneous office machine requirements shall be included in the cost of the field office.

530 All costs necessary to establish, install and maintain mobile internet service, including required hardware, software, fees, monthly charges, setup, installation, and technical support shall be included in the cost of mobile internet service.

The Contractor shall provide a copy of the detailed invoice from the service provider for each cellular telephone unit each month.

DIVISION 700 – STRUCTURES

SECTION 701 – DRIVEN PILING

701.01 Description

This work shall consist of furnishing and driving foundation piles of the type and dimensions specified including cutting off or building up foundation piles when required. This work shall also consist of providing test piles and performing loading tests when required. Piling shall be installed at the location and to the tip elevation, the penetration depth, and nominal driving resistance shown on the plans in accordance with 105.03.

10

MATERIALS

701.02 Materials

Materials shall be in accordance with the following:

	B Borrow	211
	Bentonite Grout	913.06
	Concrete Piles	707
	Conical Pile Tips	915.01(a)2
20	End Plates	915.01(a)1
	Epoxy Coating for Piles.....	915.01(d)
	Pile Shoes	915.03
	Reinforcing Bars.....	910.01
	Steel H Piles	915.02
	Steel Pipe Piles	915.01
	Structural Concrete.....	702
	Timber Piling, Treated.....	911.02(c)
	Timber Piling, Untreated.....	911.01(e)

30 Unless otherwise specified, reinforcing bars may be either plain or epoxy coated.

Steel pipe piles shall consist of a steel pipe which is driven into place and filled with class A concrete.

The Contractor may furnish and drive steel pipe piles with thicker walls than specified.

40 Treated and untreated timber piles shall be strapped with at least three straps: one approximately 18 in. from the butt, one approximately 24 in. from the butt, and one approximately 12 in. from the tip. Additional straps shall be provided at approximately 15 ft centers between the butt and tip. Strapping shall encircle the pile once and be tensioned as tightly as possible. Straps shall be 1 1/4 in. wide, 0.031 in. thick, cold rolled, fully heat treated, high tensile strapping, painted and waxed, with breaking

strength of 5,500 lb. The strap shall encircle the pile once and shall be crimped with a notch type sealer to furnish a joint yielding 80% of the strap tensile strength. Treated timber piles shall be strapped after treatment.

701.03 Handling of Epoxy Coated Piles

50 Epoxy coated piles shall be protected at all times from damage to the epoxy coating. Damage to epoxy coated piles shall be repaired in accordance with 915.01(d). Epoxy coated piles will be rejected if the total area of repair to the coating exceeds 2% of the total coated surface area.

CONSTRUCTION REQUIREMENTS

701.04 Equipment for Driving Piles

(a) Approval of Pile Driving Equipment

60 All pile driving equipment, including the pile driving hammer, hammer cushion, helmet or pile drive head, pile cushion, and other appurtenances furnished by the Contractor shall be in working condition and approved in writing by the Engineer prior to delivery of the pile driving equipment to the job site. All pile driving equipment shall be sized such that the piles can be driven to the length required without damage. Approval of pile driving equipment does not relieve the Contractor of the responsibility to drive piles, free of damage, to the required nominal driving resistance and, if specified, the minimum tip elevation shown on the plans. Pile driving equipment will be subject to satisfactory performance during production.

70 The Contractor shall submit a completed pile and driving equipment data form to the Engineer at least 15 calendar days prior to driving piles. The pile and driving equipment data form is available on the Department's website. The Contractor will be notified of the acceptance of the proposed pile driving system within 15 calendar days of the receipt of the pile and driving equipment data form. Acceptance of pile and driving equipment does not relieve the Contractor of the responsibility to provide equipment suitable for driving the specified piling to the required bearing without damage.

80 If the method of pile driving approval is in accordance with the dynamic formula shown in 701.05(a) the dynamic formula method will be used to determine if the pile driving equipment is acceptable for use. To be considered for approval, the proposed driving system shall obtain the nominal driving resistance between the specified blow count range of 30 and 120 blows per foot.

If the nominal driving resistance is to be determined by dynamic pile load test in accordance with 701.05(b) or static load test in accordance with 701.05(c), the Engineer will use the wave equation analysis method for driving system approval. To be approved, the proposed driving system shall obtain the nominal driving resistance between the specified blow count range of 30 and 120 blows per foot, and shall maintain driving stresses below the specified driving stress limits for the pile type

90 being driven. If wave equation predicted driving stresses are greater than specification limits or the wave equation blow count for the nominal driving resistance is outside the specified blow count range, the Contractor shall modify or replace the proposed equipment until subsequent wave equation analyses indicate the piles can be driven to the nominal driving resistance within the allowable blow count range and within driving stress limits.

If the driving system requires revision, the Contractor will be notified of the acceptance of the revised driving system within seven calendar days of receipt of a revised pile and driving equipment data form.

100

The Contractor shall use the approved pile driving system. No changes shall be made without prior written approval from the Engineer, with the exception that the concrete pile cushion thickness may be increased to control driving stresses. A change in the pile driving system will only be considered after the Contractor has submitted a new pile and driving equipment data form. The Contractor will be notified of the acceptance of a proposed change in driving equipment within three work days of receipt of the pile and driving equipment data form. If the Engineer determines the Contractor's hammer is not functioning properly and is unable to drive the piles to the required penetration depth or nominal driving resistance, the hammer shall be removed from service.

110

1. Dynamic Formula Method

If the dynamic formula method is used, the energy of the pile driving equipment shall be rated by the manufacturer at or above the appropriate minimum manufacturer's rated hammer energy for the corresponding nominal driving resistance as shown in the table below. The table below will be used as the basis of approval of pile driving equipment for the dynamic formula method.

Dynamic Formula Method Minimum Pile Hammer Requirements	
Nominal Driving Resistance	Minimum Manufacturer's Rated Energy
kip	ft·lb
≤ 180	12,000
181 - 300	21,000
301 - 400	28,800
> 400	Wave Equation Analysis required

120

The minimum rated energies do not account for losses and inefficiencies in the pile driving system. If the hammer selected cannot satisfy all of the criteria, a wave equation analysis shall be submitted by the Contractor for approval.

2. Wave Equation Analysis Method

For the pile driving equipment to be acceptable, the driving stresses predicted by

the wave equation analysis shall not exceed the values where pile damage impends. These limiting values shall be calculated as follows:

- 130
- a. The maximum compressive and tensile driving stresses for steel piles = $0.9F_y$.
 - b. The maximum compressive driving stress for prestressed concrete piles = $(0.85f'_c - f_{pe})$, where f_{pe} is the effective prestress value.
 - c. The maximum tensile driving stress, psi, for prestressed concrete piles = $\sqrt[3]{f'_c + f_{pe}}$, where f'_c and f_{pe} are expressed in psi.
- 140
- d. The effective prestress, f_{pe} , shall be obtained from the approved working drawings.
 - e. The maximum driving stress, psi for timber piles shall not exceed $3F_{co}$, where F_{co} is the base resistance of wood in compression parallel to the grain, in psi.

(b) Pile Hammers

150 Piles may be driven with air, steam, diesel, or hydraulic hammers. Gravity hammers, vibratory hammers, and other pile driving methods shall be used only if specified or approved in writing by the Engineer.

1. Gravity Hammers

Gravity or drop hammers shall be used to drive timber piles only. The ram shall have a weight of between 2,000 and 3,500 lb. The height of drop shall not exceed 12 ft. The weight of gravity hammers shall not be less than the combined weight of the helmet and pile. All gravity hammers shall be equipped with hammer guides and helmet to ensure concentric impact on the drive head.

2. Single or Double Acting Steam and Air Hammers

160 The plant and equipment furnished for steam and air hammers shall have sufficient capacity to maintain, under working conditions, the volume and pressure specified by the manufacturer of the hammer. The hose connecting the air compressor to the hammer shall be at least the minimum size recommended by the manufacturer. The plant and equipment shall be equipped with accurate chamber pressure gauges which are easily accessible to the Engineer. If wave equation analysis is not used for pre-approval, the weight of the striking parts of air and steam hammers shall be equal to or greater than one-third the combined weights of the drive head and pile being driven. The striking parts shall not weigh less than 2,800 lb. Proximity switches and an electronic readout device shall be provided prior to driving piling.

170

3. Diesel Hammers

Open-end or single acting diesel hammers shall be equipped with a device such as graduated rings or grooves on the ram to enable the Engineer to visually determine hammer stroke at all times during pile driving operations. The Contractor shall provide the Engineer a chart from the hammer manufacturer equating stroke, blows per minute, and potential energy for the approved open-end diesel hammer. The Contractor shall also provide and maintain, in working order, an approved device that automatically measures and displays the ram stroke for open-end diesel hammers.

180 Closed-end double acting diesel hammers shall be equipped with an accurate bounce chamber pressure gauge, easily accessible to the Engineer. The Contractor shall provide the Engineer a calibrated chart equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used. Calibration of actual hammer performance shall be performed no more than 90 days prior to the beginning of the work.

4. Hydraulic Hammers

190 Under working conditions, the power plant shall have sufficient capacity to maintain the volume and pressure for the hydraulic hammer as specified by the manufacturer. Hydraulic hammers shall also be equipped with a controlled variable stroke system and a readout device to measure ram energy. The plant and equipment shall be equipped with accurate pressure and velocity gauges and an energy readout device which are easily accessible to the Engineer.

5. Vibratory Hammers

200 Except for pile lengths which have been evaluated from load test piles, the nominal driving resistance of the piles driven with vibratory hammers shall be verified by re-driving the first pile driven in each group of 10 or fewer piles with an impact hammer of suitable energy to measure the nominal driving resistance before driving the remaining piles in the group. All piles which rely on point bearing capacity shall be re-driven with an impact hammer.

(c) Pile Driving Aids

Pile driving aids such as jets and followers, shall not be used unless specified or approved in writing by the Engineer. If specified or approved, pile driving aids shall be used for installing production piles only after the minimum pile tip elevation is established by means of load testing or indicator test piles conventionally driven in accordance with 701.05. The Contractor shall perform all extra load tests or extra work required to drive indicator test piles as determined by the Engineer.

210

1. Hammer Cushion

All impact pile driving equipment, except gravity hammers, shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving behavior. Impact hammers designed such that a hammer cushion is not required are excluded from this requirement. Hammer cushions shall be made of durable, manufactured materials, provided in accordance with the

hammer manufacturer's guidelines. Wood, wire rope, or asbestos hammer cushions shall not be used. A striker plate, as recommended by the hammer manufacturer, shall be placed on the hammer cushion to ensure uniform compression of the cushion material. The condition of the hammer cushion shall be checked with the Engineer when beginning pile driving at each structure or after each 100 h of pile driving, whichever is less. A hammer cushion whose thickness has been reduced to less than 75% of the original thickness shall be replaced.

2. Helmet

Piles driven with impact hammers shall have an adequate helmet that adequately distributes the hammer blow uniformly and concentrically to the pile head. The helmet shall be axially aligned with the hammer and the pile shall be guided by the leads and not be free-swinging. The helmet shall fit around the pile head and prevent transfer of torsional forces during driving while maintaining proper alignment of hammer and pile.

For steel and timber piling, the pile heads shall be cut squarely. For timber piles, the least inside helmet horizontal dimension or hammer base horizontal dimension shall not exceed the pile head diameter by more than 2 in. If the timber pile diameter slightly exceeds the least helmet or hammer base dimension, the pile head shall be trimmed to fit the helmet.

A helmet as recommended by the manufacturer shall be provided to hold the axis of the pile in line with the axis of the hammer. The pile head shall be plane and perpendicular to the longitudinal axis of the pile to prevent eccentric impacts from the drive head.

3. Pile Cushion

The heads of concrete piles shall each be protected with a pile cushion made of plywood, hardwood, or composite plywood and hardwood materials. The use of manufactured pile cushion materials shall be by the hammer manufacturer's recommendation. The pile cushion dimensions shall equal or exceed the cross sectional area of the pile top, and shall be sized to fit the dimensions of the pile cap. The minimum pile cushion thickness placed on the pile head prior to driving shall be either as recommended by wave equation analysis or not less than 4 in. if the dynamic formula is used. A new pile cushion shall be provided for each pile. The pile cushion shall be replaced if, during the driving of the pile, the cushion is either compressed more than one-half the original thickness or begins to smolder or burn. Pile cushions shall be protected from weather and kept dry prior to use. Pile cushions shall not be soaked in liquid unless approved by the Engineer.

A used pile cushion in acceptable condition shall be used for restrrike tests. The used pile cushion shall be the same pile cushion from the end of initial driving on that pile unless the condition of that pile cushion is no longer within specification limits. If the original pile cushion is not within specification limits, a used cushion of similar thickness as the end of drive pile cushion shall be used.

4. Leads

Piles shall be supported in line and position with leads while being driven. Pile driver leads shall be constructed in a manner that affords freedom of movement of the hammer while maintaining alignment of the hammer and the pile to ensure concentric impact for each blow. Leads may be either fixed or swinging type. Swinging leads, when used, shall be fitted with a pile gate at the bottom of the leads. The leads shall
270 be adequately embedded in the ground, or the pile shall be constrained in a structural frame such as a template to maintain alignment. The leads shall be of sufficient length to make the use of a follower unnecessary, and shall be designed as to enable proper alignment of battered piles.

5. Followers

Followers shall only be used if specified or approved in writing by the Engineer. If a follower is allowed, the first pile in each bent and every tenth pile driven thereafter shall be driven full length without a follower, to verify that adequate pile length is being attained to develop the nominal driving resistance. The follower and pile shall
280 be held and maintained in equal and proper alignment during driving. The follower shall be of such material and dimensions to enable the piles to be driven to the required penetration depth determined necessary from the driving of the full length piles.

The final position and alignment of the first two piles installed with followers in each substructure unit shall not exceed more than 3 in. from the locations shown on the plans before additional piles are installed.

6. Jets

Jetting shall only be allowed if specified or approved in writing by the Engineer.
290 The Contractor shall determine the number of jets and the volume and pressure of water at the jet nozzles necessary to freely erode the material adjacent to the pile without affecting the lateral stability of the final in-place pile. The Contractor shall be responsible for all damage to the site caused by unapproved or improper jetting operations. If jetting is specified, the jetting plant shall have sufficient capacity to enable installation to the required elevation, location, and alignment in accordance with 701.09(b). Unless otherwise directed, external jet pipes shall be removed once the pile tip is 5 ft above the prescribed tip elevation, depending on soil conditions. The pile shall then be driven to the nominal driving resistance with an impact hammer. The Contractor shall provide suitable sediment control measures for jet water in
300 accordance with the specifications. Where practical, all piles in a pile group shall be jetted to the required penetration depth before beginning pile driving. Where large pile groups or pile spacing and batter make this impractical, restrike tests on a select number of previously driven piles shall be performed to check nominal driving resistance after jetting operations are completed.

Upon completion of driving a jetted pile, all voids around the pile shall be filled with B borrow and saturated with water.

7. Collars

310 Where timber piles are used, collars, bands, or other devices shall be provided to protect piles against splitting and brooming.

8. Pile Shoes, End Plates, and Conical Pile Tips

Pile shoes shall be used when specified. End plates or conical pile tips shall be used on pipe piles. Steel pile shoes shall be used on H piles if specified.

If shoes are required on timber piles, the tips of timber piles shall conform to the approved steel shoes to ensure a firm uniform contact and prevent local stresses concentrations in the timber.

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701.05 Nominal Driving Resistance of a Driven Pile

The Engineer will use one of the following methods as specified to determine the nominal driving resistance of a driven pile.

(a) Dynamic Formula

The nominal driving resistance will be determined by means of a dynamic formula. Piles shall be driven to the penetration depth necessary to obtain the nominal driving resistance. The nominal driving resistance, as shown on the plans, can be calculated from the formula as follows:

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$$R_{\text{ndr}} = 1.75\sqrt{E} \times (\log 10N) - 100$$

where:

R_{ndr} = nominal driving resistance in kips

E = manufacturer's rated energy in foot-pounds at the field observed ram stroke and not reduced for efficiency

$\log 10N$ = logarithm to the base 10 of the quantity 10 multiplied by N , where N is the number of hammer blows per 1 in. at final penetration.

340

An indicator test pile shall be the first pile driven at each bent and pier and shall be driven to the plan tip elevation or to the nominal driving resistance whichever occurs first. All indicator test piles shall be driven with impact hammers unless otherwise directed. The length of indicator test piles shall be greater than the estimated length of production piles in order to provide for variation in soil conditions. Precast concrete and treated timber test piles shall be a minimum of 10 ft longer than the estimated length of piling shown on the plans. Steel piles shall be provided such that additional 10 ft of driving will not require an additional splice.

The driving equipment used for driving indicator test piles shall be identical to that proposed for use on the production piling and shall be subject to approval. The Contractor shall excavate the ground at each indicator test pile location to the elevation of the bottom of the footing before the pile is driven, unless otherwise shown on the plans.

350 To assess the effects of relaxation and setup, each indicator test pile shall be
restruck after the number of hours specified unless otherwise approved. The hammer
shall be warmed up before driving begins by applying at least 20 blows to another
fixed object. The maximum amount of penetration required during restrike shall be 3
in., or the total number of hammer blows shall be 20, whichever occurs first. If the
indicator test pile does attain the nominal driving resistance upon restriking, the
penetration resistance attained during initial driving shall be used to establish the
adequacy of production piles. If the nominal driving resistance is not attained upon
360 restriking, the Contractor shall re-drive the indicator test pile until it achieves the
nominal driving resistance and repeat the restrike procedure described above. If the
nominal driving resistance is still not obtained, pile driving shall stop immediately and
the Office of Geotechnical Services shall be notified.

A record of driving indicator test piles, which includes the number of hammer
blows per 1 ft for the entire driven length, the as-driven length, cutoff elevation,
penetration, and all other pertinent information will be kept by the Engineer. The
penetration resistance at various hammer strokes versus nominal driving resistance
relationship will be determined based on the driving of representative indicator test
piles.

370 If indicator piles are not shown on the plans, all piles shall be driven to the nominal
driving resistance and restriking is not required.

(b) Dynamic Pile Load Test

Dynamic monitoring will be performed for the purpose of obtaining the nominal
driving resistance, pile driving stresses, pile integrity, and pile driving system
performance. Dynamic monitoring will be conducted by PDA in accordance with
ASTM D4945. PDA will be performed on the first pile driven. The length of the pile
used in the dynamic pile load test shall be a minimum of 10 ft greater than the
estimated length of production piles in order to provide for variation in soil conditions.

380 The Contractor shall assist the Department in obtaining dynamic measurements with
the PDA during initial pile driving and during pile restrikes. If a static load test is
required, the dynamic pile load test shall be performed on the same pile as the pile
used in the static load test. The restrike for the dynamic pile load test on a static load
test pile shall be performed within 48 h of completion of the static load test.

1. Scheduling

The Contractor shall notify the Engineer at least seven calendar days before the
scheduled date of driving piles to be monitored by PDA. The Contractor shall confirm
the driving date three calendar days prior to the scheduled driving date. The Contractor
390 shall indicate at which foundation production pile driving is to begin. The Engineer
will provide final driving criteria for the indicated foundation first.

2. Dynamic Monitoring

The Contractor shall make the steel piles available so that the Engineer can
predrill the required instrument attachment holes prior to the Contractor placing the

701.05

pile in the leads. Each pile to be tested shall be instrumented with force and acceleration transducers provided by the Department. The Contractor shall install the transducers before striking the pile. The pile driving may have to be temporarily interrupted for the transducers to be adjusted or replaced, or for the monitoring results assessed.

Prior to placement in the leads, the Contractor shall make each designated concrete or timber pile available for taking of wave speed measurements and for predrilling the required instrument attachment holes. When wave speed measurements are made, the piling shall be in a horizontal position and not in contact with other piling. Predriving wave speed measurements will not be required for steel piles. The Contractor shall mount the instruments near the head of the pile after the pile is placed in the leads.

The Contractor shall drive the test pile to the minimum tip elevation and to the penetration depth at which the dynamic test equipment indicates that the nominal driving resistance shown on the plans and in accordance with 701.04(a) has been achieved. The Contractor may reduce the driving energy transmitted to the pile by using additional cushions or reducing the energy output of the hammer in order to maintain stresses below the values shown in 701.04(a)1. If non-axial driving is indicated by the dynamic test equipment measurements, the Contractor shall immediately realign the hammer system. Upon determination by the Engineer that valid data have been secured, the Contractor shall assist the Engineer with the removal of the instrumentation from the pile.

3. Restrike

The Contractor shall wait the specified minimum time period prior to the restriking of a dynamic load test pile. The Contractor shall assist the Engineer with reattachment of dynamic test instruments. The hammer shall be warmed up before restriking begins by applying at least 20 blows to another pile or other fixed object. The maximum amount of penetration required during restrike will be 3 in., or the total number of hammer blows will be 20, whichever occurs first. If the pile does not achieve the required nominal driving resistance during restrike, the Engineer will either accept the tip elevation or specify additional pile penetration and testing.

Once the restrike test for the test pile is complete, the Engineer will run CAPWAP analyses and will provide the final driving criteria within two business days of the restrike test. Production piles driven prior to receipt of the final driving criteria shall be done at the Contractor's risk. Final driving criteria for additional structures will be provided within two business days of the restrike test or, when multiple test piles are restruck the same day, at a rate of one substructure location per business day in the order requested by the Contractor.

4. PDA on Local Public Agency Contract

The Contractor shall perform the PDA in accordance with ASTM D4945. The firm conducting the PDA shall have at least one geotechnical engineer who shall have

achieved one of the following certification levels: intermediate, advanced, master, or expert, within the last three years through the Dynamic Measurement and Analyses Proficiency Test conducted by Pile Dynamics, Inc., and the Pile Driving Contractors Association. An engineer with a lower certification level can provide services so long as this individual is under the direct supervision of an engineer with intermediate certification level or higher. The Case Pile Wave Analysis Program, CAPWAP, shall be utilized to determine the as-built pile capacity from the PDA data. The first pile driven for each substructure unit shall be a PDA test pile. The pile driving criteria with the PDA and CAPWAP results shall be submitted to the Department's Office of Geotechnical Services for approval.

(c) Static Load Test

A static load test shall be conducted on a non-production test pile at the location shown on the plans. The test pile axial deflection in compression shall be verified by performing actual loading tests of the designated static load test pile in accordance with ASTM D1143, Quick Load Test Method, with loads applied by hydraulic jack. The test shall be continued until either plunging failure is achieved or the capacity of the loading system is reached. The nominal pile resistance will be determined from the settlement versus load curve generated by the incremental loading in accordance with 701.05(c)1.

The top elevation of all test piles shall be determined immediately after driving and again just before load testing to check for heave. A pile which heaves more than 1/4 in. shall be redriven, or jacked, to the original elevation prior to testing. The Contractor shall wait 36 h between the driving of a load test pile and the commencement of the load testing unless otherwise specified.

The Contractor shall provide complete protection at all times for the pile, supports, and reference beam from wind, direct sunlight, frost action, or other disturbances. The Contractor shall maintain an air temperature in the immediate vicinity of the test pile and reference beam of not less than 50°F and shall provide adequate lighting for the duration of the test.

No production piles shall be driven until completion of the static pile load test unless approved by the Engineer. Reaction piles shall be driven prior to driving the static load test pile.

1. Load Test Procedure

The Contractor shall furnish and construct a suitable reaction frame or load platform to provide a load on the pile having a capacity of 2,000 kips or 150% of the nominal driving resistance, whichever is less. A minimum of seven days prior to driving the static load test pile or construction of the reaction frame or load platform, the Contractor shall submit, for review and approval, detailed working drawings to scale for the reaction frame or load platform and loading apparatus including the distances between the load test pile and all reaction piles and reference beam supports. The submittal shall also include a proposed load test and reaction pile driving

sequence, a scaled profile drawing of the loading apparatus detailing the ground surface elevation, the pile cutoff elevation, and the dimensions and locations of all bearing plates, the jack, the load cell, the spherical bearing plate, and the reaction beam or platform. Working drawings for the reaction frame and loading apparatus shall be submitted in accordance with 105.02. The submittal shall include calibration certifications for the hydraulic jacks, load cell, pressure gauges, and hydraulic pumps conducted within 30 days of the load test. If required by the Engineer, the jack, load cell, and pressure gauge shall be recalibrated after the load test. The loading apparatus shall be constructed to allow the various increments of the load to be placed gradually, without causing vibration to the test pile. If the approved method requires the use of tension or reaction piles, the reaction piles, if feasible, shall be of the same type and dimensions as the production piles, and when possible shall be driven in the location of permanent piles. Reaction piles that are the same type and dimensions as the production piles and are driven in the location of permanent piles will be considered permanent piles. Timber or tapered piles installed in permanent locations shall not be used as tension piles. The primary method of determining the applied load shall be from a calibrated load cell. Incremental loads of 5% of the nominal driving resistance shall be placed on the pile at 5 minute intervals until continuous jacking is required to maintain the incremental load or the capacity of the load frame is reached. Support for the load test plates, jack, and ancillary devices shall be provided to prevent them from falling in the event of a release of load due to hydraulic failure, test pile failure, or other cause.

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The Contractor shall furnish the hydraulic pump, load cell, spherical bearing plate, and two reference beams. Each reference beam shall be a W or M section, of minimum length of 20 ft, and a weight of 5 to 20 lb/ft unless otherwise approved. The Engineer will conduct the static load test and will provide the gauges to measure movement of the test pile. The Contractor shall provide all assistance necessary to perform the static load test. The Contractor shall furnish and install telltale rods encased in a lubricated pipe in the test pile prior to the static load test.

If the nominal pile resistance of a pile from the load settlement curve does not equal or exceed the nominal driving resistance shown on the plans, the Contractor shall redrive the pile to an adequate nominal driving resistance. The increase in nominal driving resistance will be determined by PDA. The pile shall be load tested again after the appropriate waiting period. Load tests shall be repeated as many times as necessary until the pile carries the required load. The pile axial resistance will be determined from the test data in accordance with the Davisson Method as specified in the AASHTO LRFD Bridge Design Specifications.

2. Hydraulic Jacks, Pressure Gauges, and Load Cell

Hydraulic jacks and pressure gauges shall be used for the superimposed load. The jacks, pressure gauges, load cell, and hydraulic pumps shall be calibrated with each other within the last 30 days by an independent laboratory. When a jack, pressure gauge, load cell, and hydraulic pump are calibrated, they shall be calibrated and used as a unit. All calibration checks shall be within 5% of the applied load if calibrated as

a unit. Changing one of the four components shall require recalibration prior to use. Pressure gauges shall be a minimum of 4 1/2 in. in diameter with gradations in accordance with ASTM D1143. Hydraulic jacks shall have a nominal load capacity exceeding the maximum anticipated jack load by at least 20%. The jack, pump, and any hoses, pipes, fittings, gauges, or transducers used shall be rated to a safe pressure corresponding to the nominal jack capacity. The Contractor shall provide copies of the most recent calibration certification a minimum of five days prior to the static load test.

3. General Requirements

On completion of the static load test, a test pile or anchor pile which is not a part of the finished structure shall be removed or cut off at least 1 ft below either the bottom of footing or the finished ground elevation if not located within the footing area.

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550 701.07 Piling Length

The lengths of piles shown on the plans and in the Schedule of Pay Items are estimated lengths and are for bidding purposes only. The Contractor shall provide the actual length of piles necessary to obtain the nominal driving resistance and penetration depth required as determined from results obtained from driving representative test piles or other pertinent data. There will be expected variations in final tip elevations due to differences in nominal pile driving resistance. The final tip elevation of each pile will be determined during the driving operation. If minimum tip elevations are specified, the Contractor shall drive piles to a penetration depth that satisfies this requirement in addition to the nominal driving resistance. If no penetration depth or minimum tip elevation is specified, the pile shall be driven a minimum of 10 ft below the bottom of the footing elevation. The Contractor shall also furnish satisfactory evidence as to the identification, such as heat numbers for steel piles, of all portions of a built-up pile.

701.08 Nominal Driving Resistance of Production Piles

Production piles shall be driven the depth necessary to obtain the required nominal driving resistance as determined by 701.05. If a minimum pile tip elevation is shown on the plans, in addition to obtaining the required nominal driving resistance, production piles shall also be driven to the minimum pile tip elevation or to practical refusal.

When the nominal driving resistance is determined in accordance with 701.05(a), for acceptance, the Engineer will record, at a minimum, the number of hammer blows per inch or per foot of pile movement for the last 24 in. of driving. When the nominal driving resistance is determined in accordance with 701.05(b), for acceptance, the Engineer will record the blow count per inch or foot of pile movement and the associated hammer stroke for the last two consecutive feet of driving, and the final pile tip elevation as per the pile driving criteria established through the dynamic pile load test.

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Practical refusal will be defined as 20 blows per inch of penetration with the hammer operated at its maximum fuel or energy setting, or at a reduced fuel or energy setting recommended by the Engineer based on pile installation stress control and less than 1/4 in. rebound per blow. The Contractor shall stop driving as soon as the Engineer determines that the pile has reached practical refusal.

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The nominal driving resistance of jetted piles shall be based on impact driving penetration resistance after the jet pipes have been removed. Jetted piles not attaining the nominal driving resistance at the ordered length shall be spliced and driven with an impact hammer until the nominal driving resistance is achieved in accordance with the driving criteria in 701.05.

The required nominal driving resistance of piles driven with followers will only be considered acceptable if the piles with followers attain the same tip elevation as the full length piles driven without followers, installed in accordance with 701.04(c)5.

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The required nominal driving resistance of piles driven with vibratory hammers shall be based on the driving resistance recorded during impact driving after the vibratory equipment has been removed from the first pile in each group of 10 piles. Vibrated piles not attaining the nominal driving resistance at the ordered length shall be spliced and driven with an impact hammer until the nominal driving resistance is achieved in accordance with the driving criteria in 701.05. Once the nominal driving resistance is attained, the remaining nine piles in the group shall be installed to similar penetration depths with similar vibratory hammer power consumption and rate of penetration as the first pile.

701.09 Preparation and Driving

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For steel and timber piling, the pile heads shall be plane and perpendicular to the longitudinal axis of the pile before the helmet is attached. The pile heads shall be protected with a hammer cushion.

Precast concrete pile heads shall be flat, smooth, and perpendicular to the longitudinal axis of the pile. Prestressing strands shall be cut off below the surface of the end of the pile. The pile head shall be chamfered on all sides. The heads of all concrete piles shall be protected with a pile cushion.

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Approval of a pile hammer relative to driving stress damage will not relieve the Contractor of responsibility for piles damaged due to misalignment of the leads, failure of hammer cushion or cushion material, failure of splices, malfunctioning of the pile hammer, or improper construction methods. Piles damaged for such reasons will be rejected and shall be replaced if the Engineer determines that the damage impairs the strength of the pile.

(a) Pilot Holes

Pilot holes are prebored, predrilled, or cored. After a pile is driven thru a pilot

hole, all voids around the pile shall be filled with B borrow. Water shall be added to the hole to saturate the final placement of B borrow.

630 If the Engineer determines that preboring or predrilling has disturbed the nominal driving resistance of previously installed piles, those piles that have been disturbed shall be restored by means of re-driving or other approved remedial measures. Redriving or other remedial measures shall be instituted after the preboring or predrilling operations in the area have been completed.

1. Preboring

640 When shown on the plans, the Contractor shall prebore holes at the locations shown and to the depth specified. Prebored holes shall be 2 in. smaller than the diameter or diagonal of the pile cross section that is sufficient to allow penetration of the pile to the specified depth. If subsurface obstructions, such as boulders or rock layers, are encountered, the hole diameter may be increased to the least dimension which is adequate for pile installation.

Augering, wet-rotary drilling, spudding, or other methods of preboring shall be used only when specified or approved in writing by the Engineer. The procedures shall be carried out so as not to impair the nominal driving resistance of the piles already in place or the safety of existing adjacent structures.

650 Except for end bearing piles, preboring shall be stopped at least 5 ft above the pile tip elevation shown on the plans. The pile shall be driven with an impact hammer to the specified penetration resistance. Where piles are to be end-bearing on rock or hardpan, preboring may be carried to the surface of the rock or hardpan. The piles shall then be driven with an impact hammer to ensure proper seating.

2. Predrilling

The hole shall have a minimum diameter of not less than the greatest dimension of the pile cross section plus 4 in. The holes shall be drilled to the elevations shown on the plans.

660 Before driving piles for end bents, holes to receive piling shall be predrilled or spudded through new embankment to the original ground elevation if the new embankment is 10 ft or more in height. If the new embankment is less than 10 ft in height, predrilling is not required. If new embankment in the area of the end bents is to be constructed of sand, gravel, or other permeable material in which a predrilled hole would not remain open, the piling shall be driven before the embankment is constructed.

670 Pilot holes for end bent piles for structures with integral end bents shall be predrilled to the depth specified in the plans, regardless of the height of new embankment.

If pile sleeves are shown on the plans, the drilled holes shall be sleeved to maintain the opening during the driving of the piles.

If bentonite grout is shown on the plans, it shall be used to fill the annular space around the pile. The grout shall be placed at the depths shown on the plans or as directed. The entire annular space shall be filled from the bottom upwards to the top of the pile in one pumping operation using a tremie pipe.

680 Tremie pipe construction shall include side discharge ports. The tremie pipe can be terminated by means of a tee connection. Tremie pipe may be PVC, however, joints shall not be glued or cemented.

3. Cored Hole in Rock

When specified, holes shall be cored into rock to accommodate pile placement. The approach grade shall be completed before coring is begun. Holes of the diameter shown on the plans shall then be predrilled through the embankment into solid rock to the elevations shown on the plans or as otherwise directed. The piles shall be driven to practical refusal at the bottom of the cored holes. The holes in cored rock shall then be filled with concrete.

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(b) Location and Alignment Tolerance

A maximum deviation of 1 1/2 in. in any direction from the plan position will be allowed in pile trestle bents and exposed pile bents. A maximum deviation of 6 in. in any direction will be allowed for a foundation pile in footings for piers or abutments. The tendency of concrete or steel piles to twist or rotate shall be prevented and corrected. Piles to be swaybraced shall be aligned as necessary so that the swaybracing may be properly welded to the piles by a welder qualified in accordance with 711.32. No pile shall be closer than 4 in. from an edge of the pile cap. Pulling or pushing laterally on installed piles to correct misalignment, or splicing a properly aligned section on a misaligned section will not be allowed. The pile head at cutoff elevation shall be within 2 in. of plan elevation for bent caps supported by piles.

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Piles driven at integral end bents shall be installed so that the axial alignment of the top 10 ft of the pile is within 2% of the specified alignment.

Battered piles shall be installed so that the alignment of the top 10 ft of the pile does not vary by more than 3% from the batter rate shown on the plans.

710 If the location or alignment tolerances are exceeded, the extent of overloading shall be investigated. If the Engineer determines that corrective measures are necessary, such corrective measures shall be designed and constructed by the Contractor. Proposed corrective measures will be subject to approval by the Engineer.

(c) Heaved Piles

The Contractor shall take an elevation reading on each pile in a foundation immediately after each pile in that foundation has been driven and again after all piles in that foundation have been driven. Elevation readings for checking pile heave shall continue until the Engineer determines that such checking is no longer required. All

720 piles which have heaved more than 1/4 in. shall be redriven to the required resistance or penetration. If pile heave is detected for pipe piles, the piles shall be redriven to original position prior to filling with concrete. A hammer-pile cushion system shall be submitted and approved prior to redriving pipe piles which have been filled with concrete.

(d) Installation Sequence

730 The order of placing individual piles within a pile group shall begin from the center of the group and proceed outward in both directions unless an alternate installation sequence is approved in writing. For a bent with a single row of piles, pile driving shall begin at one end of the bent and proceed toward the opposite end.

(e) Inspection

The Engineer shall be given a minimum of 24 h notice before driving piling. No pile shall be driven except in the presence of the Engineer.

Prior to placing concrete in driven pipe piles, the Contractor shall supply suitable lighting for the inspection of each pipe pile by the Engineer throughout its entire length.

(f) Pouring Concrete

740 After all water and other foreign substances have been removed from the pipe piles and the final approval given, reinforcing bars, if specified, shall be placed, and the pipe piles shall be filled with class A concrete in the presence of the Engineer. Concrete shall be deposited into pipe piles in a stream with a cross-sectional area that is no more than approximately 50% of the area of the pipe pile to prevent air pockets from forming. At a minimum, concrete shall be vibrated in the upper 25 ft of the pipe piles. Concrete shall not be placed in pipe piles until all pile driving has progressed beyond a radius of 15 ft from the pile to be filled. All pile driving within the above limits shall be discontinued until the concrete in the last pile cast has cured for a minimum of 48 h.

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701.10 Unsatisfactory Piles

The method used in driving piles shall not subject the piles to excessive or undue abuse which produces deformation of the steel, injurious splitting, splintering, and brooming of the wood, or crushing and spalling of the concrete. All piles damaged during driving due to internal defects, improper driving, being driven out of its proper location, or being driven below the designated cutoff elevation shall be corrected as directed.

760 Piles which have been bent, or otherwise damaged, during installation shall be considered unsatisfactory unless the nominal driving resistance is proven by load tests performed by the Contractor. If such tests indicate inadequate pile resistance, corrective measures such as the use of the bent piles at reduced pile resistance, installation of additional piles, strengthening of the bent piles, or replacement of the bent piles shall be done as approved by the Engineer.

701.11

A concrete pile will be considered defective if a visible crack appears around the entire periphery of the pile or if a defect is observed, as determined by the Engineer.

701.11 Splicing Piles

770 Full length piles shall be placed in the leads if practical. However, if splicing is necessary, the following methods shall be used.

(a) Steel Piles

780 Splicing of steel piles shall be made as shown on the plans. The top of the pile to be extended shall be restored to its original cross section shape. The mating end of the other pile shall be beveled as shown on the plans. A wire brush or grinder shall be used to remove any scale, dirt, slag, or other foreign material that is detrimental to fabricating a sound weld from all surfaces to be welded. For H piles, a mechanical splice shall not be used within 20 ft of the ground surface unless it is proven that the splice can transfer the full pile strength in compression, tension, and bending. Splices for pipe piles shall be watertight. All work shall be done with approved methods and materials and by welders qualified in accordance with 711.32. If the temperature of the piles is below 50°F, both piles to be spliced shall be preheated to a minimum temperature of 70°F in the vicinity of the splice immediately prior to welding. The temperature of the piles shall be maintained at a minimum of 50°F until the welding is complete. There shall not be more than two splices exposed to view in each length of piling after driving is completed. A mechanical splice shall not be used in integral end bents.

790 **(b) Timber Piles**

Timber piles shall not be spliced.

(c) Concrete Piles

Full length concrete piles shall be used where practical. If splicing is necessary, concrete splice details shall conform to the contract documents. Mechanical splices including drive-fit splices may also be used if the splice can transfer the full pile strength in compression, tension and bending.

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701.13 Cut-Off Lengths

The tops of all steel pile shall be cut off at the elevation shown on the plans. All unused cut-off lengths shall become the property of the Contractor and shall be removed from the project site.

The length of timber pile above the elevation of cut-off shall be sufficient to enable the complete removal of all material injured by driving. Immediately after making final cut-off on treated timber foundation piles, the cut area shall be treated with copper naphthenate in accordance with AWWA Standard M4.

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Timber piling supporting timber structures where the piles are cut off, but not concrete capped, shall be treated with copper naphthenate in accordance with AWWA

Standard M4. A layer of saturated building felt or fiberglass cloth which overlaps the side of the pile at least 2 in. shall be securely fastened and completely covered with 20 gauge thick galvanized metal or aluminum sheeting. All cuts, injuries, and holes, which occur from removal of nails or spikes that penetrate the treating zone as well as bolt holes for connections, shall be treated by applying coal-tar roof cement in accordance with ASTM D5643.

820 **701.14 Method of Measurement**

The driven length of treated timber piles, untreated timber piles, steel pipe piles, steel H piles, and concrete piles will be measured by the linear foot to the nearest 0.1 ft. This includes piles used as indicator test piles, dynamic test piles, or static load test piles. Measurement will be made only for the actual number of linear feet of piling complete in place. For concrete piles, this length will not include extensions or the portion of the pile cutoff to make the extension.

Dynamic pile load test, static pile load test, indicator test pile restrrike, dynamic test pile restrrike, pile shoes, and conical pile tips will be measured per each.

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The limits of the epoxy coated steel pipe portion of the pile will be measured by the linear foot to the nearest 0.1 ft as shown on the plans.

Prebored holes and cored holes in rock will be measured by the linear foot complete in place of the diameter specified.

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Class A concrete, reinforcing bars, epoxy coating, reaction piles if not used as production piles, splices, end plates, predrilling, cleaning of drilled holes, drilling fluids, sealing materials, casing, jetting, followers, spudding, or other methods used to facilitating pile driving will not be measured for payment.

Reinforced concrete encasement for steel H piles will be measured by the linear foot as shown on the plans.

701.15 Basis of Payment

All treated timber piles, untreated timber piles, steel pipe piles, steel H piles, and concrete piles driven will be paid for by the linear foot. Payment will be made only for the actual number of linear feet of piling complete in place. Extensions for concrete piles will be paid for in accordance with 109.05.

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Driven piles used as indicator test piles or dynamic test piles that are left in place and subsequently used as production piles will be paid for by the linear foot as either production indicator test piles or production dynamic test piles. Reaction piles used in a static pile load test that are left in place and subsequently used as a production pile will be paid for by the linear foot as the type of production pile they represent. Driven piles used as indicator test piles, dynamic test piles, or static load test piles that are not used as production piles will be paid for by the linear foot as non-production dynamic, indicator, or static test piles respectively.

860 If the quantity of driven piling is less than the plan quantity or the quantity as ordered by the Engineer, the Department will pay 50% of the cost to re-stock unused piling if the Contractor elects to re-stock piling and provides a paid invoice showing the re-stocking fee. Payment will be made for piling, restock.

The epoxy coated portion of the piles may be furnished and driven at lengths greater than those shown on the plans. These additional lengths of epoxy coated piles left in place and accepted will be paid for as the uncoated portion below the plan limits of required epoxy coating.

870 Prebored holes and cored holes in rock will be paid for at the contract price in linear feet.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Conical Pile Tip, _____ pile size	EACH
880	Cored Hole in Rock, _____ in. diameter	LFT
	Dynamic Pile Load Test	EACH
	Pile Shoe, _____ pile size	EACH
	Pile, Concrete _____ x _____ size	LFT
	Pile, Prestressed Concrete _____ x _____ size	LFT
	Pile, Steel H, Epoxy Coated, HP _____ x _____ size	LFT
890	Pile, Steel H, HP _____ x _____ size	LFT
	Pile, Steel Pipe, _____, _____ pipe wall thickness diameter	LFT
	Pile, Steel Pipe, Epoxy Coated, _____, _____ pipe wall thickness diameter	LFT
	Pile, Timber	LFT
	Pile, Timber, Treated	LFT
	Piling, Restock	LS
900	Prebored Hole, _____ in. diameter	LFT
	Reinforced Concrete Encasement for H Piles	LFT
	Static Pile Load Test, _____ pile size	EACH
	Test Pile, Dynamic, _____, Non-Production pile size	LFT

702.01

thicker walled pipe piles than specified.

An increase in the size of a pile cap to satisfy edge distance clearance requirements, when approved, shall be at no additional cost to the Department.

If the method for driving the piles is specified as 701.05(b) and the contract is a local public agency contract, the Contractor shall include the cost of acquiring the PDA consultant in the cost of the Dynamic Pile Load Test.

The cost of mobilization and demobilization for pile driving operations shall be included in the cost of mobilization and demobilization in accordance with 110.04.

The cost to control sediment in water from jetting operations shall be included in the cost of the piling.

The cost of forms, falsework, class A concrete, reinforcing bars, and necessary incidentals shall be included in the cost of reinforced concrete encasement for H piles.

SECTION 702 – STRUCTURAL CONCRETE

702.01 Description

This work shall consist of furnishing and placing portland cement concrete for structures and incidental construction in accordance with 105.03.

702.02 Classes of Concrete

The following classes of concrete shall be used where specified.

Class of Concrete	A	B	C
Cement content in lb/cu yd	564	470	658
Maximum water/cement ratio in lb of water per lb of cement	0.450	0.620	0.443
Minimum water/cement ratio in lb of water per lb of cement*	0.380	0.400	0.380
* The minimum water/cement ratio for all slipformed railings shall be 0.360.			

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Unless specified otherwise, the concrete used shall be class A. When class A is specified, class C may be used as a substitution. When class B is specified, class A or class C may be used as a substitution.

Concrete in superstructure, integral bents, and railings shall be class C. Concrete in bent caps, unless poured integrally with the superstructure; pier caps; abutment caps; pier stems; abutment walls; mudwalls; columns; crashwalls; collision walls; and wingwalls, unless poured with integral end bents, shall be class A. Concrete in footings shall be class B.

20

MATERIALS

702.03 Materials

Materials shall be in accordance with the following:

	Admixtures for Use in Concrete.....	912.03
	Castings	910.05
	Concrete Coarse Aggregate	
	For exposed concrete, Class A or Higher.....	ITM 226, 904
30	For non-exposed concrete, Class B or Higher.....	ITM 226, 904
	Curing Materials.....	912.01
	Curing-Sealing Materials.....	912.02
	Elastomeric Bearings.....	915.04
	Fabric for Waterproofing.....	918.06
	Fine Aggregate Size No. 23.....	904
	Fly Ash.....	901.02
	Geotextile for Use With Underdrains.....	918.03
	Ground Granulated Blast Furnace Slag	901.03
	High Density Bearing Strips.....	906.08
40	Permanent Metal Forms	910.03
	Polychloroprene Joint Membrane and Adhesive.....	906.02(a)4
	Preformed Expansion Joint Filler.....	906.03
	Portland Cement.....	901.01(b)
	Silica Fume.....	901.04
	Slag Cement	901.03
	Utility Asphalt, UA-1	902.01(d)
	Water	913.01

Drainage pipe through concrete masonry shall be in accordance with 715.

Grout material for field drilled holes shall be either a high-strength, non-shrink, non-metallic, cementitious grout in accordance with U.S. Army Corps of Engineers Specification CRD-C 621 or from the QPL of Chemical Anchor Systems.

702.04 Shipping and Storage

The cement shall be well protected from rain and moisture. All cement damaged by moisture or which fails to meet the specified requirements shall be rejected and removed from the work. Cement stored for a period longer than 60 days shall be retested before being used on the work. Cement of different brands, types, or from different mills shall be stored separately.

CONSTRUCTION REQUIREMENTS

702.05 Proportioning

Control of PCC for air content, slump, or relative yield will be determined on the basis of tests performed by the Engineer. Concrete and necessary labor for sampling

shall be furnished by the Contractor as required by the Engineer. Testing will be in accordance with the Frequency Manual.

- 70 A CMDS shall be submitted seven calendar days prior to production and be approved by the Engineer on the Department provided spreadsheet. The absolute volume of the mix design shall be 27.0 cu ft at the design air content of 6.5%.

The aggregate blend submitted on the CMDS shall produce an optimized aggregate gradation in accordance with ITM 226 sections 6.2.1 and 6.3. The aggregate blend shall consist of, at a minimum, one concrete coarse aggregate and one fine aggregate, No. 23. One additional class A or higher for exposed or class B or higher for non-exposed intermediate-sized coarse aggregate may be included if approved by the Engineer.

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The proportion of ingredients of each batch shall be within the following limits, and shall be approved.

The relative yield of the concrete shall be determined in accordance with 505. The concrete when produced shall provide a relative yield of 1.00 ± 0.02 . When the relative yield is outside the tolerances, adjustments to the batch weights shall be made. The minimum amount of cement shall be used for the desired class of concrete. The cement content shall not be increased more than 60 lb/cu yd. The relative yield of the concrete shall be maintained as stated above. If type IP or type IP-A cements are to be used in the structural concrete, the cement content shall be increased by a multiplier of 1.06 times the minimum amount of cement required or the desired increased cement content for the specified class of concrete.

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For example: $1.06 \times 564 = 598$ lb/cu yd for class A concrete.

- 100 Fly ash from a qualified source may be used as a partial replacement for portland cement. The substitution of fly ash for portland cement will not be allowed in conjunction with the use of ground granulated blast furnace slag or blended cement types IP, IP-A, IS, or IS-A. Mix designs will be based on using a maximum 20% cement reduction with a minimum 1.25:1 ash-to-cement replacement ratio, by weight.

Ground granulated blast furnace slag from a qualified source may be used as a partial replacement for portland cement. The substitution of ground granulated blast furnace slag for portland cement will not be allowed in conjunction with the use of blended cement types IP, IP-A, IS, or IS-A or fly ash. Mix designs will be based on using a maximum 30% cement substitution with a 1:1 slag-to-cement ratio, by weight.

Slag cement or silica fume in accordance with 709.05(c) shall be used in all bridge decks, reinforced concrete bridge approaches, and terminal joint lugs.

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Blended portland pozzolan cements, fly ash, and slag cement may be used in concrete when the ambient temperature is above 50°F during the entire placement

period. Immediately following placement, the average ambient temperature shall be above 50°F for the entire curing period. The average temperature shall be calculated based on hourly temperature measurements taken at the jobsite or from published weather station data within 10 miles of the jobsite. If the temperature restrictions are not met during placement or during the required curing period, curing shall continue and the element shall not be put into service until the strength requirements in accordance with 702.24 are met. If no test specimens are available to determine the concrete strength, curing shall continue and the concrete will be adjudicated as failed material. In no case shall the curing period be reduced below the minimum number of days specified for the element.

All concrete shall have an air content of $6.5\% \pm 1.5\%$ by volume. Air content shall be determined in accordance with 505.

Powdered admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, and all shall be within 3% of the amount required. When admixtures are used in small quantities in proportion to the cement, as is the case for air-entraining admixtures, mechanical dispensing equipment shall be provided.

Class A concrete shall contain a water-reducing admixture. Class C concrete shall contain either a water-reducing admixture or both a water-reducing admixture and a retarding admixture. The types used shall not be changed during any individual contiguous pour. For class C concrete, the types of admixtures to be used shall be selected based on the expected concrete or air temperature. When either temperature is expected to be 65°F or above, both a water-reducing admixture and a retarding admixture shall be used. A water-reducing admixture shall be used when both temperatures are expected to be below 65°F unless retardation is required due to the structure design or the proposed pour sequence such as the requirements for floor slab pours set out in 704.04. If class C concrete contains ground granulated blast furnace slag, the producer may propose an alternate temperature threshold for including a retarding admixture. If either class A concrete or class C concrete is used in slipformed railings, the requirement to use a water reducing admixture is waived. Air-entraining cements will not be allowed in class C concrete.

The manufacturer's data, which relates recommended addition rates to ambient temperatures, shall be furnished. The proposed addition rates and adjustments to the rates, as conditions require, will be reviewed for approval using this data and the anticipated temperature. The addition rate shall not be reduced below the minimum rate recommended by the manufacturer, regardless of the concrete or air temperature. The air entraining admixture and water-reducing retarding admixture shall be added to the batch separately. The method and equipment for adding water-reducing retarding admixture shall be as approved.

If the contract requires stay-in-place metal forms for the bridge deck or if the Contractor elects to use such forms, the bridge deck concrete shall incorporate class AP coarse aggregate instead of class A.

160 702.06 Measuring and Batching

Unless otherwise specified, the minimum batch shall be 2 cu yds. Measuring and batching of materials shall be done at a batching plant. Different kinds or sources of coarse aggregate or different brands of cement shall not be used in any unit of the structure except in an emergency and then only by written permission.

(a) Portland Cement

170 Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed. All bulk cement shall be weighed on an approved weighing device. The bulk cement weighing hopper shall be sealed and vented to preclude dusting during operation. The discharge chute shall not be suspended from the weighing hopper and shall be so arranged that cement does not lodge in it or leak from it. Accuracy of batching shall be $\pm 1\%$ of the required weight.

If fly ash is used as a pozzolan in portland cement concrete, the cement and fly ash shall be weighed and discharged separately when a manual operation is utilized. When an automatic batching plant is utilized, the fly ash may be weighed into the cement weigh hopper in one cumulative operation with the portland cement always being weighed in first.

180 (b) Water

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within 1% of the required amount.

(c) Aggregates

190 The batch plant site, layout, equipment, and provisions for transporting material shall be such as to assure a continuous supply of reasonably uniform material to the work. Aggregate stockpiles shall be located in areas sufficiently well drained to prevent the dirt underneath from becoming softened and pumping into the aggregate to a level from which the aggregate is to be removed and used in the work. Stockpiles shall be built in layers not to exceed 6 ft in depth. Upper layers shall be prevented from spilling over the sides of the layers below.

The removal of aggregates from stockpiles shall be done in such a manner that segregation will not occur. Aggregate which has become mixed with dirt shall not be used in the work.

200 Washed aggregates shall drain for at least 12 h prior to use. An increase in the drainage time may be required, as directed, at any time when the moisture becomes non-uniform in aggregates from any source. Aggregates from different sources shall not be stockpiled together without written approval.

Batching shall be conducted so as to obtain the weights of materials required within a tolerance of $\pm 2\%$.

(d) Bins and Scales

The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and scale for cement shall be included. If fly ash is used, the separation of cement and fly ash bins will be as approved. Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.

Means of control shall be provided so that as the quantity required in the weighing hopper is approached the material may be added slowly and shut off with precision. A port or other opening for removing an overload from the hopper shall be provided. A port for sampling cement shall be provided and may be either the overload port or a separate port located at any point from the bottom of the storage bin to the weigh hopper. The sampling port shall be located and constructed so as to provide a representative sample of the cement being used. Weighing hoppers shall be constructed so as to eliminate accumulation of tare materials and to discharge fully.

For applied loads of 1,000 lb and greater on the cement scale and applied loads of 4,000 lb and greater on the aggregate scale, the scales shall be accurate to 0.5%. For applied loads of less than 1,000 lb and 4,000 lb for the cement and aggregate scales, respectively, the scales shall be accurate to 2.0% or one graduation, whichever is larger. Poises shall be designed to be locked in any position to prevent unauthorized change of position. Scales will be inspected as often as necessary to ensure their continued accuracy. No less than ten 50 lb weights shall be provided at all times for testing of scales.

Batching plants may be equipped with approved automatic weighing devices to proportion aggregates and bulk cement.

(e) Batching

When batches are hauled to the mixer, bulk cement shall be transported either in waterproof compartments or between the fine and coarse aggregates. When cement is placed in contact with the aggregates, batches may be rejected unless mixed within 1 1/2 h of such contact. Sacked cement may be transported on top of the aggregates.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer without loss and, when more than one batch is carried on the truck, without spillage of material from one batch compartment into another.

702.07 Mixing

Concrete may be mixed at the site of construction, at a central point, or wholly or in part in truck mixers. Retempering concrete by adding water or by other means will not be allowed after initial set. When concrete is delivered in transit mixers, additional water may be added occasionally to increase the slump, if allowed, and additional mixing shall be performed as directed and all operations completed within the time limits in accordance with 702.09(c). The amount of water added shall be determined

702.08

accurately and noted on the batch ticket. Such addition of water will not be allowed as a continuing operation. The total of all water included in the mix shall not exceed the maximum in accordance with 702.02.

Concrete that is outside the specified slump limits at time of placement shall not be used. Except as required in 702.05 for class A and class C concrete, chemical admixtures type A, type B, type D, type F, and type G, may be used in the concrete. Chemical admixtures type C and type E will be allowed only with prior written permission.

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702.08 Mixing at Site of Work

For concrete to be acceptable, not more than 1 h shall elapse from the time mixing water has entered the mixer until the mixed batch is deposited into the forms.

The concrete shall be mixed in an approved batch mixer which has a rated capacity of not less than 188 lb except for pours of 20 cu yds or less, or where otherwise specified, a 94 lb minimum capacity mixer may be used. Mixers shall ensure a uniform distribution of ingredients throughout the mass. No mixer shall be operated beyond its factory rated capacity.

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The concrete shall be mixed no less than 60 s after all ingredients, including water, are in the mixer.

During the period of mixing the drum shall rotate at the speed for which it was designed, which shall be no less than 14 and no more than 20 revolutions per minute. If this procedure does not mix the concrete thoroughly, a sufficient additional number of turn at the same rate shall be made until a thorough mixing of the ingredients is obtained.

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The mixer shall be equipped with a batch meter for counting the number of batches discharged and a timer for automatically locking the discharge chute to prevent emptying the mixer prior to the specified minimum mixing time. Mixers shall be equipped with mechanical means for preventing the addition of ingredients, including water, after mixing is started. The first batch shall contain an additional quantity of cement, fine aggregate, and water sufficient to coat the inside surface of the drum in order to avoid diminishing the mortar content of the initial batch. The entire contents of the drum shall be removed before the materials for the next batch are introduced. Upon cessation of mixing for any considerable time, the drum shall be cleaned thoroughly.

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Structural concrete shall be mixed only in such quantities as are required for immediate use and shall be placed while fresh before initial set has occurred. Hand mixing will not be allowed except in an emergency and then only with permission. Hand mixing shall be done on a watertight platform in such manner and so continued to ensure a homogeneous mixture of the required consistency. Hand mixed batches shall not exceed 1/2 cu yd in volume.

702.09 Ready-Mixed Concrete

300 (a) General Requirements

Ready-mixed concrete shall be mixed and delivered by means of one of the following operations:

1. Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck-agitator or truck-mixer at agitating speed or in approved non-agitating equipment in accordance with 702.09(d). Concrete delivered under these provisions shall be known as central-mixed concrete.
- 310 2. Mixed partially in a stationary mixer and the mixing completed in a truck-mixer. Concrete delivered under these provisions shall be known as shrink-mixed concrete.
3. Mixed completely in a truck-mixer. Concrete delivered under these conditions shall be known as transit-mixed concrete.

320 The source of ready-mixed concrete shall be approved prior to delivery of the concrete. This approval will be based on the capacity and condition of the equipment, volume of production, and length of haul, with consideration of the use of the concrete. Original approval will not constitute continued approval if satisfactory concrete or rate of delivery is not maintained.

Approval may be refused or previous approval may be withdrawn for a truck mixer or for a part of equipment not functioning in such manner as to produce and deliver uniform concrete to the site of the work at a uniform rate.

330 Before a pour is started, the number of trucks to be assigned to the work, the rate of production, and all other conditions necessary for furnishing satisfactory concrete shall be subject to approval. Such assigned equipment shall be in satisfactory operating condition prior to the start of the pour. Once assigned to a pour, equipment shall not be diverted for another purpose without approval.

(b) Mixers and Agitators

Mixers and agitators shall be in accordance with the following:

- 340 1. Mixers may be stationary mixers or truck-mixers. Agitators may be truck-mixers or truck-agitators. Each mixer and agitator shall have attached to it in a prominent place a metal plate or plates on which are plainly marked, for the various uses for which the equipment is designed, the

- capacity of the drum or container in terms of the volume of mixed concrete, the speed of rotation of the mixing drum, and manufacturer's name and address. Stationary mixers shall be equipped with an acceptable timing device which does not enable the batch to be discharged until the specified mixing time has elapsed. Truck-mixers shall be equipped with means by which the number of revolutions of the drum may be verified readily. The counters shall be actuated at the time of starting mixing at mixing speed.
- 350
2. The mixer, when loaded to the manufacturer's rated capacity without overload, shall be capable of combining the ingredients of the concrete within the specified time into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity in accordance with requirement 4 of 702.09(b).
- 360
3. The agitator, when loaded to the manufacturer's rated capacity without overload, shall be capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity in accordance with requirement 4 of 702.09(b).
- 370
4. Slump tests may be made of individual samples taken when discharged at approximately the one-quarter and three-quarter points of each load. If the slumps differ by more than 1 in. when the average slump is 3 in. or less, or by more than 2 in. when the average slump is greater than 3 in., the mixer or agitator shall not be used until conditions are corrected, except as set out in requirement 5 of 702.09(b).
5. Use of equipment may be allowed when operations with a longer mixing time or with a smaller load will enable the requirements in requirement 4 of 702.09(b) to be met.
- 380
6. Mixers and agitators shall be examined daily for changes in conditions due to the accumulations of hardened concrete or mortar or to wear of blades. When such change of conditions is found, the tests described in requirement 4 of 702.09(b) shall be repeated.

(c) Mixing and Delivery

Mixers and agitators shall be operated within the limits of the capacity and speed of rotations designated by the manufacturer. The following shall apply in fulfilling these requirements.

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1. The complete mixing time for a stationary mixer shall be no less than 60 s. Mixing time shall be measured from the time all cement and aggregates are in the drum. The batch shall be so charged into the mixer that some of the water enters in advance of the cement and aggregates. All required water shall be in the drum by the end of the first quarter of the specified mixing time.

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2. If a stationary mixer is used for shrink mixing, the time in the stationary mixer may be reduced to the minimum required to intermingle the ingredients, or approximately 30 s. Mixing shall then be completed in a truck-mixer by no less than 50 and no more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. Additional mixing, if required, shall be at the speed designated by the manufacturer as agitating speed.

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3. If the concrete is mixed in a truck-mixer loaded to its rated capacity, the number of revolutions of the drum or blades at mixing speed shall be no less than 70 and no more than 100, but not less than that recommended by the mixer manufacturer.

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4. If a truck-mixer or truck-agitator is used for transporting concrete that has been completely mixed in a stationary mixer, further mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

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5. If a truck-mixer or truck-agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and its discharge completed within 90 minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of cement to the aggregates, unless a shorter time is otherwise specified. When a truck-mixer is used for the complete mixing of the concrete, the mixing operations shall begin within 30 minutes after the cement has been added to the aggregates.

6. When authorized, a truck-mixer may be charged with aggregates and water at the batching plant and with bagged cement at the point of delivery, provided the truck-mixer is then operated at mixing speed for the required additional revolutions and satisfactory concrete is produced.

702.10

7. For truck-mixers, wash water shall not be used as a portion of the mixing water for succeeding batches.

440 **(d) Non-Agitating Equipment**

Central mixed concrete may be transported from the mixing plant to the place of use in non-agitating equipment when and as approved. The following shall apply in fulfilling these requirements.

1. Bodies of non-agitating equipment shall be smooth, watertight, metal containers equipped with gates that enable control of the discharge of the concrete. Covers shall be provided for protection of the concrete when required.
- 450 2. The concrete shall be delivered to the site of the work in a thoroughly mixed and uniform mass and discharged with the degree of uniformity in accordance with requirement 3 of 702.09(d). Discharge shall be completed within 30 minutes after the introduction of the mixing water to the cement and aggregates.
- 460 3. Slump tests shall be taken in accordance with requirement 4 of 702.09(b). If the slump differs by more than these tolerances the non-agitating equipment shall not be used until the conditions are corrected in accordance with requirement 4 of 702.09(d).
- 470 4. If the requirements of requirement 3 of 702.09(d) are not met when the non-agitating equipment is operated at minimum capacity for the maximum time of haul and with the concrete mixed the minimum time, the equipment may still be used when operated using smaller loads, shorter hauls, or longer mixing times, or combinations thereof, which enables the requirements in requirement 3 of 702.09(d) to be met.

702.10 Pumping Concrete

480 If the Contractor elects to convey concrete by means of pumping, the concrete shall be handled so as to minimize disturbance to the concrete which significantly alters the properties of the concrete being pumped, especially the loss or variability of the air content. The pumping equipment shall be mechanically sound, suitable in kind, and adequate in capacity for the proposed work. The concrete shall not be pumped through aluminum or aluminum alloy pipe. All pipes used for pumping concrete shall be kept clean and free from coatings of hardened concrete. Pump lines shall not rest directly on epoxy coated reinforcing bars. The pumping equipment shall be located such that operational vibrations will not damage freshly placed concrete.

When placing concrete directly from a truck mounted boom, the concrete pump lines shall have a flexible end section at least 10 ft long. Methods of placement shall be such as to result in a steady and continuous discharge. If necessary, this may require the use of a restrictive device at or near the end of the discharge tube, the laying the flexible end section horizontally, or other means. For the initial placement of concrete pours which are predominantly vertical, the discharge end of the flexible end section shall be within 2 ft of the bottom of the pour.

The Contractor shall submit a description of the pumping procedures which it intends to use, and shall notify the Engineer as to the pumping procedure at least 24 h in advance of concrete placement.

702.11 Cold Weather Concrete

When it is necessary to place concrete at or below an atmospheric temperature of 40°F, or whenever it is determined that the temperature may fall below 40°F within the curing period, the water, aggregates, or both shall be heated and suitable enclosures and heating devices provided. Cold weather concrete shall be placed at the risk of the Contractor and shall be removed and replaced with no additional payment if it becomes frozen or otherwise damaged.

When aggregates or water are heated, the resulting concrete shall have a temperature of at least 50°F and not more than 80°F at the time of placing. Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. The equipment shall be capable of heating the materials uniformly. Neither aggregates nor water used for mixing shall be heated to a temperature exceeding 150°F. When aggregates or water are heated to 100°F or above, they shall be combined first in the mixer before the cement is added. The maximum temperature of concrete produced with heated aggregates shall be 90°F. Materials containing frost or lumps of frozen material shall not be used.

Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. However, a drier may be used if approved.

When aggregates are heated in bins, steam-coil heating, water-coil heating, or other methods which are not detrimental to the aggregates may be used. The use of salt or other chemicals to accelerate hardening of the concrete will not be allowed unless approved in writing.

Immediately after a pour is completed, the freshly poured concrete and forms shall be covered so as to form a complete protective enclosure around the element being poured. If the element is a bridge deck, the enclosure shall encompass the top, bottom, and all sides. The air within the entire enclosure shall be maintained at a temperature above 50°F for a minimum of 144 h for bridge decks, the top surface of reinforced concrete slab bridges, and for a minimum of 72 h for all other concrete. If for any

530 reason this minimum temperature is not maintained, the heating period shall be extended. When dry heat is used, means shall be provided to maintain adequate moisture in the air within the enclosure.

All necessary measures shall be taken during protective heating to keep the heating equipment in continuous operation and to ensure maintenance of the proper temperature around all sides, top and bottom of the concrete. Adequate fire protection shall be provided where heating is in progress and such protection shall be accessible at all times.

540 Where practicable, forms insulated with at least 2 in. thick blankets made of fiberglass, rock wool, balsam wool, or similar commercial material capable of maintaining the surface of the concrete at no less than 50°F may be used in lieu of other protection of concrete involving housing and heating. When forms are insulated, exposed horizontal surfaces shall be protected with a similar layer of the insulating material fastened securely in place. If the insulated forms do not maintain the proper temperature at the surface of the concrete, auxiliary protection and heat shall be used.

702.12 Consistency

550 Slump will be measured in accordance with 505 and shall be no less than 1 in. and no more than 6 in. except for concrete placed in foundation seals.

702.13 Forms

(a) Construction

Forms shall be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations, including vibration. Forms shall be constructed and maintained so as to prevent the opening of joints due to shrinkage of the lumber.

560 Unless otherwise provided, all forms for exposed surfaces except the undersides of girders, slabs, and arch rings shall be lined with approved plywood, metal, or similar satisfactory composition. The lining shall not be sprung into place. Before concrete is placed, all open joints shall be filled with a satisfactory filler which is impervious to moisture, does not stain or otherwise injure the concrete, and produces a tight joint. The lining shall present a smooth uniform surface. Lining of sufficient thickness to resist the pressure of the concrete without deflection may be applied directly to the studding if it otherwise complies with the foregoing provisions for form lining.

570 In designing forms, fresh concrete shall be considered as a liquid weighing 150 lb/cu ft for vertical loads and 100 lb/cu ft for horizontal pressure. A live load allowance of 50 lb/sq ft shall be used on horizontal projections of surfaces. The scheme of formwork for work on a span over active railroad tracks shall provide a horizontal clearance of not less than 8 ft from the centerline of track and a clearance height of not less than 22 ft from the top of the track rail.

Spreader blocks and bracing shall be removed from the inside of forms before concrete is placed and a portion of wood shall not be left in the concrete.

580 Forms for exposed concrete edges shall be chamfered 3/4 in. Forms shall be given a bevel or draft in the case of all projections, such as girders and copings, to ensure easy removal.

(b) Ties

Approved ties or anchorages within the forms shall be so constructed as to enable their removal to a depth of at least 1 in. from the face without injury to the concrete. Ties may be metal or fiberglass. Ties shall be capable of supporting the designed loads. Fiberglass ties shall be ground flush with the face of the concrete surfaces. The cavities shall be filled with cement mortar and the surface left sound, smooth, even, and uniform in color. Filling of the cavities will not be required between the fascia beams or girders on the underside of decks, the bottom surface of slab decks, or the bottom 590 deck surface of box culverts. In general, tie rods shall be designed to also act as struts or spreaders. The use of wood struts will not be allowed in copings, railings, and walls less than 2 ft thick. Devices which, when removed, leave an opening entirely through the concrete will not be allowed unless approved in writing. Wire ties shall not be used.

(c) Walls

Where the bottom of the forms is inaccessible, the lower form boards shall be left loose or other provisions made so that extraneous material may be removed from the forms immediately before placing the concrete.

600

(d) Surface Treatment

All forms shall be treated with a formulated form coating that allows them to be released without adhering, discoloring, or otherwise damaging the concrete.

(e) Metal Forms

1. Removable

610 The specifications for forms as they regard design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, re-use, and oiling apply to metal forms. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms together rigidly and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

2. Permanent

620 Fabricated permanent metal forms for concrete deck slabs may be used as an alternate method of forming on a steel beam, steel girder, prestressed concrete I-beam, prestressed concrete spread box beam, or prestressed concrete bulb-T beam bridge.

Permanent metal forms shall not be removed and shall otherwise be in accordance with the applicable requirements of this section.

630 The metal forms shall be designed on the basis of dead load of form, reinforcing bars, and plastic concrete plus 50 lb/sq ft for construction loads. The unit working stress in the steel sheet shall be not more than 0.725 of the specified minimum yield strength of the material furnished but not to exceed 36,000 psi. Deflection under the weight of the forms, the plastic concrete, and reinforcing bars shall not exceed 1/180 of the form span or 1/2 in., whichever is less. However, the deflection loading shall not be less than 120 lb/sq ft total. The allowable form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits. The design span of the form sheets shall be the clear span of the form plus 2 in. measured parallel to the form flutes. If the design span of the form sheets exceeds 9.5 ft, concrete will not be allowed to be placed in the valleys of the corrugations of the metal forms. Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specifications for the Design of Cold Formed Steel Structural Members.

640 All reinforcing bars shall have a minimum clearance of 1 in. from the forms. The plan dimensions from the top surface for all primary deck reinforcing bars shall be maintained. The deck reinforcing bars shall be tied down at a maximum of 6 ft centers. Permanent metal forms shall not remain in place closer than 1 ft from any joint exposed to the underside of the slab, except when an overlay is used on the deck.

650 Fabricator's working drawings shall be submitted for approval. These drawings shall indicate the grade of steel and the physical and section properties for all permanent metal bridge deck form sheets. If the bridge is a steel beam or steel girder structure, these drawings shall also include a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stress. The drawings shall be certified by a registered professional engineer prior to submittal.

Form sheets shall not rest directly on the top of the beam flanges. Sheets shall be securely fastened to the form supports and shall have a minimum bearing length of 1 in. at each end. All attachments shall be made by welds, bolts, clips, or other approved means. Except as amended by these specifications, welding and welds shall be in accordance with the requirements of 711.32 pertaining to fillet welds. However, 1/8 in. fillet welds will be allowed. The vertical leg of angles used as form supports shall not extend higher than the top of the permanent metal form.

660 Form supports at steel beam or girder bridges shall be placed in direct contact with the top flange of the beam or girder and shall be adjusted to maintain the required deck thickness. If straps are used on the top flanges, the straps shall be No. 8 gauge thick, fit tight, and shall not be galvanized. Form supports shall not be welded to flanges of non-weldable grades of steel or to steel flanges subject to tensile stresses.

Form supports at prestressed concrete I-beam, prestressed concrete spread box

670 beam, and prestressed concrete bulb-T beam bridges shall be placed in direct contact with the sides of the box or edge of the I-beam or bulb-T beam flange and shall be adjusted to maintain the required deck thickness. The form supports may be attached to steel inserts cast into the top of the box, I-beam, bulb-T beam, straps extending across the top of the flange, hangers mechanically attached to reinforcing bars extending from the top flange, or by other approved methods. If straps are used across the top flange, they shall be No. 8 gauge thick, fit tight, and shall not be galvanized. Attachments shall not be welded directly to beam reinforcement. In addition, the use of recesses cast into the beam to serve as a form supports will not be allowed.

680 All permanently exposed form metal, where the galvanized coating has been damaged, shall be thoroughly and satisfactorily cleaned, wire brushed, and painted with two coats of zinc oxide-zinc dust primer in accordance with Federal Specification MIL-P-2441, type II, with no color added. Minor heat discoloration in areas of welds need not be touched up.

Concrete shall be placed in accordance with 702.20. Particular emphasis shall be placed on proper vibration of the concrete to avoid honeycombs and voids, especially at construction joints, expansion joints, attachment hardware, and valleys and ends of form sheets. Pouring sequences, procedures, and mixes shall be submitted for approval.

690 If it is determined that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, at least one section of the forms shall be removed at a location and time selected for each span in the contract. This is to be done as soon after placing the concrete as practical in order to provide visual evidence that the concrete mix and the procedures are obtaining the desired results. An additional section shall be removed if it is determined that there has been any change in the concrete mix or in the procedures warranting additional inspection.

700 After the deck concrete has been in place for a minimum of two days, the concrete shall be tested for soundness and bonding to the forms by sounding with a hammer as directed. If areas of doubtful soundness are disclosed by this procedure, the forms shall be removed from such areas for visual inspection after the pour has attained adequate strength. This removal of the permanent metal bridge deck forms shall be with no additional payment. At locations where sections of the forms are removed, form replacement will not be required, but the adjacent metal forms and supports shall be repaired to present a neat appearance and ensure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombs, and other defects. If irregularities are found, and it is determined that these irregularities do not justify rejection of the work, the concrete shall be repaired as directed and shall be given a finish in accordance with 702.21. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab, and the methods of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed or repaired as directed.

710

The amount of sounding and form removal may be moderated as directed after a substantial amount of slab has been constructed and inspected, if the methods of construction and the results of the inspections as outlined above indicate that sound concrete is being obtained throughout the slabs. All necessary facilities shall be provided for the safe and convenient performance of inspection procedures.

720 (f) **Blank**

(g) **Removal and Re-Use of Forms**

The forms for any portion of the structure shall not be removed until the concrete is strong enough to withstand damage. If field operations are not controlled by beam or cylinder tests, the following periods, exclusive of days when the ambient temperature is below 40°F, for removal of forms and supports may be used as a guide.

	Centering under beams	15 days
	Roadway Slabs	7 days
730	Walls, Columns, Sides of Beams, and all other parts	12 h

If high-early strength cement is used, these periods may be reduced as directed. If portland-pozzolan cement, type IP or IP-A, fly ash or ground granulated blast furnace slag as a pozzolan is used in the structural concrete, these periods shall not apply and the removal of forms and supports shall be controlled by test beams in accordance with 702.13(h).

740 In order to obtain a satisfactory surface finish, forms for railings, parapets, and exposed vertical surfaces shall be removed no less than 12 h and no more than 48 h after the concrete is placed, depending on weather conditions.

Copings, corners, and projections shall not be cracked or injured during the removal of the forms. If damage occurs, the amount of concrete adjacent to the damaged portion shall be removed and replaced as directed with no additional payment.

750 The shape, strength, rigidity, water-tightness, and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged lumber shall be re-sized before being used. Unsatisfactory forms shall not be used.

(h) **Test Beams**

When portland-pozzolan cement, type IP or IP-A, is incorporated into the structural concrete elements listed below, when fly ash or ground granulated blast furnace slag is incorporated into the structural concrete elements listed below, or when field operations are being controlled by beam tests, the removal of forms will be allowed when the modulus of rupture reaches or exceeds the following values:

Concrete Use	Required Flexural Strength, psi, Dead Load Only
Girders, Arches, and similar units	390
Interior Bent or Pier Caps	480

760 The beams will be cured under the same conditions as the concrete which they represent. Beams will be tested for flexural strength as simple beams with third-point loading in accordance with 505.

702.14 Falsework and Centering

Detailed working drawings for falsework and arch centering shall be submitted in accordance with 105.02. Since the quality of the lumber is not known and because of the uncertainty of computing nailed joints, no responsibility will be assumed by the Department for the strength of falsework and centering.

770 Working drawings for falsework shall include details for support of interior bent caps, hammerhead piers, and the portion of the bridge floor and coping beyond fascia girders or beams if the overhang is 18 in. or more, or if a finishing machine, concrete spreader, or other equipment is to be supported by the overhang.

The scheme of falsework for work on a span over active railroad tracks shall provide a minimum horizontal clearance of 13 ft from the centerline of the nearest tangent track or 14 ft from the centerline of the nearest track on a horizontal curve and a minimum vertical clearance of 22 ft from the top of the highest track rail unless different clearance values are approved by the railroad.

780 (a) Design and Construction

Falsework shall be designed and constructed so as to safely carry the full load coming upon it with a minimum settlement and deflection and with sufficient camber to counteract unavoidable shrinkage, deformation, and settlement. Structures shall have a permanent camber only when shown on the plans and the falsework shall be set to provide it.

790 For designing falsework and centering, a weight of 150 lb/cu ft shall be assumed for plastic concrete. A live load allowance of 50 lb/sq ft shall be added for horizontal projections of surfaces. All beams supporting plastic concrete shall be so designed that there are no appreciable deflection under full load. The beams shall be considered as being unsupported by knee-bracing, such bracing to be considered as relieving sagging and bending only. The use of inclined columns, where properly braced, will be allowed.

The unsupported lengths of wooden columns and compression members shall not exceed 30 times the dimensions of the least side, or 30 times the least diameter.

Unit stresses in timber shall not exceed the following:

702.14

- 800 For Douglas fir, white oak, long-leaf yellow pine:
Bending.....1,800 psi
Columns.....1,800 (1-L/60D) psi
For spruce, cypress, short-leaf pine, white pine, western hemlock:
Bending.....1,500 psi
Columns.....1,500 (1-L/60D) psi
In the above:
L = length of column in inches
D = least diameter or least dimension in inches.

810 Hardwood wedges may be required to take up any settlement in the falsework, either before or during the placing of concrete.

Arch centering shall be constructed so as to enable it to be lowered or released gradually and uniformly after pouring arch ribs and rings. Lagging for arch centering shall be of uniform thickness. Unless otherwise specified, the nominal thickness shall be no less than 2 in. A smooth surface shall be produced on the undersides of arch rings. The upper sides of all lagging shall be oiled before concrete is placed.

820 Unless driving of piles for falsework bents is precluded by soil or other special conditions or unless otherwise specified, all bents for falsework shall have driven piles. These shall be driven to support the required loads without settlement, spacing, and subsequent removal shall be satisfactory.

If permission is given to place frame bents, they shall be placed on continuous concrete mudsills, or as approved.

(b) Removal

Unless otherwise specified, the following shall apply to the removal of falsework and centering:

- 830
1. Falsework under a reinforced concrete slab top not supported by beams or girders shall remain in place at least seven days after concrete placement and until attaining or exceeding 480 psi flexural strength. Operations on the slab may continue after achieving the required flexural strength. No additional concrete shall be cast until the falsework has been released.
 - 840 2. Falsework under a bridge deck supported by beams or girders including the bridge deck overhang shall remain in place at least three days after concrete placement and until attaining or exceeding 480 psi flexural strength. Falsework jacks may be loosened, but not removed, and operations may continue on overhangs three days after concrete placement and achieving the required flexural strength. Falsework jacks may be removed after seven days.

- 850 3. Falsework for substructure concrete, such as interior bents and pier caps, shall remain in place at least three days after concrete placement and until attaining or exceeding 480 psi flexural strength.
4. Falsework and arch centering under multiple-span arch bridges shall not be released from any one span until the adjacent and spandrel walls have cured for the required time and the next adjacent arch ring has been poured for at least 48 h.
- 860 5. Falsework under continuously reinforced concrete slab and girder units shall not be released from any span until the entire continuous unit has been completed and all concrete cured for the required period.
6. For concrete poured during March, April, October, and November, or any time between April and October when the average temperature is less than 50°F, the above periods shall be increased 20%. For concrete poured during December, January, and February, they shall be increased 40%.
- 870 7. Removal of supports shall be such that it enables the concrete to take the stresses, due to its own weight, uniformly and gradually.
8. The removal of falsework shall be at the risk of the Contractor. Permission for removal may be refused if it is determined that there may be resulting damage to the structure.

880 **702.15 Joints**

(a) Construction Joints

Construction joints shall be located across regions of low shearing stress and, so far as possible, where they are hidden from view in the finished structure. They shall be made only where shown on the plans, unless otherwise specified in writing, in accordance with this specification.

890 Placing of concrete shall be continuous between construction joints. If placing is interrupted and a construction joint becomes necessary, provisions shall be made for interlocking with the preceding layer by constructing raised keyways as shown on the plans or as directed.

When fresh concrete is to be joined to that in place which has already set, the surface of the concrete in place shall be cut over with a suitable tool to remove all loose and foreign material. This surface shall then be scrubbed with wire brooms and kept wet until the new concrete is placed thereon. Immediately before the new concrete is placed, the forms shall be drawn tight against the concrete in place and the exposed surface of the concrete shall be coated with a thin coating of mortar composed on one part cement and two parts No. 23 sand.

900

All concrete for slabs, beams, girders, cantilevered brackets, and footings shall be placed in one continuous operation to form monolithic construction. However, if, because of rain or other unavoidable reasons, concreting is interrupted where monolithic construction is required, the concrete shall be kept plastic by placing frequent small batches until this part of the work is completed or until normal operations can be resumed. If the interruption is such that even partial operations cannot be carried on and construction joints are unavoidable, the joints shall be made in planes exactly normal to the main reinforcing bars and only where the shear is a minimum. In simply supported slabs, beams, and girders, such regions of minimum shear are at or near the center of the span.

910

Unless otherwise provided, pours in all abutments for an arch bridge shall be continuous from the top of footing to the skewback. If it is advisable to pour only a portion of the abutment at one time, a vertical construction joint may be placed parallel to the major reinforcement of the arch ring with written permission.

Horizontal construction joints will not be allowed in footings. If there is a probability that the entire amount of concrete cannot be poured monolithically, vertical or other construction joints shall be provided as directed.

920

Horizontal construction joints in the shafts of reinforced piers, retaining walls, and abutments, other than abutments for arch bridges, may be made only if approved. Where such joints show on an exposed surface, special care shall be taken to make the joints truly straight, clean, and watertight. To avoid visible joints so far as possible on exposed faces, the top surface of the concrete shall be finished to the underside of a strip nailed to the form work for the exposed surface of the concrete, the strip to be placed as directed. If such a horizontal joint intersects any coping or any sloping surface where a featheredge would be formed, an inclined bulkhead shall be placed so as to make the joint normal to the sloping surface for a distance of no less than 6 in. or, if there is a coping, no less than the depth of the coping. Horizontal construction joints will not be allowed in the stems of concrete T-beams or at the junction of T-beam stems and flanges.

930

(b) Expansion Joints

Bridge expansion joints shall be of the form, dimensions, material, and design shown on the plans. Open expansion joints shall be completely open for the dimensions specified and for their entire length. Preformed expansion joint filler, shall be placed true and even and with abutting sections pressed together tightly. The material shall be of the size shown on the plans and shall be in accordance with 906.03.

940

(c) Folded Metal Joints

These joints shall be free from kinks and watertight. At bends, the strip shall be one piece if possible. Unless otherwise shown on the plans, the joints shall be soldered. Copper shall be in accordance with 910.16. Lead sheets shall be no less than 1/8 in. thick.

(d) Sliding Joints

The surface of the supporting concrete for a sliding joint shall be troweled to a smooth finish and then covered with the required thickness of bituminous material, or
950 otherwise treated if so designated.

(e) Polychloroprene Joint Membrane

Polychloroprene joint membrane used for semi-integral end bents shall be secured to the concrete with an adhesive. The polychloroprene joint membrane shall be centered vertically on the joint and shall have no gaps. Any field joint in the polychloroprene membrane shall be lapped a minimum of 12 in.

702.16 Drainage Pipes Through Concrete Masonry

At all enclosures where water could not otherwise escape through the concrete,
960 drainage pipes shall be installed as shown on the plans. Before fill is placed around these pipes, geotextile for use with underdrains shall be placed over the drain pipe and securely held in place and loose stone shall be laid by hand over the inlet end to provide a cover which shall be sufficient to retain the fill and enable free drainage. Drains through abutments and retaining walls shall be placed with a slight incline downward towards the exposed face.

702.17 Encased Pipes and Conduits

Pipes and conduits which are to be encased in the concrete shall be installed before the concrete is placed. Unless otherwise provided, such pipes and conduits shall be
970 delivered at the site of the work by those for whose use they are intended. No direct compensation will be allowed for their installation. However, no deduction in concrete quantities will be made for the volume occupied.

702.18 Roadway Surface Drainage

Drainage grates and basins, necessary fittings, and connections to drainage pipes shall be placed as shown on the plans or as directed.

702.19 Pouring Bent Caps

Caps shall not be poured on end bents or on any other bents falling within the
980 limits of the approach grade until the filling material has been placed.

702.20 Placing Concrete**(a) General Requirements**

Concrete shall not be placed until forms and reinforcing bars have been checked and approved. The forms shall be clean of all debris before concrete is placed. The

method and sequence of placing concrete shall be approved.

990 Where concrete floor slabs are to be poured, walkways shall be provided to protect reinforcement from pedestrian traffic. Before placing concrete, continuous walkways shall be placed parallel to the section of floor to be poured and shall remain in place until after the concrete is placed and hardened sufficiently so as not to be injured. Walkways shall be constructed so as not to come in contact with the reinforcement and be of sufficient width to provide for finishing operations entirely from the walkway.

1000 Except as otherwise provided, concrete shall be placed in horizontal layers of no more than 24 in. thick. When less than a complete layer is placed in one operation, it shall be terminated by a vertical bulkhead. Each layer shall be placed and consolidated before the preceding layer has taken initial set in order to avoid planes of separation between the layers and injury to the plastic concrete underneath. On horizontal surfaces and at horizontal construction joints, the forms shall be overfilled approximately 1/2 in. and then struck off to the required elevation prior to the initial set of the concrete.

1010 When placing is temporarily discontinued and as soon as it becomes firm enough to retain its shape, the concrete shall be cleaned of all laitance and other objectionable material to a depth sufficient to expose sound concrete. Unless otherwise authorized, depositing concrete shall not be discontinued within 18 in. of the top of a face. However, if provisions have been made for a coping of less than 18 in. thick, a construction joint may be made at the underside of the coping.

Where new concrete is to abut existing concrete, the existing concrete surfaces and existing exposed reinforcement shall be cleaned free of dust, chips and water. Epoxy resin adhesive, in accordance with 909.11, shall be used to coat the existing concrete surfaces. The epoxy coating shall be tacky at the time that the new concrete is placed. If the epoxy coating has cured beyond the obvious tacky condition, it shall be reapplied prior to placing the new concrete.

1020 After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

The external surface of all concrete shall be worked thoroughly, during placing, by means of tools of an approved type. The working shall be such as to force all coarse aggregate from the surface and to bring mortar against the forms to produce a smooth finish substantially free from water and air pockets or honeycomb.

(b) Chutes and Troughs

1030 Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. Open troughs and chutes shall extend as nearly as possible to the point of

deposit. Equipment made of or coated with aluminum alloys shall not be used to transport concrete. Pumping of concrete shall be in accordance with 702.10. When the discharge needs to be intermittent, a hopper or other device for regulating the discharge shall be provided. Placement of supplementary bins or hoppers may be ordered above the point where concrete is being deposited. The concrete shall be allowed to accumulate in these containers in considerable quantity and shall be discharged immediately through pipes extending from the bottoms of these bins or hoppers. All
 1040 chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete. The water used for flushing shall be discharged clear of the concrete already in place.

Concrete shall not be dropped in the forms a distance of more than 5 ft except when confined by closed chutes or pipes. Each part of the form shall be filled by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

1050

(c) Vibrating

Unless otherwise directed, the concrete shall be compacted with mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to ensure proper and adequate compaction. Vibrators shall be of an approved type and design, adequately powered and capable of transmitting 10,800 impulses per minute in air. The diameter of the head of the vibrator shall be 1 1/4 to 2 1/2 in. Vibrators shall be manipulated so that the concrete is thoroughly worked around the reinforcement and imbedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to
 1060 cause concrete to flow or run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs. Vibrators shall not be attached to or allowed to contact forms or reinforcement or to penetrate beyond any layer of fresh concrete.

(d) Depositing Concrete Under Water

No concrete except for foundation seals shall be deposited under water, without written permission. If such permission is granted, care shall be exercised to prevent the formation of laitance. Concrete shall not be deposited until any laitance, which may have formed on concrete previously placed, has been removed. Pumping shall be
 1070 discontinued while depositing foundation concrete if it results in a flow of water inside the forms. If concrete, except for foundation seals, is deposited under water, the proportion of cement used shall be increased at least 25% with no additional payment to compensate for losses due to water. Concrete deposited under water shall be placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved method and shall not be disturbed after being deposited.

A tremie shall consist of a tube having a diameter of no less than 10 in. and constructed in sections having flanged couplings fitted with gaskets. Support of the

1080 tremie shall be such that it enables free movement of the discharge end over the entire top surface of the area on which the concrete is to be deposited and also enables rapid lowering when necessary to retard or stop the flow of the concrete. The discharge end shall be kept closed until immediately prior to depositing in order to prevent water entering the tube and shall be completely sealed except when concrete is actually being deposited. The tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete through the tube shall be started by slightly raising the discharge end, but always keeping it in the previously deposited concrete. The flow shall be continuous until all the required concrete is deposited.

(e) Placing Footing Concrete

1090 Except as otherwise provided for a foundation seal, footing concrete shall not be placed except when the cofferdam is dewatered and so maintained during placement.

If it is necessary to operate the pump while placing footing concrete, or immediately thereafter, the seepage water shall be conducted to a sump at the pump intake in such manner that it does not flow over the fresh concrete. Special care shall be taken to prevent pumping cement out of the fresh concrete.

1100 Footing concrete may be placed directly against sheet piling of the cofferdam when so shown on the plans or authorized in writing. Where class X excavation has been extended beyond established neat lines of a footing, the bottom 12 in. of such footing shall be poured to the actual limits of the excavation. When necessary, the foundation material on which the footing is to rest shall be protected from freezing. Where an existing structure is to be extended, the existing footings shall be protected from damage. Damaged footings shall be repaired as directed with no additional payment.

1110 Piling, if any, shall be driven to or cut off at the proper elevation to enable embedment in the footing concrete equal to that shown on the plans. All laitance or other unsatisfactory material shall be removed from the exposed surface of the concrete in place by some means which does not injure the concrete. If a footing is to be constructed on a foundation seal, it shall be to the dimensions shown on the plans and, if necessary, the height of the shaft adjusted to bring the bridge seat to the required elevation.

1120 Placing concrete in footings shall start at one end of the footing and be continued until the surface of the concrete is brought to the elevation of the top of the footing. The concrete shall be allowed to work forward, displacing any water with as little help as possible. The concrete shall not be dragged through or shoveled into water or deposited into running water. Placing concrete in more than a few inches of water shall be done only with written permission.

(f) Concrete Foundation Seal

A foundation seal may be required by the plans, as requested, or as directed. When required by the plans, the seal shall be constructed to the size shown, or as specified

in writing. Where adverse dewatering conditions are encountered as described in 206.09, a foundation seal may be required to be placed to the necessary dimensions.

1130 If a foundation seal is requested, written permission shall be obtained before starting such work. If approval is given, the seal shall be placed to designated dimensions.

Seals shall be of class A concrete having a slump of from 5 to 8 in., placed continuously from start to finish, and in accordance with 702.20(d). To ensure thorough bonding, each successive layer shall be placed before the preceding layer has taken initial set. The cofferdam shall have been vented or ported at low-water level. The surface of the concrete shall be kept as nearly horizontal at all times as practicable. The seal shall be of the thickness ordered. When the seal has hardened sufficiently to withstand the hydrostatic pressure, the cofferdam shall be dewatered and the remainder of the concrete poured in the dry.

1140

702.21 Finishing Concrete Surfaces

Unless otherwise authorized, the surface of the concrete shall be finished immediately after form removal. Only the minimum amount of covering necessary to allow finishing operations to be carried on shall be removed at one time. Subject to approval, metal ties may be left in the concrete for the purpose of supporting or bracing subsequent work. Such ties shall be in accordance with 702.13(b) and shall be of a type which uses a cone and rod as both spreader and tie. Before final acceptance of the work, the cones shall be removed and the cavities filled, in accordance with 702.13(b).

1150 All concrete surfaces shall be given a finish immediately following the removal of any forms.

At the time of the removal of forms, the concrete surface shall be scraped to remove all fins and irregular projections. The surface shall then be power ground to smooth all joints and chamfers.

1160 After grinding is completed, a paste of grout shall be applied to the concrete surface with a sponge float to fill all air holes and small irregularities. The paste grout shall be six parts of pre-mix mortar mix for masonry and one part white portland cement in accordance with ASTM C150, type 1.

After the paste grout takes its initial set, the surface of the concrete shall be scraped with a steel drywall knife to remove the paste from the surface.

1170 The concrete surfaces of pier and bent caps, the front face of mudwalls, and any other concrete surfaces specified shall be sealed. The material used for sealing shall be in accordance with 709. It shall be applied so as to obtain a finished film thickness of at least 10 mils. Mixing, surface preparation, and method of application shall be in accordance with the manufacturer's recommendations. However, the surfaces to be sealed shall be prepared in accordance with 709 prior to applying the sealer.

702.22 Curing Concrete

Concrete in bridge decks or the top surface of reinforced concrete slab bridges shall be cured continuously 24 h per day for a minimum of 168 h commencing immediately after the surface is able to support the protective covering without deformation. Water curing in accordance with 702.22(a)1 shall be initiated within 60 minutes after the finishing machine completes the final strike off of any portion of the concrete surface. Curing or other protective efforts which may include the use of evaporative retardants shall begin sooner if adverse conditions exist. Adverse conditions include, but are not limited to, high winds, extreme temperatures or low humidity. A work bridge shall be used following the finishing machine to facilitate the placement of curing materials, if necessary. Curing time for bridge decks and the top surface of reinforced concrete slab bridges are not controlled by beam tests and the cure time shall not be reduced. In addition to the minimum of 168 h cure period, curing shall continue until a flexural strength of 550 psi has been attained. Curing of patches or small full depth deck replacement areas on existing bridge decks that are to be overlaid, may be controlled by test beams in accordance with 702.24(a).

Unless otherwise specified, all other concrete shall be cured continuously 24 h per day for at least 96 h commencing immediately after the surface is able to support the protective covering without deformation. In addition to the required hours, curing shall continue until the flexural strength stated in 702.13(h) and 702.24 has been attained.

Membrane forming curing compound may be used in lieu of protective covering curing methods. Where it has been determined that a surface treatment is to be used, the membrane forming curing compound shall not be used. Membrane forming curing compound shall not be used on bridge decks nor on reinforced concrete slab bridges.

The curing of surfaces to be waterproofed may be discontinued when waterproofing is started.

If further precautions are necessary to ensure strength, they shall be taken as directed.

(a) Protective Covering Curing Methods

1. Water Curing Method

Surfaces to be cured shall be protected and kept continuously and thoroughly wet during the curing period. Curing shall consist of pre-wetted burlap underneath a layer of white plastic sheeting with a network of soaker hoses. Other wet curing systems including engineered mats or blankets shall be submitted to the Engineer for approval at least 14 days prior to use. Burlap shall be free of contamination and shall be prepared by soaking in clean water for at least 2 h before beginning concrete placement. New burlap shall be soaked at least 12 h prior to use. Immediately before use, the burlap shall be draped or suspended vertically to remove excess water that may dilute or damage plastic concrete. Soaker hoses shall be placed after the concrete is hard enough

1220 to walk on without deformation. The protective covering shall be suitably anchored to keep the protective materials in place during the curing period. Curbs, walls, handrails, copings, and other surfaces requiring a finish in accordance with 702.21 may have the covering temporarily removed for finishing, but the covering shall be restored as soon as possible.

2. Membrane Forming Curing Compound

All surfaces shall be given the required surface finish prior to application of the curing compound. During the finishing period, the concrete shall be protected by the water curing method.

1230 The curing compound shall be mixed thoroughly within 1 h before use. The rate of application shall be as approved, with a minimum spreading rate per application of 1 gal. of liquid coating for 150 sq ft of concrete surface. Curing compound shall be applied to provide a uniform, solid, white opaque coverage on all surfaces, similar to a white sheet of paper. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately after stripping of forms and acceptance of the concrete finish. If the surface is dry, the concrete shall be wetted with water and the curing compound applied just as the surface film of water disappears. The second application shall be applied after the first application has set. During curing operations all unsprayed surfaces shall be kept wet with water.

1240 The coating shall be protected against marring for at least 10 days after application. All coatings marred or otherwise disturbed shall be given an additional coating. If the surface coating is continuously subjected to injury, immediate application of water curing may be required. If the use of a curing compound results in a streaked or blotchy appearance, the method shall be stopped and water curing applied until the cause of the defective appearance is corrected.

(b) Curing-Sealing Materials

1250 Curing-sealing materials may be used in lieu of protective covering curing methods when surface seal is required. These materials may only be used on concrete surfaces that are not subjected to vehicular wear and that have been formed using the slip form method. Curing-sealing material shall not be applied to cast-in-place concrete.

When curing-sealing materials are used for curing concrete, surface seal will not be required.

1260 The curing-sealing material shall be mixed in accordance with the manufacturer's instructions prior to application. The rate of application shall be as specified on the QPL of PCC Curing-Sealing Materials. All concrete cured-sealed by this method shall receive two applications of the curing-sealing compound. The first coat shall be spray applied after the finished surface has been achieved. The second coat shall be applied while the first coat is still tacky.

702.23

The use of curing-sealing material shall be discontinued if plastic shrinkage cracks occur that cannot be corrected by decreasing the application rate. The concrete shall then be cured and surface sealed in accordance with 702.22(a)1 and 709, respectively.

1270 The coating shall be protected against damage after application. All coatings that have been disturbed shall be given an additional coating. If the surface coating is continuously subjected to injury, immediate application of curing in accordance with 702.22(a)1 may be required. The concrete shall then be surface sealed in accordance with 709.

702.23 Waterproofing

The expansion joint shall be waterproofed on the following: the back surfaces of retaining walls; the top surface of all slabs under fills; the extrados of arches; the inside faces of spandrel walls; and abutments up to the finish grade line. The inside face of spandrel walls and extrados of arches shall be waterproofed.

1280 A firmly bonded membrane consisting of two layers of dry fabric and three applications of waterproofing material, shall be placed at all expansion joints set out herein. One uncoated layer of fabric shall not touch another layer or the concrete at any point. There shall be at least three complete and separate applications of the waterproofing material. The application shall be sufficiently heavy to conceal the weave in the fabric. Sufficient fabric shall be placed in V-strips at the joints to enable the movement of adjacent sections of concrete without tearing the fabric. The membrane shall be carefully flashed at all exposed edges and laps sealed down thoroughly. Waterproofing shall be planned so that, at the close of work each day, all fabric placed shall have received the final application of waterproofing material.

1290 Concrete surfaces to be waterproofed shall be reasonably smooth and free from projections and holes. Immediately before the application, the surface shall be cleaned of dust and loose materials. Waterproofing shall be done only when the surface is at least dry enough to prevent the formation of steam when the hot material is applied. When the air temperature is below 35°F, waterproofing shall not be done, unless otherwise specified.

1300 The material shall be applied so as to cover the area completely. If necessary, more than one coat shall be applied in order to secure a satisfactory coating and proper adhesion. Coating and fabric shall stop a uniform distance below the top surfaces of walls. The material shall not be splattered over surfaces or faces of concrete which subsequently are exposed in the finished structure. Utility asphalt for waterproofing shall be heated to a temperature of between 300°F and 350°F. The material shall be stirred frequently to prevent local overheating. The waterproofing material shall not be damaged when backfill is placed against a waterproofed joint.

702.24 Application of Loads to and Acceptance of New Concrete

Except as otherwise hereinafter provided, application of loads to new concrete shall be in accordance with the following:

- 1310 (a) Equipment or traffic will not be allowed on structures until test beams representing all concrete required to carry live loads have attained a flexural strength of 550 psi for third-point loading.
- (b) Unbalanced backfill will not be allowed until test beams representing the concrete required to resist it have attained a flexural strength of 440 psi for third-point loading. The unbalanced height shall not exceed 10 ft until test beams representing the concrete have attained a flexural strength of 480 psi for third-point loading.
- 1320 (c) The dead weight of steel or precast concrete superstructure shall not be placed on concrete until test beams representing the concrete have attained a flexural strength of 400 psi for third-point loading. A dead load shall not be placed on hammer-head piers until test beams representing the concrete have attained a flexural strength of at least 480 psi for third-point loading. The concrete floor, if to be placed thereon, shall not be poured until test beams representing the concrete supporting the superstructure have attained a flexural strength of at least 440 psi for third-point loading.
- 1330 (d) Test beams representing concrete anchoring inserts to support falsework shall attain a flexural strength of a minimum of 480 psi for third-point loading, before a dead load of concrete is applied.
- (e) When blended portland pozzolan cements, fly ash, or slag cement are used in bridge railings or concrete barrier and the temperature limitations in accordance with 702.05 are not met, the bridge railings or concrete barrier may be put into service when flexural strength testing performed on test specimens indicate a modulus of rupture of 500 psi has been attained.
- 1340

No time extension will be considered for delays due to time necessary to attain specified strengths.

- Beams will be prepared and tested in accordance with 702.13(h). Before traffic is allowed over a concrete structure built to be under fill, it shall be covered with 9 in. or more of earth or other suitable material, or otherwise protected. All other structures shall be properly protected against impact or other damage.
- 1350

When compressive strength is used as a basis for acceptance of concrete, for determining when a latex modified concrete overlaid bridge deck may be opened to traffic, for determining form removal time, or for determining when a structure may

1360 be put into service, standard specimens shall be made and cured in accordance with ASTM C31, and shall be tested in accordance with ASTM C39. Strength requirements shall be in accordance with ASTM C94, with the exception as follows: the strength shall be the average of the strengths of all cylinders tested at the age specified, with a minimum of two cylinders. This average shall be equal to or greater than the required strength. If the compressive strength of one or more cylinders in a strength test is below 75% of the required strength, the entire test will be considered as failed.

Failure to meet the strength requirements will be cause for rejection of the quantity of concrete represented by the cylinders. All molds, facilities, and materials necessary to prepare and cure the specimens shall be furnished with no additional payment.

702.25 Field Drilled Holes in Concrete

1370 This work shall consist of field drilling holes of the diameter and length shown on the plans or as directed.

When vertical holes are to be drilled into the top of a concrete bridge deck, a minimum clearance of 2 in. shall be maintained between the bottoms of holes and bottom of slab. When vertical holes are to be drilled over a steel beam flange, the holes may be extended to the top of the beam flange. When vertical holes are to be drilled over a concrete I-beam, concrete box beam, concrete bulb-T beam, or concrete girder, the depths of the holes shall be as shown on the plans. If breakout occurs on the bottom of slab during the drilling process, the work shall be stopped, the breakout shall be repaired as directed, and an approved alternate drilling method shall be used to prevent breakout.

1380 When grouted holes are specified, the diameter and length of the holes shall be in accordance with the grout manufacturer's recommendations.

702.26 Artificial Lighting

No portion of the work which cannot be finished during daylight hours shall be started unless written permission to the contrary is given, in which case adequate lighting shall be provided and maintained.

702.27 Method of Measurement

1390 Concrete will be measured by the cubic yard in accordance with the neat lines shown on the plans or as directed. No deductions will be made for the volume of joint material, embedded reinforcement, encased piles, or for a pipe with an area of less than 1 sq ft.

Cast iron grates, basins, and fittings will be measured by the number of complete assemblies installed. Drainage pipe through concrete masonry will be measured in accordance with 715. Field drilled holes will be measured by the number of holes drilled.

1400 Concrete in railings will be measured in accordance with 706.07. Reinforcing bars will be measured in accordance with 703.07.

702.28 Basis of Payment

The accepted quantities of structural concrete will be paid for at the contract unit price per cubic yard of concrete, for the class and use specified. Cast iron grates, basins, and fittings will be paid for at the contract unit price per each assembly, complete in place. Steel drain pipe will be paid for at the contract lump sum price. Field drilled holes in concrete will be paid for at the contract unit price per each.

1410 Concrete in railings will be paid for in accordance with 706.08. Reinforcing bars will be paid for in accordance with 703.08. Drainage pipe through concrete masonry will be paid for in accordance with 715.

1420 If a foundation seal is constructed as shown on the plans, it will be paid for at the contract price per cubic yard for concrete, foundation seal. If ordered to be done, or allowed to be done, payment will be made at a unit price per cubic yard equal to 75% of the contract unit price per cubic yard for class B concrete in footings. The excavation for the foundation seal will be paid for at the contract unit price per cubic yard for the class of excavation specified for the footing. Unless otherwise provided, the pay quantity for excavation for foundation seal will be equal to the theoretical volume bounded by the bottom of the proposed footing, the bottom of the approved excavation, and vertical planes 18 in. outside the neat line of the footing and parallel thereto, regardless of the quantity actually removed. If design of the structure requires sheeting to be outside these limits, the limits will be extended to 6 in. beyond the neat lines required by the design of the structure. If the Contractor chooses to construct a rectangular cofferdam around a U-shaped abutment in lieu of following the outline of the footing, the maximum allowable increase in the pay quantity above the theoretical shall not exceed 25%. The pay quantity for the foundation seal will be equal to the excavation volume described above.

1430 Payment will be made under:

Pay Item	Pay Unit Symbol
Concrete, A, Substructure.....	CYS
Concrete, A, Superstructure.....	CYS
Concrete, B, Above Footings	CYS
Concrete, B, Footings	CYS
Concrete, C, _____	CYS
use	
Concrete, Foundation Seal.....	CYS
Field Drilled Hole in Concrete	EACH
Grates, Basins, and Fittings, Cast Iron	EACH

1440

The cost of forms, PVC for bridge floor drains, falsework, falsework piling, centering, expansion joints, preformed expansion joint filler, waterproofing, curing, finishing, and necessary incidentals shall be included in the cost of the pay items. The

703.01

1450 cost of placing epoxy resin adhesive on existing concrete surfaces shall be included in the cost of new concrete which abuts the existing concrete. Payment for concrete used in footings in class X excavation will be made at the contract unit price only for the cubic yards placed within the neat lines of the footings as shown on the plans or as revised.

If the Contractor elects to increase the cement content as allowed herein, no additional compensation will be made.

1460 The cost of permanent metal forms shall be included in the cost of concrete, C, superstructure. The pay quantity of concrete in the slab will be computed from the dimensions shown on the plans, with no allowance for form deflection or geometry.

Elastomeric bearings will not be paid for directly, unless otherwise specified. The cost thereof shall be included in the cost of the structural member they support. The cost of protecting existing footings to be extended shall be included in the cost of concrete, B, footings, unless otherwise specified.

1470 The cost of grout for grouting reinforcing bars in place, the length of grouted hole recommended by the grout manufacturer in excess of the length shown on the plans, and the additional length of reinforcing bars required shall be included in the cost of field drilled hole in concrete.

The cost of furnishing and installing polychloroprene sheeting shall be included in the cost of concrete, A, substructure.

The cost of high density plastic bearing strips shall be included in the cost of concrete, A, substructure.

SECTION 703 – REINFORCING BARS

703.01 Description

This work shall consist of furnishing and placing reinforcing bars and threaded tie bar assemblies with reinforcing bars in accordance with 105.03.

MATERIALS

703.02 Materials

10 Materials shall be in accordance with the following:

Reinforcing Bar Splicing System	910.01(b)3
Reinforcing Bars, Plain or Epoxy Coated.....	910.01
Support Devices	910.01(b)9
Threaded Tie Bar Assembly	910.01(b)2

The sizes and lengths of reinforcing bars shall be marked plainly to facilitate inspection and checking.

20 **703.03 Bar List**

The Contractor shall verify the quantity and size of reinforcing bars against the structure drawings prior to ordering. Errors in the bar list and bending schedule will not be cause for adjustment of the contract unit price.

703.04 Protection of Materials

30 Plain and epoxy coated reinforcing bars shall be protected from damage during storage, handling, installation and concrete placement. Plain and epoxy coated reinforcing bars shall not be stored in direct contact with the ground. Epoxy coated reinforcing bars shall be protected from exposure to ultraviolet light and moisture during storage. Once placed into the work, epoxy coated reinforcing bars shall not be exposed to ultraviolet light for a total of more than 21 days prior to placement of concrete. At the time of concrete placement, reinforcing bars shall be free of dirt, loose rust or scale, grease, oil, or other foreign substance. If the Engineer suspects the epoxy coating has been damaged by exposure to ultraviolet light, a sample will be obtained and will be tested in accordance with 910.01(b)9.

40 Damage to the epoxy coating of epoxy coated reinforcing bars shall be repaired or the bars shall be replaced. Repairs to the epoxy coating shall be performed on all damaged areas larger than 1/4 by 1/4 in. A bar will be rejected if the accumulated area of damaged coating exceeds 2% of the nominal surface area of the bar or if the total area of repaired coating exceeds 5% of the nominal surface area of the bar. All damaged areas shall be cleaned and the repair shall be performed before visible oxidation appears. Coating repair material shall be in accordance with 910.01(b)9.

CONSTRUCTION REQUIREMENTS

703.05 Bending

50 Reinforcing bars required to be bent shall be accurately cold bent in a bending machine to the shapes shown on the plans. All bars in which cracks or splits occur at bends will be rejected.

703.06 Placing and Fastening

Reinforcing bars shall not be ordered for piers or bents to be founded on soil or rock until the foundation conditions have been investigated. The bottom elevations of such footings will then be determined. Written permission will then be given to order such reinforcing bars. Sufficient excavation and all necessary soundings shall be made as directed so that exact bottom elevations of footings may be determined.

60 All dimensions shown on the plans for spacing of reinforcing bars apply to centers of bars unless otherwise noted. All bars shall be accurately placed and, during placing of the concrete, held firmly in the position as shown on the plans. Distances from the forms shall be maintained by means of chairs, ties, hangers, or other approved support

devices. All reinforcing bars shall be wired rigidly or fastened securely at sufficient intervals to hold the bars in place. Chairs and supports holding upper layers of reinforcing bars shall support the transverse bars. The upper layer of reinforcing bars in bridge floors shall be tied or fastened at such intervals as necessary to prevent an upward or a lateral movement of a bar from the planned position.

70 Layers of reinforcing bars shall be separated by spacers. Reinforcing bars shall be separated from horizontal surfaces by being suspended or supported on approved chairs and spacers capable of supporting the designed loads. Supports and spacers shall be of such shape as to be easily encased in concrete. That portion which is in contact with the forms shall be non-corrosive and non-staining material. They shall be of an approved type. Vertical stirrups shall always pass around main tension members and shall be securely attached thereto. The use of pebbles, pieces of broken stone or bricks, metal pipe, wooden blocks, and similar devices for holding bars in position will not be allowed.

80 After being placed, reinforcing bars will be inspected and approved before the concrete is deposited. The positions of the reinforcing bars shall not be disturbed both during and after depositing the concrete. All concrete placed in violation of this requirement may be rejected and its removal will be required. Where reinforcing bars project from construction joints, all mortar clinging to the reinforcing bars from previous pours shall be removed before the next enveloping pour is made.

All reinforcing bars shall be furnished in the full lengths shown on the plans unless splices are indicated. No other splicing will be allowed except with written permission. Unless otherwise shown on the plans, reinforcing bars shall be lapped 32 diameters to make a splice. Construction joints shall not be made within the limits of lapped bars.

90 For lapped splices, reinforcing bars shall be placed in contact and rigidly clamped or wired in an approved manner. Insofar as possible, splices shall be staggered and well distributed or located at points of low tensile stress. Splices will not be allowed at points where the section does not provide a distance of at least 2 in. between the splice and the nearest adjacent bar or surface of the concrete.

When splicing is indicated or allowed, an appropriate splice system on the QPL of Reinforcing Bar Splicing Systems may be used in lieu of lapped bars. The splicing system shall be installed in accordance with the manufacturer's recommendations. If an offset splicing system is selected, it shall only be used on spiral, hoop, or ring-type reinforcement.

100

WWR, when required, shall be placed as shown on the plans or as otherwise directed. The sheets shall overlap sufficiently to maintain uniform strength and shall be securely fastened at lapped ends and edges. The laps shall be no less than one mesh in width.

Spiral reinforcement, consisting of evenly spaced continuous spirals, shall be held firmly in place by attachment to vertical reinforcement. The spirals shall be held true

110 to line by vertical spacers. Anchorage for spiral reinforcement shall be provided with 1 1/2 extra turns of the spiral rod or wire at each end of the spiral unit. Splices in spiral rods or wire shall be made with a lap of 1 1/2 turns.

Threaded tie bar assemblies may be used in lieu of spliced reinforcing bars shown on the plans. Threaded tie bar assemblies shall achieve the minimum strength in accordance with 910.01(b)2. The Contractor shall coat any exposed part of threaded bar assemblies in accordance with 910.01(b)2.

703.07 Method of Measurement

120 Reinforcing bars will be measured by the pound based on the theoretical number of pounds complete in place as shown on the plans or placed as ordered. The quantities of materials furnished and placed shall be based upon the calculated weights of the reinforcing bars actually placed in accordance with these specifications. The weights calculated shall be based upon the following table:

Bar Designation No.	Weight per linear foot, pounds	Bar Designation No.	Weight per linear foot, pounds
1/4 in.	0.167	8	2.670
3	0.376	9	3.400
4	0.668	10	4.303
5	1.043	11	5.313
6	1.502	14	7.65
7	2.044	18	13.60

Threaded tie bar assemblies will be measured by the number of assemblies placed.

WWR will not be measured.

130 703.08 Basis of Payment

The accepted quantities of reinforcing bars will be paid for at the contract price per pound, complete in place.

If the substitution of reinforcing bars larger than those specified is allowed, payment will be made for only that weight which would be required if the specified bars had been used.

140 If the use of reinforcing bar lengths shorter than those shown on the plans is allowed for convenience in transporting or placing the bars, payment will be based on the weight of the lengths shown on the plans.

Payment for threaded tie bar assemblies will be at the contract unit price per each, complete in place, If epoxy coating is specified, payment for the assemblies will be at the contract unit price per each for threaded tie bar assembly, epoxy coated.

704.01

Payment will be made under:

	Pay Item	Pay Unit Symbol
150	Reinforcing Bars.....	LBS
	Reinforcing Bars, Epoxy Coated.....	LBS
	Threaded Tie Bar Assembly.....	EACH
	Threaded Tie Bar Assembly, Epoxy Coated.....	EACH

The cost of metal chairs, spacers, clips, wire, or other mechanical means used for fastening or holding reinforcement in place, and laps shall be included in the cost of reinforcing bars. The cost of coating materials and repair of damaged or removed coating materials on reinforcing bars and on metal chairs, spacers, clips, or other mechanical means used for fastening or holding reinforcement in place, and laps shall be included in the cost of epoxy coated reinforcing bars. If threaded tie bar assemblies are used in lieu of spliced reinforcing bars as shown on the plans, the cost of such assemblies shall be included in the cost of reinforcing bars.

If WWR is required, the cost of furnishing and placing shall be included in the cost of the concrete in which it is placed.

SECTION 704 – CONCRETE FLOOR SLABS

704.01 Description

This work shall consist of placing cement concrete and reinforcing bars as a bridge floor in accordance with 105.03.

MATERIALS

704.02 Materials

10 Materials shall be in accordance with the following:

Castings	910.05
Concrete, Class C	702
Joint Materials	906
Profile Wall PVC Pipe.....	907.22
Reinforcing Bars.....	910.01
Smooth Wall PVC Pipe.....	907.23

CONSTRUCTION REQUIREMENTS

20

704.03 Forms

Forms shall be in accordance with 702.13.

The forms for transverse and longitudinal construction joints shall have a top plate

conforming to either or both the grade and crown shown on the plans or as established. When forms are unsatisfactory in any way, either before or during placing of concrete, the placing shall be suspended until defects are corrected.

30 The welding of angles, clips, rods, or other designs for form supports to the flanges of steel beams or girders in the areas where flanges are designed to carry tensile stress will not be allowed. The areas where welding will be allowed will be established in writing.

704.04 Placing Reinforcement and Concrete

Applicable provisions of 703 shall apply to placing reinforcing bars. No concrete shall be placed until the reinforcement is entirely and securely in place and has been inspected and approved. Walkways shall be in accordance with 702.20(a). Placing of reinforcement during placing of concrete will not be allowed without prior written approval. Splices, when allowed, shall be at locations of least tension in the steel.

40

The concrete deck pour sequence and procedure shall be submitted for approval a minimum of 14 days prior to the planned deck pour. The submittal shall include the following information:

- (a) the contract number;
- (b) the Contractor's name;
- (c) the bridge file number;
- (d) the Contractor's proposed pour sequence;
- (e) the Contractor's proposed pour rate;
- 50 (f) the approved concrete mix design; and
- (g) the delivery time from the concrete batching location to the jobsite.

Bridge approaches shall not be poured continuous with deck pours.

If, during the pour, the approved pour rate is not achieved, placement of transverse construction joints may be directed as shown on the plans. Placement of concrete shall be continuous between joints. Horizontal joints will not be allowed.

60 Floor drains shall be placed in gutters at locations shown on the plans and fastened securely before placing the surrounding concrete. The tops of the floor drains shall be no more than 1/2 in. below the adjacent gutter grade. The drains shall be constructed so drainage water is not discharged against portions of the structure.

Expansion joints shall be constructed as shown on the plans and the material shall be in accordance with 906.01.

704.05 Finishing Concrete

70 Concrete shall be placed and spread to the approximate contour for the full width being placed. The concrete may then be consolidated by the use of mechanical internal vibrators in accordance with applicable provisions of 702.20(c). Vibrators shall not be

used to spread or move the concrete horizontally to the extent that they cause segregation. Excessive vibration shall be avoided.

The use of a self-propelled finishing machine shall be used on all structures when either a new floor or an overlay is placed. Concrete for the full width of all traffic lanes shall then be struck off to proper profile grade and cross section by an approved, self-propelled, oscillating, finishing machine. The finishing machine may be for traffic lane widths or full width of the structure when approved. Manually operated strike-off may be used on areas outside of the width of traffic lanes or where required construction joints limit the length of deck pours to 60 ft or less.

The finishing machine shall be in accordance with the applicable requirements of 508.04(b) except it shall have a minimum of one reciprocating non-vibrating screed. The weight of the machine shall not cause undue deflection of the bridge members or falsework. The machine shall travel on steel rails, pipe, or other approved grade control, which shall be adequately supported by adjustable support securely fastened in place at spacing sufficiently close to prevent any appreciable deflection of the screed. Welding of supports to structural bridge members will not be allowed. Prior to the placing of concrete, rails for the machine support shall be set to correct elevations shown on the plans or as approved. Rails shall extend a sufficient distance beyond the area to be placed so that the machine clears all finishing operations. The screed or strike-off beam shall be made of metal or the bottom shall be metal-clad. The bottom of the screed or strike-off shall be adjusted to the true cross section of the floor surface. The machine shall make only the number of passes over the slab as required to obtain a uniform surface free of voids and reasonably true to the planned profiles and cross section. Any necessary hand finishing after removing the rails and rail supports shall be accomplished promptly, in order to fill any depressions and remove any roughness of the surface in the area from which the supports are removed. The longitudinal mechanical screeding method may be used when approved. A mechanical bridge deck finishing machine using a rotating cylinder setting approximately parallel to the longitudinal movement of the machine and operating transversely may be used for screeding the bridge deck, when approved.

When a finishing machine is not required or used, as soon as the concrete is placed and consolidated it shall be struck-off to the specified cross section and grade by means of a steel template or other satisfactory metal clad implement having a minimum width of 9 in. or greater.

For all methods of striking off the surface, an excess of concrete shall be kept in front of the cutting edge at all times. The strike-off shall go over the entire area only for the number of times necessary to produce the required profile and cross section. In general, the strike-off process shall be in accordance with 508.04 except a vibrator on the strike-off will not be required.

Immediately after screeding to the required cross section, the surface shall be checked with a long handled 10 ft straightedge of light construction laid parallel to the

centerline at intervals of no more than 2 ft transversely and 5 ft longitudinally. In case it is impracticable to operate the straightedge otherwise, it shall be operated from a footbridge or from bridges on the floor. All high spots shall be removed and
 120 depressions filled with fresh concrete and then leveled with a float having a blade approximately 5 ft long and 8 in. wide. Floating and manipulating concrete to fill depressions shall be held to a minimum. Checking and leveling shall continue until the surface has the required contour and is free of voids. The application of water to the surface for the purpose of lubricating the floats and straight edges may be used only when absolutely necessary and shall be held to a minimum. The water applied for this purpose shall be limited to such quantity as may be applied by heavy fogging as approved.

As soon as the water begins to leave, the surface shall be given a final check with
 130 the lightweight straightedge. The required cross section shall be preserved. The final surface shall be free from porous spots caused by the disturbance of coarse aggregate particles during the final checking and brooming. After final checking, the surface shall be tined in accordance with 504.03. If a new bridge deck is to be overlaid with latex modified concrete, the surface of such deck shall be heavily broom textured to provide maximum bonding of the overlay material.

Just before the concrete has taken the initial set, the ends of slabs, exposed edges, and transverse construction joints shall be rounded to a 1/4 in. radius. Longitudinal construction joints shall not be edged unless otherwise directed.
 140

Smoothness shall be in accordance with 502.20. If, after the above requirements have been met, portions of the floor are not entirely satisfactory, the removal and replacement of such portions may be ordered to secure a satisfactory floor. Such removal and replacement shall be done with no additional payment.

704.06 Curing

Floor slabs shall be cured in accordance with 702.22(a)1. Where it has been determined that a surface treatment to prevent scaling is to be used, the Engineer may prohibit the use of the membrane forming curing compound on any part of the
 150 superstructure. All vertical surfaces with exposed reinforcement shall be cured in accordance with 702.22. The floor shall be protected from pedestrian and vehicular traffic. If walking is necessary, the surface shall be timber laid on a double burlap cushion or approved equivalent.

Opening to traffic shall be in accordance with the applicable provisions of 702.24.

704.07 Method of Measurement

Concrete floor slab will be measured by the cubic yard in accordance with 702.27. However, no allowance will be made for variations in beam fillet depths, coping
 160 depths, or diaphragm depths, which are deemed necessary due to the beam camber, as constructed, which varies from that shown on the plans. Reinforcing bars will be measured in accordance with 703.07. Castings will be measured in accordance with 702.27.

704.08 Basis of Payment

The accepted quantities of concrete floor slab will be paid for at the contract unit price per cubic yard for concrete, C, superstructure. Reinforcing bars will be paid for in accordance with 703.08. Castings will be paid for in accordance with 702.28.

170 Payment will be made under:

Pay Item	Pay Unit Symbol
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Concrete, C, Superstructure.....	CYS
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The cost of forms, curing, finishing, preformed expansion joints within structure limits, slab bridge floor drains, and necessary incidentals shall be included in the cost of the pay items.

180

SECTION 705 – SIDEWALKS ON STRUCTURES

705.01 Description

This work shall consist of placing cement concrete sidewalks as an integral part of structures and reinforced concrete bridge approaches in accordance with 105.03.

MATERIALS

705.02 Materials

10 Materials shall be in accordance with the following:

Concrete, Class C	702
Joint Filler.....	906.01
Reinforcing Bars.....	910.01

705.03 Construction Requirements

The concrete shall be placed in the forms in such amount that, after being tamped and struck off, the full required thickness results. Reinforcing bars shall be in accordance with 703.

20

After floating, the surface shall be marked into uniform rectangles by transverse markings formed with a jointer having 1/4 in. radii, if shown on the plans. On cantilevered sidewalks, a marking shall be placed over the center of each bracket and the space between brackets divided into uniformly marked rectangles as directed.

At expansion joints, the sidewalk and curb shall be cut entirely through and the specified type of joint installed. All edges shall be finished to a 1/4 in. radius.

30 As soon as finished, the sidewalk shall be cured for no less than 96 h in accordance with 704.06.

The surface shall be checked with a 10 ft straightedge placed parallel to the centerline at sufficient transverse intervals to check the general contour. An acceptable surface shall vary no more than 1/8 in. from the straightedge, except at grade changes, and shall be free from blemishes.

705.04 Method of Measurement

40 Sidewalks on structures and reinforced concrete bridge approaches will be measured by the cubic yard in accordance with the dimensions shown on the plans or as ordered. Reinforcing bars will be measured by the pound in accordance with 703.07.

705.05 Basis of Payment

The accepted quantities of sidewalks on structures and reinforced concrete bridge approaches will be paid for at the contract unit price per cubic yard for concrete, C, superstructure. Reinforcing bars will be paid for at the contract unit price per pound in accordance with 703.08.

Payment will be made under:

50	Pay Item	Pay Unit Symbol
	Concrete, C, Superstructure.....	CYS

SECTION 706 – BRIDGE RAILINGS

706.01 Description

This work shall consist of the furnishing and placing of concrete or steel railings on bridges, atop or aside of wingwalls and retaining walls, furnishing and placing bridge railing pedestrian fences on new existing bridge railings, and furnishing and placing reinforced concrete moment slabs in accordance with 105.03.

MATERIALS

10

706.02 Materials

Materials shall be in accordance with the following:

	Barrier Delineators	926.02(c)
	Bridge Railing Pedestrian Fence	910.18(b)5
	Coarse Aggregate, Class B or Higher, Size No. 8 or 9.....	904.03
	Concrete, Class C	702
	Dowel Bars	910.01(b)10
	Joint Materials	906
20	Organic Zinc Primer	909.02(a)2
	Polyurethane Finish Coat	909.02(c)
	Reinforcing Bars, Epoxy Coated.....	910.01
	Steel Bridge Railing Components	910.20

Concrete for reinforced concrete moment slabs shall be QC/QA PCCP in accordance with 501 or PCCP in accordance with 502.

30 Thrie-beam railing and guardrail elements for retrofit bridge railing shall be steel and shall be in accordance with the applicable requirements of 910.09 and 910.11 for steel beam guardrail.

CONSTRUCTION REQUIREMENTS

706.03 Concrete Railing

Concrete railings shall not be placed until the falsework for all of the spans have been removed and the spans are self supporting. Concrete railings shall be constructed in accordance with 702 and 703.

40 Forms shall be smooth, tight fitting, held true to line and grade, and be removed without damaging the concrete. These forms shall be made from selected dressed lumber or steel. Moldings, panel work, and bevel strips shall be constructed according to the detail plans with mitered joints, true corners and be sharp, clean-cut, and free from cracks, spalls, or other defects. The forms shall be constructed with a plate at the base of the copings. Lumber which is 2 in. thick shall be used for coping forms.

Concrete bridge railing shall be built monolithically and continuous from support to support. A joint shall be provided at the end of the bridge between the bridge railing and the railing transition as shown on the plans.

50 Unless otherwise specified the slip form method may be used as a means to place concrete railing on bridge structures. If the slip form method is chosen, a signed and dated QCP shall be prepared and submitted to the Engineer for acceptance at least 15 days prior to the start of slip form barrier rail placement. The QCP shall include, as a minimum, the Contractor's concrete mix design, including materials sources and admixtures; the Contractor's methods of materials control and testing; the Contractor's proposed method of placement, including finishing and curing; and the corrective action that will be taken when defects are found. The QCP shall also contain documentation that shows the Contractor had a successful trial demonstration of the slip form machine previously and that proper consolidation around the reinforcing bars

60 in the wall was achieved. The slip form paver shall consolidate, screed, and finish the freshly placed concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous railing in conformance with the plans and specifications. The requirement to include a water-reducing admixture in accordance with 702.05 will be waived if the railing is both slipformed and the concrete contains silica fume in accordance with 709.05(c). The slump shall be 1 3/4 in. \pm 3/4 in. The joints may be formed or sawed as long as a satisfactory joint is attained. If joints are to be sawed, the full depth saw cut shall be made before uncontrolled shrinkage cracking occurs and within 48 h of concrete placement. Before full depth sawing, partial depth saw cuts of 2 1/2 in. \pm 1/2 in. at the

70 joint locations may be made as soon as the concrete has hardened sufficiently to enable sawing without raveling. All saw cuts shall be made at the locations shown on the plans or as directed.

All concrete bridge railings shall be reflectorized in accordance with 602.03(f).

Posts and joints shall be constructed perpendicular to grade. The line and grade shall not follow any unevenness of the superstructure.

80 If concrete railing is not in compliance with the specified design, does not present a uniform appearance of smoothness or color, or is not otherwise a workmanlike job, the Engineer may require such railing to be removed and replaced. The surface of the concrete shall vary no more than 1/4 in. in 10 ft from the specified cross section, as measured longitudinally.

706.04 Concrete Railing With Reinforced Concrete Moment Slab

90 The railing portion shall be constructed in accordance with 602.03 except it shall be cast-in-place. Type D-1 contraction joints in the moment slab shall match the locations of the joints in the abutting PCC pavement. If the abutting pavement is HMA, the D-1 contraction joints shall be spaced at 18 ft. The locations of the transverse joints in the moment slab and the railing shall be the same.

Moment slabs shall be formed with either steel or wood forms in accordance with 508.04(c)1 or 508.04(c)2. Vibration of the concrete shall be in accordance with 702.20(c). The thickness of the moment slab shall match that of the adjoining PCCP, but it shall not be less than 12 in.

The underdrains for MSE walls layer shall be compacted in accordance with 302.06(b). The MSE-wall coping may be precast or cast-in-place.

100 Type D-1 contraction joints and dowel bar assemblies shall be in accordance with 503.

Finishing and curing the moment slab shall be in accordance with 504. Finishing and curing the railing shall be in accordance with 702.

Job control testing for acceptance shall be in accordance with 502.05.

706.05 Steel Railings

110 Fabrication and placement of steel railings shall be completed in accordance with the applicable requirements of 711. Ends of tube sections shall be milled or sawed. Cut ends shall be true, smooth, and free from burrs and ragged edges. The rail system shall be continuous except as shown on the plans. Joints shall be spliced as detailed on the plans. Welding of steel shall be in accordance with 711.32. Radiographic, magnetic particle, and dye penetrant inspection will not be required. Anchor bolts shall be pre-set in concrete.

706.06 Bridge Railing Pedestrian Fence

120 Posts shall be installed plumb. They may be shimmed with an approved metallic shim. Base plate anchor bolts shall be galvanized, positioned as shown on the plans, and shall be anchored by means of epoxy adhesive.

The fabric shall be connected to the tension bar with brace bands and tension bands as shown on the plans.

The top and bottom fabric selvages shall be knuckled. If the coating is damaged during handling or placement, such portion of the fabric shall be replaced.

706.07 Method of Measurement

130 Concrete railing, including all concrete work above the top of curb, will be measured by the linear foot or by the cubic yard in accordance with the dimensions shown on the plans. No deductions will be made for reinforcing bars or joints. Concrete bridge railing transition will be measured per each for the type specified.

Bridge railing pedestrian fence will be measured by the linear foot along the bottom of the fence, from center to center of end posts.

140 Reinforced concrete moment slabs will be measured by the square yard for the thickness specified. Underdrains for MSE walls placed under moment slabs will be measured in accordance with 718.09. Type D-1 contraction joints will be measured in accordance with 503.07.

Reinforcing bars in the railing will be measured in accordance with 703.07.

Barrier delineators will be measured in accordance with 602.05.

Steel railing will be measured by the linear foot in accordance with the dimensions shown on the plans or as directed.

150 Linear measurements will be made from end to end of the railing along the centerline.

706.08 Basis of Payment

160 The accepted quantities of concrete railing will be paid for at the contract price per linear foot or cubic yard, for railing, concrete, of the type specified. Steel railing will be paid for at the contract unit price per linear foot of the type specified. Concrete bridge railing transitions will be paid for at the contract unit price per each for the type specified. Bridge railing pedestrian fence will be paid for at the contract unit price per linear foot. Reinforced concrete moment slabs will be paid for at the contract unit price per square yard for the thickness specified, complete in place. Underdrains for MSE walls placed under moment slabs will be paid for in accordance with 718.10. Type D-1 contraction joints will be paid for in accordance with 503.08. Reinforcing bars for

concrete railings and concrete bridge railing transitions will be paid for in accordance with 703.08. Barrier delineator will be paid for in accordance with 602.06.

Payment will be made under:

Pay Item	Pay Unit Symbol
170 Bridge Railing Pedestrian Fence	LFT
Concrete Bridge Railing Transition, _____ type	EACH
Railing, Concrete _____ type	LFT CYS
Railing, Steel _____ type	LFT
Reinforced Concrete Moment Slab, _____ thickness	SYS

180 The cost of painting, washers, rivets, welding, anchor bolts, and necessary incidentals shall be included in the cost of the pay items in this section.

The cost of all miscellaneous hardware including anchor bolts, base plates, fence post caps, horizontal rail end cups, fence post loop caps, tension bars, tension bands, brace bands, and fabric ties, and replacement fence due to damaging coating during handling or placement shall be included in the cost of bridge railing pedestrian fence.

The cost of the epoxy coated reinforcing bars and tie bars in the moment slab shall be included in the cost of the reinforced concrete moment slab.

190 The cost of all labor and materials required to provide for the monolithic concrete coping with moment slabs shall be included in the cost of the moment slab.

The cost of furnishing and placing all materials not specified as pay items shall be included in the cost of the pay items in this section.

SECTION 707 – PRECAST AND PRECAST, PRESTRESSED CONCRETE STRUCTURAL MEMBERS

707.01 Description

This work shall consist of fabricating, furnishing, and installing reinforced precast concrete structural members cast outside the structure, transported to, and incorporated into the structure, or precast, prestressed concrete structural members having a design 28-day concrete compressive strength, f'_c , of up to and including 8,000 psi, all in accordance with 105.03.

MATERIALS

707.02 Materials

Materials shall be in accordance with the following:

	Admixtures for Concrete	912.03
	Backer Rod.....	906.02(b)
	Coarse Aggregates, Class A or Higher, Size No. 91	904.03
	Concrete Curing Materials	912
20	Elastomeric Bearings.....	915.04
	Fine Aggregates, Size No. 23	904
	Fly Ash.....	901.02
	Ground Granulated Blast Furnace Slag	901.03
	Non-Epoxy PCC Sealers	909.10
	PCC Sealer/Healer.....	901.06
	Portland Cement.....	901.01(b)
	Reinforcing Bars.....	910.01
	Silica Fume.....	901.04
	Uncoated Seven-Wire Strand	910.01(b)7

30

Structural steel for steel intermediate diaphragms shall be in accordance with 910.02(a) and shall be galvanized in accordance with ASTM A123 after cutting, bending, and welding. Bolts for steel intermediate diaphragms shall be 7/8 in. and in accordance with 910.02(g), except they shall be type 1. All bolts, nuts, washers, and similar threaded fasteners shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55.

40

All precast, non-prestressed structural members shall be manufactured by a precast concrete producer from the QPL of Certified Precast Concrete Producers . All precast, prestressed structural members including, but not limited to concrete box-beams, I-beams, U-beams, and bulb-T beams shall be manufactured by a precast prestressed concrete producer from the QPL of Certified Precast Prestressed Concrete Producers.

CONSTRUCTION REQUIREMENTS

707.03 General Requirements

Dimensions and design requirements for structural members shall be as shown on the plans. Lengths and dimension tolerances shall be as shown on the plans or as otherwise specified. A beam which is to include a field attached curb shall have curb reinforcement located longitudinally within 3/4 in. of the locations shown on the plans. If detailed drawings are not included in the plans, working drawings shall be submitted for approval in accordance with 105.02. Certified mill test reports shall be furnished for all uncoated seven-wire strands.

Where temperature requirements are specified herein, the Contractor shall provide

the Department with written verification that the temperature requirements have been met.

- 60 Prior to the beginning of fabrication, a prefabrication meeting shall be held at the fabrication facility or another agreed upon location. The meeting shall be conducted by the Contractor and attended by the fabricator's production supervisor and quality control inspector, and the Engineer. The Contractor shall take notes of the meeting and distribute copies to all attending parties within five days of the date of the meeting. Items to be discussed at the meeting shall include a minimum of: fabrication and shipping schedule including hours of operation; line of communication between the Contractor and the Engineer; material test reports; working drawings; special fabrication methods; and fabrication hold points for inspection; final inspection and acceptance of materials; method of shipment. The requirement to hold prefabrication
- 70 meetings may be waived by the Department.

A type A field office in accordance with 628 shall be provided at any facility that fabricates precast, prestressed structural members for the Department's exclusive use. In lieu of a field office, a work area and the following items in accordance with 628 for the exclusive use by the Department shall be provided on the property where the structural members are being fabricated.

- 80
- (a) office desktop
 - (b) office chair
 - (c) broadband internet service
 - (d) telephone
 - (e) fax machine
 - (f) copier
 - (g) filing cabinet.

707.04 Steel and Concrete Requirements

(a) Reinforcing Bars

- 90 A tight coat of concrete grout extending 1/2 in. maximum from the top of precast and precast, prestressed concrete structural members will be allowed to remain on reinforcing bars extending from precast and precast, prestressed structural members. All loose and flaky material on these reinforcing bars shall be removed. Lap splices shall be in accordance with 703.06.

(b) Prestressing Strands

- 100 Uncoated seven-wire strands shall be used as prestressing strands. The splicing of straight prestressing strands is acceptable provided that the location of the splice does not occur within a concrete structural member. Splicing of draped strands is not allowed. Spliced prestressing strands shall have the same twist or lap. For single strand tensioning, slippage of the splices shall be considered in computing the elongation. For multiple strand tensioning, either all of the strands shall be spliced or not more than 10% of the strands. If all of the strands are spliced the average splice slippage

shall be considered in computing the elongation. If 10% or less of the strands are spliced, no slippage allowance will be required.

Wire breaks will be allowed to remain on the prestressed concrete casting bed as follows:

Number of Strands in Bed	Wire Breaks
19 or fewer	0
20 through 39	1
40 through 59	2
60 or more	3

110 The ends of each allowable wire break shall be tied to the strand. If more than the allowable number of wire breaks appears in a particular strand pattern, or if more than one broken wire appears in an individual strand, such strands shall be removed and replaced.

The tolerance for the center of gravity for a prestressing strand group shall be $\pm 1/4$ in. The tolerance for the longitudinal position of handling devices shall be ± 6 in.

(c) Concrete

120 Concrete shall be air entrained and in accordance with the applicable requirements of 702.05. The concrete shall have a minimum temperature of 50°F and a maximum temperature of 90°F at the time of placement. When a chemical admixture type A, D, F, or G is used, it shall be used in combination with an air entraining admixture. A high range water reducing, HRWR, or high range water reducing retarding, HRWRR, admixture system may be used. Chemical admixture types B, C, and E will only be allowed with prior written permission. Air-entraining cement will not be allowed. The cement content of the mixed concrete shall be sufficient to obtain the specified minimum 28 day compressive strength. The total of portland cement and other cementitious materials shall be a minimum of 564 lb/cu yd and shall not exceed 800 lb/cu yd. Silica fume may be added in an amount not to exceed 5% of the total cementitious material.

130

When a type A, D, or E admixture is not used, or if a type B or C chemical admixture is used, slump shall be no less than 1 in. or more than 3 in. When concrete admixtures type A, D, or E is used, slump shall be no less than 2 in. or more than 5 in. When concrete containing admixture type F, G, or admixture systems is used, the concrete shall have a slump no less than 3 in. or more than 8 in. The amount of time from mixing to placement and consolidation shall be a maximum of 30 minutes. The concrete shall not be retempered with additional amounts of chemical admixture types F or G after the initial mixing has been completed.

140

1. Cold Weather Concrete

Cold weather concrete shall be in accordance with 702.11.

2. Hot Weather Concrete

When it is necessary to fabricate concrete structural members during times of hot weather the mix water may be chilled or an appropriate amount of ice may be added to the concrete mix in order to produce concrete of the temperature specified herein.

3. Acceptance Testing

150 Acceptance of precast and precast, prestressed structural members will be based on tests for slump, air content, and compressive strength. All slump, air content, and compressive strength tests shall be performed in the presence of the Engineer. Slump and air content measurements shall be obtained each time cylinders are made. Compressive strengths of the structural members shall be determined from cylinder sets described herein. The 28-day compressive strength shall be equal to or greater than the specified concrete compressive strength. The compressive strength of the concrete for each structural member will be determined from the average strength of the cylinder set representing that member. No individual strength within a cylinder set representing a structural member shall be less than 90% of the specified concrete
160 compressive strength.

All molds, facilities, labor, and materials necessary to prepare, cure, and test the cylinder sets shall be furnished.

a. Cylinder Set

A cylinder set shall consist of at least three cylinders obtained from three separate batches or loads of concrete used in casting a structural member. The batches or loads to be sampled may be as directed by the Engineer. All cylinders for acceptance shall be 6 in. diameter by 12 in., molded and field cured in accordance with ASTM C31.
170 The Contractor may make additional cylinder sets for use in acceptance testing.

All cylinders shall be identified by use of Department-marked cylinder identification tags which are inserted a maximum of 3/8 in. into the top of each freshly molded cylinder. The cylinder number, a unique structural member identification number, temperature, air content, and slump of the concrete represented by each cylinder shall be referenced to the numbers on these cylinder identification tags and provided to the Engineer by the end of each day in which cylinders are cast.

180 Cylinders shall be stored as near as possible to the point of deposit of the concrete represented. All surfaces of the cylinders shall be protected from the elements in the same manner as the formed structural members. Cylinders shall be cured at the same temperature and moisture environment as the structural members.

Cylinders shall be in the moisture condition resulting from the selected curing treatment prior to testing. To meet these conditions, the cylinders shall be removed from the molds at the time the structural member is removed from the form work. Cylinders shall be tested in accordance with ASTM C39. The Contractor shall have on file a certificate of calibration for the testing machine. All cylinders in a cylinder set, for a given age, shall be broken within the time tolerances shown in ASTM C39.

190 The Department will remove cylinder identification tags prior to the Contractor testing the cylinders.

b. Precast, Non-Prestressed Structural Members

When fabricating precast, non-prestressed structural members, a minimum of one cylinder set shall be made per member cast. The 28-day compressive strength of the concrete for each structural member will be determined by the average strength of the cylinder set representing that member. The fabricator may elect to make additional cylinder sets for use in acceptance testing prior to 28 days.

200 **c. Precast, Prestressed Structural Members**

A minimum of two cylinder sets shall be made for each structural member cast. One cylinder set shall be tested and used to determine when the precast, prestressed structural member has met or exceeded the required strength for detensioning the prestressing bed. If an additional cylinder set as described above has been made, the Contractor may test this set to determine if the required strength for detensioning of the prestressing bed has been met or exceeded, or if the required 28-day compressive strength has been met or exceeded prior to an age of 28 days. The Engineer will accept the results from the compression testing on the additional cylinder set, in place of either the detensioning strength test results, or the 28-day compressive strength test results, if the results equal or exceed the respective compressive strength requirements. If an additional cylinder set was not made, or if the additional cylinder set does not meet or exceed the 28-day compressive strength requirement, the remaining cylinder set shall be tested at 28 days of age to determine the acceptability of the structural members.

Coring of precast, prestressed structural members shall not be performed. Precast, prestressed structural members that have been cored will not be accepted. Compressive strength results for cylinders that exceed 28 days in age or results from cylinders that do not have the Department-marked cylinder identification tag intact will result in the structural members not being accepted.

220

(d) Other Requirements

Precast concrete structural members which are not prestressed shall have a minimum compressive strength of 4,500 psi in 28 days. Precast, prestressed structural members shall be in accordance with the following unless otherwise shown on the plans:

1. Maximum water/cementitious ratio in pounds of water per pound of cementitious material shall be 0.420.
- 230 2. Minimum 28-day compressive strength of concrete shall be 5,000 psi.
3. Minimum compressive strength of concrete at time of prestressing shall be 4,000 psi.

4. Initial tension of prestressing strands shall be as shown on the plans.

240 Inspection of the precast, prestressed structural member during manufacture and
checking and testing aggregates, cement, concrete, and steel specimens shall be
performed. All specimens shall be furnished without cost to the Department.
Inspection, checking, and testing performed by the Department will not relieve the
Contractor or the fabricator from performing their own quality control inspection,
testing, and checking as necessary to maintain quality control over the manufacturing,
handling, and curing procedure. A permanent record of the force applied to and
measured elongation obtained for each prestressing strand shall be provided. The
record shall also identify the strand and structural member to which the record applies.
The accuracy of this record shall be certified by the fabricator's production supervisor
that it accurately represents the force applied and measured elongation. The certified
250 record shall be provided to the Engineer prior to shipment.

707.05 Forms

Structural members shall be manufactured in steel forms which are unyielding,
smooth, mortar-tight, and of sufficient rigidity to prevent distortion due to pressure of
the concrete. They shall be so designed that the finished concrete is in accordance with
the required dimensions and contours. The design of the forms shall take into account
the effect of vibration of the concrete as it is placed. Forms shall be chamfered in
accordance with 702.13(a). Exposed edges of curbs shall be beveled or edged. Forms
shall be set and maintained true to the lines designated until the concrete is sufficiently
260 hardened or for periods hereinafter specified. Interiors of forms shall be treated with
an approved formulated form coating which allows them to be released without
adhering, discoloring, or otherwise damaging the concrete. Form coating materials
shall not come in contact with either reinforcing bars or prestressing strands.

707.06 Placing and Finishing Concrete

The temperature of the prestressing strands and forms shall be monitored between
the time of the application of prestressing force and the placement of the concrete.
During hot weather, approved means shall be undertaken to cool the forms
immediately prior to placement of the concrete.
270

When abutment anchorage set-ups where prestressing strands are anchored to
abutments that are independent from the form, thermal adjustments shall be made if
the temperature of the prestressing strands at the time of tensioning differs by more
than 25°F from the temperature of the concrete mixture during placement. This
requirement will not apply to self-stressing beds.

Void boxes, inserts, and attachments shall be securely fastened in order to
maintain the proper position during concrete placement and consolidation. All voids
shall have weep holes or otherwise be vented during beam production until after the
280 initial concrete set, then sealed before the beams are shipped.

707.07

During and immediately after depositing, concrete shall be consolidated with vibrators and suitable spading tools. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators used may be internal, external, or a combination of both. Internal vibration shall be of sufficient duration and intensity to consolidate thoroughly, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point so that localized areas of grout are formed.

290 The entire operation of depositing and consolidating the concrete shall be conducted so that the concrete will be smooth, dense, and free from any honeycomb or pockets of segregated aggregates. The concrete in each structural member shall be placed in one continuous operation. The outside vertical faces of fascia structural members and the exposed face and top of the curb section, if applicable, shall be finished in accordance with 702.21.

The tops of all beams and the outside faces and bottom flanges of the fascia beams shall be sealed in accordance with 709.

300 **707.07 Removal of Forms and Curing**

Curing shall be in an enclosure designed to minimize heat and moisture loss. Insulated blankets may be used. The concrete in the form shall be maintained at a minimum temperature of 50°F during the entire curing cycle. Curing for precast or precast, prestressed structural members shall be done by wet curing without supplemental heat or by accelerated curing. During the period of initial set of the structural member and during the accelerated curing by radiant heat, the concrete shall be kept wet by the method outlined below for wet curing without supplemental heat.

310 Approval shall be obtained before curing is done by any means other than those outlined below.

Side forms may be removed when no distortion, slump, or misalignment of the concrete will result. Precast structural members which are not prestressed shall remain on the bottom supporting forms for the span until the concrete has reached a strength of at least 2,000 psi as evidenced by cylinders sets made and cured in the same manner as the slab.

(a) Wet Curing without Supplemental Heat

320 When wet curing without supplemental heat is used, the exposed surfaces of the structural members shall be covered by two layers of wet burlap and the burlap shall be kept wet to ensure that free water is present at all times. In lieu of using wet burlap, the Contractor may propose an alternate method which provides a moist environment with free water being present at all times. Written approval from the Engineer will be required prior to use of the proposed alternate method. Additional curing of precast or precast, prestressed structural members will not be required provided the minimum specified ultimate strength can be obtained.

330 In precast, prestressed concrete structural members, wet curing without supplemental heat shall continue until such time as the compressive strength of the concrete reaches or exceeds the strength specified for transfer of prestress or detensioning. At this point wet curing is considered to have concluded. Detensioning shall be performed within 6 h after wet curing has concluded. In precast, non-prestressed structural members, wet curing without supplemental heat shall continue until such time as the compressive strength of the concrete reaches the strength specified for stripping of forms.

(b) Accelerated Curing

340 When accelerated curing of the concrete is used, it shall be done by low pressure steam or radiant heat curing. Radiant heat may be applied by means of pipes circulating steam, hot oil or hot water, or by electric heating elements. When steam is used, the jets shall be positioned so that they do not discharge directly on the concrete, forms, or cylinders. The steam shall be at 100% relative humidity to prevent loss of moisture and to provide moisture for proper hydration of the cement.

350 Except to maintain a minimum concrete temperature of 50°F, heat shall not be applied until the concrete has attained initial set. The time of initial set may be determined by ASTM C403. Once the penetration resistance, as performed in accordance with ASTM C403, equals or exceeds 500 psi accelerated curing may begin. When the initial set is not determined by ASTM C403, the initial application of heat shall be a minimum of 4 h after final concrete placement. When retarders are used and the initial set is not determined by ASTM C403, this time shall be increased to a minimum of 6 h after final concrete placement. Heat shall always be applied at a controlled rate following the initial set of the concrete, and an effective method of retaining the heat and moisture in the concrete shall be used during the entire curing cycle.

360 During the initial application of radiant heat or live steam, the temperature measured in the concrete shall increase at an average rate not exceeding 36°F/h. The maximum concrete temperature shall not exceed 158°F. A minimum of three time and temperature recording devices capable of recording temperatures in degrees Fahrenheit at intervals not exceeding 15 minutes shall be provided throughout a contiguous form group and common heat source. The time and temperature recording devices shall be located at the portions of the contiguous form group likely to experience the maximum temperatures during curing.

370 The curing temperature shall be sustained until the concrete has reached the minimum required compressive strength for detensioning the structural members. Once the concrete has achieved the required compressive strength, detensioning shall be performed while the concrete is still warm and moist. Detensioning operations shall not interfere with the curing of the structural member.

As the application of heat is discontinued, the concrete temperature shall decrease at a rate not to exceed 50°F/h. When the concrete temperature has reached 40°F or less

above the ambient temperature outside the curing enclosure, accelerated curing is considered to have concluded. A thermometer shall be provided to monitor ambient air temperatures. This thermometer does not have to have recording capabilities.

The time and temperature recording devices shall be used to verify compliance with the heating and cooling rates contained herein.

380

When multiple structural members are cast in the same bed, all members shall meet or exceed the specified release strength prior to detensioning. Additional curing of precast or precast, prestressed structural members will not be required provided the minimum specified ultimate strength can be obtained.

390

A grinder or other methods that induce minimal amounts of heat into the prestressing strand shall be used to cut off prestressing strands. The ends of the concrete structural member where prestressing strands have been cut to be flush with the end of the member shall be coated with bituminous mastic sealant in accordance with 907.11. All prestressing strands that are exposed and protrude from the end of the beam shall be protected from rusting by use of a spray, brush, or roller-applied rust-inhibiting paint or other material that is not considered detrimental to bonding with concrete.

707.08 Handling and Shipping

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Precast and precast, prestressed structural members shall not be subjected to excessive abuse which produces crushing or undue marring of the concrete. All structural members damaged during handling, storing, transporting, or erecting shall be replaced. Unless otherwise approved, precast and precast, prestressed structural members shall be handled with a suitable hoisting device provided with a spreader sling. The spreader shall be of sufficient length to prevent horizontal forces being produced in the structural member due to lifting and shall be equipped with leads and hooks at each end. The structural members shall be lifted by the devices shown on the plans. Proposed alternate lifting devices and procedures shall be approved prior to use and shown on the working drawings. If any other method of handling is used, it shall be shown on the working drawings and approved prior to use. If the method produces horizontal forces in the precast or precast, prestressed structural member, sufficient reinforcement shall be added to compensate for them.

410

The structural members shall remain in an upright position at all times and shall be supported as indicated herein when in storage and during transportation to the construction site.

In storage, all structural members shall be fully supported across their width on battens not less than 4 in. wide with one being placed at each end at the centerline of the bearing. The supports of the structural members while in storage shall be maintained in a level position so no twisting occurs.

Precast structural members shall not be shipped or used until the concrete

420 compressive strength reaches a minimum of 4,500 psi for members which are not prestressed and 5,000 psi for members which are prestressed.

During transportation, the structural members shall be supported with truck bolsters or battens no less than 4 in. wide which are padded with no less than 1/2 in. of rubber. The ends of I-beams, U-beams, and bulb-T beams shall extend no more than the depth of the beam and not more than 3 ft 6 in. beyond the supports. The ends of box-beams shall extend no more than 1 1/2 times their depth and not more than 3 ft beyond the supports. The ends of slabs shall extend no more than the depth of the beam beyond the supports. Supports of cantilever beams shall be as shown on the plans.

430 Trucks with double bolsters will be allowed, provided the beams are fully seated on the outer bolsters and the inner bolsters are no more than 8 ft from the ends of the beams. Wood blocks or other suitable material shall be placed under the tie chains to prevent chipping the concrete.

707.09 Placing Structural Members

Erection of precast, prestressed structural members shall commence at the centerline and proceed out to the curb, one member at a time. As each structural member is placed, the transverse tie bars, if shown on the plans, shall be inserted and secured. Any shifting of the structural members shall be done while they are held free

440 of the supports by the hoisting device. The use of a steel pinch bar will not be allowed. Structural members shall be set to proper line and grade with uniform bearing on bridge seats, mortar joints, or bearing pads as required on the plans. When required, structural members shall be secured to the pier or bent with dowel rods. Holes for dowels shall be filled with mortar at fixed ends and with crack or joint filler at expansion ends. Longitudinal keyway joints shall be cleaned. A coat of cement mortar shall be scrubbed on the surface. The joint shall be filled with a non-shrinking grout composed of 1 part portland cement, 2 parts No. 23 fine aggregate, and an approved non-shrinking additive or a non-shrink, non-metallic cementation grout in accordance with ASTM C1107. All bolts or drains shown on the plans as necessary or desirable

450 to be placed in the concrete shall be placed by the methods and at the locations shown on the plans. Necessary tie rods, tie bolts, and hardware for tying structural members together shall be furnished.

Dowel holes shall not be grouted nor concrete or the forming thereof, be placed in floor slabs, diaphragms, or shear keys prior to receipt of complete documentation of the acceptability of the structural members and bearing pads, including the satisfactory laboratory reports and certifications in accordance with 915.04(f). Neither the structural members, nor the bearings will be considered incorporated into the work, and neither will be paid for until this documentation is accomplished satisfactorily.

460

Railing, when required, shall be of the type shown on the plans. The component parts shall be in accordance with 706, unless otherwise indicated on the plans. Other precast or precast, prestressed structural members shall be placed in the structure in accordance with the plans and the specifications or special provisions indicated for the type of structure being built.

The cost of all materials, including galvanizing, labor, and equipment for furnishing and installing steel intermediate diaphragms shall be included in the cost of structural member, concrete of the type and size specified.

The cost of time and temperature recording devices and their monitoring shall be included in the cost of the structural members.

520 The cost of a field office or of providing the field office items listed herein shall be included in the cost of the pay items of this section.

SECTION 708 – PNEUMATICALLY PLACED MORTAR

708.01 Description

This work shall consist of preparing stone, concrete, or other surfaces for and the pneumatic application of mortar as a plain or reinforced coating in accordance with these specifications and as shown on the plans or as directed.

MATERIALS

10 **708.02 Materials**

Materials shall be in accordance with the following:

Deformed and Smooth Steel WWR.....	910.01(b)5
Fine Aggregate	904.02(d)
Fly Ash	901.02
Portland Cement	901.01(b)
Water	913.01

20 WWR shall consist of wire, size W 1 or approximately No. 12 gauge or larger, spaced and welded at intervals greater than or equal to 2 in., and no greater than 4 in.

CONSTRUCTION REQUIREMENTS

708.03 Preparing Surface

The surface of all steel to be covered shall be thoroughly cleaned of all paint, rust, grease, dirt, or other foreign materials. All loose or defective portions of masonry to be covered shall be removed and the surface thus exposed cleaned. The use of a sand blast as an aid in cleaning any surface may be required.

30 **708.04 Reinforcement**

If WWR is required, it shall be cut into sheets of the proper sizes and bent carefully over a template so that the mesh closely follows the outline of the member to be covered. It shall be attached to such members at intervals of not to exceed 2 ft.

Insofar as feasible, the mesh shall parallel the surface of steel members 3/4 in. out from the face. Where sheets meet, they shall lap at least 4 in. and shall be fastened together securely.

- 40 WWR shall be used in all areas where the thickness of the mortar exceeds 3 in. and also if the present steel reinforcement is exposed after the disintegrated concrete has been removed. WWR shall be fastened to the concrete masonry with 1/4 in. machine bolts screwed into lead anchors driven into holes drilled into the concrete, or by pins or nails shot into the concrete by an impact gun. Such bolts or pins shall be spaced on 8 in. centers in each direction and shall be of sufficient length to space the WWR approximately 2 in. from the surface being repaired. Where WWR can be fastened to the reinforcing bars, the bolts, pins, or nails may be omitted.

708.05 Proportioning and Mixing

- 50 The dry mixture shall consist of 1 part portland cement to 3 parts sand. The cement and sand shall be dry mixed in an approved proportioning plant or in batch boxes. Measurement may be by volume or weight. Before placing the proportioned materials in the hopper of the application gun, all lumps 1/4 in. or over shall be removed by screening.

708.06 Placing Mortar

This work shall be done only by experienced personnel. No one operating the nozzle will be deemed experienced unless they have satisfactorily completed similar work on other structures of like type.

- 60 Just prior to placing mortar, the surface shall be washed with water and compressed air. The mortar shall be placed on a wet surface.

The equipment for placing the mortar shall be operated in accordance with the recommendations of the manufacturer.

- 70 In shooting any surface, the nozzle shall be held at such distance and in such position that the flowing stream of material impinges, as nearly as possible, at right angles to the surface being covered. All deposits of loose sand shall be removed. Shooting shall start on those areas where the greatest thickness is required. Mortar shall not be applied more than 2 in. thick in one operation. Where a finished thickness of more than 2 in. is required, it shall be obtained in successive operations and enough time allowed to enable the previous layer to set.

During application, the required thickness shall be maintained by shooting strips. A full thickness shall be obtained over thin edges of steel.

After completion of a section of coating, all high spots shall be cut off with a sharp trowel or screeded to a true plane as determined by the shooting strips. Finished edges shall be true and even.

708.07 Finishing

After all surfaces have been brought to the required contour and smoothness, they shall be finished with a flash coat approximately 1/8 in. thick. This coat shall produce a uniform color and finish and an approved appearance on all exposed surfaces. Proportioning and mixing of the flash coat shall be in accordance with 708.05 except white portland cement shall be used. Before placing the proportioned materials in the hopper of the application gun, all lumps 1/8 in. or larger shall be removed by screening. No less than one bag of the white cement to each 300 sq ft of surface shall be used.

90 Immediately after completion, the surface shall be covered with wet burlap or wet cotton mats and these shall be kept wet for at least 96 h. No mortar shall be placed when the air temperature is below 50°F or against a surface which contains frost. After the work has been completed, all rebound and other debris shall be removed from the work.

708.08 Method of Measurement

Pneumatically placed mortar will be measured by the square foot, complete in place. The area measured will be the actual finished surface. WWR, where used, will be measured by the square foot, complete in place.

100

708.09 Basis of Payment

The accepted quantities of pneumatically placed mortar and WWR will be paid for at the contract unit price per square foot, complete in place.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Pneumatically Placed Mortar.....	SFT
110	Welded Steel Wire Reinforcement.....	SFT

The areas where loose or defective portions of masonry exceed an average of 4 in. in depth will be paid for at a price to be determined by multiplying the contract unit price for pneumatically placed mortar, respectively, by the factors as follows:

- (a) for portions thereof whose average depth is greater than 4 in. but less than 6 in. 1.25
- 120 (b) for portions thereof whose average depth is greater than or equal to 6 in. but less than 8 in. 1.50
- (c) for portions thereof whose average depth is greater than or equal to 8 in. but less than 10 in. 1.75
- (d) for portions thereof whose average depth is greater than or equal to 10 in. but less than 12 in. 2.00

709.01

- (e) for all portions thereof whose average depth is greater than or equal to 12 in., the work shall be done as extra work. Payment will be made in accordance with 104.03.

SECTION 709 – PORTLAND CEMENT CONCRETE SEALERS

709.01 Description

This work shall consist of cleaning the concrete surface by sandblasting and applying a concrete sealer in accordance with 105.03. Surfaces to be sealed with PCC sealers shall be given a finish in accordance with 702.21. Where existing concrete or bridge decks are to be sealed, their surfaces shall be sandblasted to remove all foreign materials.

10

MATERIALS

709.02 Materials

Materials shall be in accordance with the following:

Non-Epoxy PCC Sealers 909.10

CONSTRUCTION REQUIREMENTS

709.03 General Requirements

- 20 Concrete surfaces shall be 28 days or older prior to application. The concrete surface shall be allowed to dry at least 48 h immediately prior to sealing. Sealer shall be applied only when the concrete surface, sealer, and ambient temperatures are all between 40°F and 100°F. The sealer shall be applied at the manufacturer’s specified application rate and shall not exceed the maximum rate stated on the QPL of Non-Epoxy Portland Cement Concrete Sealers. Spray applications shall be accomplished using low pressure, non-atomizing spray equipment adjusted to the wet spray condition, approximately 15 psi. The sealer shall be applied to vertical surfaces such that the spray pattern will be 6 to 8 in. wide, and all surfaces shall achieve a uniform coverage. Horizontal surfaces shall be completely flooded. The sealer shall not be applied when wind conditions may cause overspray. Sealer shall not be applied in rain or when rain is expected to occur within 2 h after completing the sealing application.

30

709.04 Surface Preparation

The surface to be sealed shall be thoroughly cleaned of all foreign materials by sandblasting if the surface is a bridge deck or older existing concrete, or by air blasting for all other surfaces, just prior to sealing. The air compressor shall be equipped with suitable separators, traps, or filters which remove water, oil, grease, or other substances from the air lines. If rain sufficient to uniformly wet the surface occurs after the cleaning operations and prior to the sealing, the surface to be sealed shall be re-sandblasted or re-airblasted.

40

The concrete to be sealed shall be cured as stated on the QPL of Non-Epoxy Portland Cement Concrete Sealers prior to sealer application.

709.05 Sealer Application

50 The concrete surface to be sealed shall be completely cleaned and shall be dry and dust free prior to the application of concrete sealer. The concrete sealer shall be applied in a crisscross pattern and should any flat or dry spots appear, more sealer shall be applied. However, there shall be no puddling of material on the surface. The sealed surface shall be allowed to cure in accordance with the manufacturer's recommendations. No vehicular traffic will be allowed on the sealed surface during the curing time.

A qualified technical representative of the manufacturer may be required to be on the job the first day the sealer is used. It shall be this representative's responsibility to instruct the workers in proper mixing, application technique, and safety precautions.

(a) Non-Epoxy PCC Sealers

60 The sealer chosen for use shall be applied at the application rate specified on the QPL of Non-Epoxy Portland Cement Concrete Sealers. The sealer shall be applied without dilution or alteration. Sealers, which are applied by spraying shall be sprayed onto the concrete surface using low pressure spray equipment with a sufficient number of passes to achieve the minimum application rate and a uniform coverage. The low pressure spray apparatus shall have a 15 psi maximum nozzle pressure with a course fan spray, such as a garden, form oil, horticulture, or other low pressure sprayer. The spray equipment tanks, and hoses shall be thoroughly clean, free of foreign matter, oil, residue, and water prior to use. Sealers shall be selected from the QPL of Non-Epoxy Portland Cement Concrete Sealers and shall be spread to achieve uniform coverage. If roller spreading is required, a clean new roller shall be used for each application
70 sequence. If brooming is specified, a clean, stiff-bristled broom shall be used to spread and work the sealer into the concrete surface.

(b) Clear Sealers

Clear sealers shall be used on all vertical wall surfaces including, but not limited to concrete bridge railing, barrier wall, and exterior concrete bridge beams when sealing is specified for these items. Clear sealers will be those identified on the QPL of Non-Epoxy Portland Cement Concrete Sealers.

(c) Alternate to Concrete Sealers

80 In lieu of concrete surface sealing for concrete barrier wall, terminal joint lugs, pier and bent caps, bridge railing, and bridge railing transitions, an alternate concrete mix design may be used.

The concrete mix design shall be as specified, except either 3% silica fume by weight of cementitious material shall be added to the mix design or 30% slag cement substitution based on the required cement content shall be incorporated into the mix.

709.06

The substitution of slag cement shall be in accordance with 702.05. A water-reducing admixture or a water-reducing retarding admixture shall be used in the mix design, and the amount of water added shall be adjusted accordingly. The use of these admixtures shall be in accordance with 702.05.

When one of these alternate concrete mix designs are used in lieu of a concrete surface sealer, a finish in accordance with 702.21 will be required.

709.06 Safety Precautions

Precautions shall be taken to protect workers from the hazards of these materials. Solvents in some of the sealers are flammable. All necessary precautions shall be taken pertaining to the handling and potential overspray of these concrete sealers.

100 **709.07 Method of Measurement**

Since payment will be made in a lump sum, only those measurements necessary to verify application rates will be made.

709.08 Basis of Payment

The accepted quantities of this work will be paid for at the contract lump sum price for surface seal.

110 If an alternate concrete mix design in accordance with 709.05(c) is used in lieu of concrete surface sealing or portions thereof, it will be paid for as surface seal.

Payment will be made under:

Pay Item	Pay Unit Symbol
Surface Seal.....	LS

The cost of all materials, labor, equipment, and necessary incidentals shall be included in the cost of this work.

120 If a curing-sealing material in accordance with 702.22(b) is used in lieu of sealing concrete surfaces or portions thereof, it will be paid for as surface seal.

SECTION 710 – PATCHING CONCRETE STRUCTURES AND REPOINTING MASONRY IN STRUCTURES

710.01 Description

This work consists of patching concrete piers, end bents, abutments, wingwalls, retaining walls, concrete structure surfaces other than bridge decks, and patching concrete drainage structures, and repointing rubble, dressed stone, or brick masonry structures in accordance with 105.03.

- 10 Bridge deck patching shall be in accordance with 722.

MATERIALS

710.02 Materials

Materials shall be in accordance with the following:

	Coarse Aggregate, Class A or Higher, Size No. 11	904.03
	Concrete, Class A	702.02
	Curing Compound	912.01
20	Epoxy-Resin-Base System	909.11
	Fine Aggregate	904.02
	Hydrated Lime.....	913.04
	Masonry Cement	901.01(c)
	Packaged Patching Products.....	901.08
	Portland Cement, Type I.....	901.01(b)
	Reinforcing Bars.....	910.01

Mortar shall consist of 1 part cement to 2 parts No. 23 fine aggregate, by volume.

- 30 Packaged patching products containing magnesium phosphate or calcium aluminate cement shall not be used.

The Contractor shall provide product-specific documentation for proportioning, mixing, placement, curing, clean up and disposal of excess patching materials.

A type B certification in accordance with 916 shall be provided for the packaged patching products. The certification shall be submitted to the Department's Concrete Engineer at least 14 calendar days prior to application of the materials.

40 **CONSTRUCTION REQUIREMENTS**

710.03 Patching Concrete Structures

(a) Concrete Removal

Areas of unsound concrete to be removed will be marked by the Engineer.

A saw cut shall be made perpendicular to the existing concrete surface a minimum of 1 in. outside marked areas. The cut shall be a minimum 1 in. deep or to the top of the reinforcement, whichever is less.

- 50 Removal of unsound concrete shall not exceed 6 in. in depth and shall be performed by means of handchipping. Handchipping tools may be hand or mechanically driven. Jackhammers shall not be heavier than nominal 45 lb class and chipping hammers shall not be heavier than nominal 15 lb class. Only chipping hammers shall be used when removing concrete within 1 in. of the reinforcement.

Mechanically driven tools shall be operated at a maximum angle of 45° to concrete surfaces.

60 Where the bond between the existing concrete and the reinforcement has been destroyed, concrete adjacent to the reinforcement shall be removed to a minimum clearance of 1 in. around the entire periphery of the exposed reinforcement. Exposed reinforcement shall not be damaged due to the removal operations. Reinforcement damaged by the Contractor shall be replaced.

Regardless of the method used, removal operations shall cease if sound concrete is being removed beyond the limits approved by the Engineer. Removal methods shall be adjusted to prevent unnecessary removal of sound concrete prior to resuming removal operations.

70 **(b) Replacement of Reinforcement**

Existing reinforcement that has lost 50% or more of its original cross sectional area shall be removed and replaced with new reinforcement of the diameter of the original reinforcement. Replacement reinforcement shall be lapped a minimum of 3 in. along the existing reinforcement.

(c) Patching

80 After concrete removal operations are completed and just prior to placing patches, all patch areas shall be sandblasted to expose aggregates in concrete surfaces and to remove rust, residual concrete and laitance layers from the surface of the reinforcement. All surfaces shall be free of dust, chips, water, and foreign material to produce a firm, solid surface for adherence of patching concrete. Cleaning shall precede application of the patching material by not more than 24 h when packaged patching products are used. Air lines for sandblasting and air cleaning shall be equipped with oil and water traps.

90 Cavities of 1/2 in. depth or greater shall be filled with concrete or a packaged patching product. Cavities of less than 1/2 in. depth shall be filled with mortar or a packaged patching product. When using concrete or mortar patching materials, the surfaces of prepared cavities and all exposed reinforcement within the cavities shall be coated with an epoxy resin adhesive in accordance with 722.07(a)1. When packaged patching products are to be applied, all surface preparation and the use of bonding agents shall be as directed by the manufacturer. The surface shall be in saturated surface damp condition with no standing water on the surface unless otherwise directed by the manufacturer.

100 The packaged patching product shall be applied only to specific surface locations recommended by the manufacturer: horizontal, vertical or overhead. Lifts of packaged patching products shall not be thicker than recommended by the manufacturer. Curing compound shall not be used between lifts. Packaged patching products may be extended with aggregate in accordance with the manufacturer's recommendations.

Concrete patches shall be finished to match the texture and finish of abutting existing concrete.

(d) Curing

For patched areas that require forms, forms may be removed after 24 h and surfaces cured in accordance with 702.22 or the forms may be left in place for 72 h and no additional curing will be required. Patched areas that do not require forms shall be cured in accordance with 702.22.

110

Patches filled with packaged patching products shall be cured in accordance with the manufacturer’s recommendations.

710.04 Repointing Rubble Masonry

Joints in rubble masonry shall be cleaned of all loose mortar and foreign material. All spaces around the rubble aggregate, after being cleaned, shall be filled with mortar and trowel finished. All loose rubble shall be settled into place before the mortar has set.

120

710.05 Repointing Dressed Stone and Brick Masonry

Joints in masonry shall be cleaned of all loose mortar and foreign material for a depth of at least twice the width of the joint. Joints shall be filled with mortar and trowel finished.

710.06 Method of Measurement

Patching concrete structures and repointing rubble, dressed stone and brick masonry in structures will be measured by the square foot of actual surface area of patching or repointing. Individual areas of less than 1 sq ft in area will be considered as 1 sq ft. Areas greater than 1 sq ft will be recorded as the actual measurement of the repaired area to the nearest 0.1 sq ft.

130

710.07 Basis of Payment

The accepted quantities of patching concrete structures will be paid for at the contract unit price per square foot complete in place. Repointing rubble, dressed stone, and brick masonry in structures will be paid for at the contract unit price per square foot of repointing masonry complete in place.

Payment will be made under:

140

Pay Item	Pay Unit Symbol
Patching Concrete Structures.....	SFT
Repointing Masonry in Structures.....	SFT

Areas where patching concrete structures or repointing rubble, dressed stone, or brick masonry in structures exceeds an average of 4 in. in depth will be paid for at a price calculated by means of multiplying the contract unit price for the respective item

711.01

by the following factors:

- 150 (a) for portions thereof whose average depth is greater than 4 in. but less than 6 in. 1.25
- (b) for portions thereof whose average depth is greater than or equal to 6 in. but less than 8 in. 1.50
- (c) for portions thereof whose average depth is greater than or equal to 8 in. but less than 10 in. 1.75
- 160 (d) for portions thereof whose average depth is greater than or equal to 10 in. but less than 12 in. 2.00
- (e) for all portions thereof whose average depth is greater than or equal to 12 in., the work shall be done as extra work. Payment will be made in accordance with 104.03.

The cost of removing the existing concrete or masonry cement, furnishing, hauling, and placing all materials, preparing the surface, and all necessary incidentals shall be included in the pay items in this section.

- 170 The cost of replacing damaged reinforcement shall be included in the cost of patching concrete structures.

SECTION 711 – STEEL STRUCTURES

711.01 Description

This work shall consist of furnishing, fabricating, erecting, and painting steel structures and parts of structures, except steel piling, in accordance with 105.03.

MATERIALS

711.02 Materials

- 10 Materials shall be in accordance with the following:

Bronze and Copper-Alloy.....	910.06
Castings	910.05
Elastomeric Bearings.....	915.04
Steel Forgings and Steel Shafting.....	910.04
Structural Steel	910.02

Where grade HPS 70W or grade HPS 50W steel is shown on the plans, the high performance steel shall be in accordance with 910.02(d).

20

Where grade 50W steel is shown on the plans, the weathering steel shall be in accordance with 910.02(b).

Material specifications shall be shown on the working drawings if the materials are different than those shown on the plans. Materials which do not require mill test reports may be changed from those shown on the plans subject to approval.

30 Sheared plates or universal mill plates shall be used for girder webs. Such plates shall be ordered with sufficient additional width to allow for trimming of edges to provide built-in camber for dead load deflection and vertical curve. Sheared plates thicker than 1/2 in. shall be planed in accordance with 711.14.

FABRICATION

711.03 General Requirements

The fabrication methods used shall be those applicable to and prescribed for the several parts of fabrication as it progresses and shall be in accordance with the requirements thereof and as further set out in this specification. Workmanship and finish shall be first-class, equal to the best general practice in a modern fabricating shop, and in strict accordance with these specifications, the plans, and such additional instructions as may be given.

Fabrication of high performance steel shall be in accordance with the Guide Specification for Highway Bridge Fabrication with HPS 70W Steel except as modified herein.

The requirements contained herein will not be waived, nor will they be modified to conform with any set of rules that any shop has adopted as its standard unless so authorized in writing.

50 Structural steel, regardless of its source, shall be fabricated within the continental limits of the United States of America.

711.04 Certification of Fabricators

(a) General Information

60 If the fabrication of secondary structural steel members and other miscellaneous structural steel components, such as but not limited to diaphragms, bearing assemblies, and miscellaneous plates does not involve any welding or heating of the steel, the fabrication facility that is fabricating these components will not be required to be American Institute of Steel Construction, AISC, certified as described in this section.

Prior to approval for fabrication, the results of the latest AISC certification review shall be made available to the Engineer to determine if items critical to successful fabrication meet the needs of the specific work.

The fabricator shall be certified from the start of the fabrication process, through and including the shop assembly in accordance with 711.44. If the certification lapses during the course of the project, the fabricator shall have plans to maintain certification or complete the fabrication process before the expiration of his certification. Failure of the fabricator to maintain his certification during the fabrication shall result in a 10% reduction in the bid price for structural steel.

Approval of the fabricator shall be requested in writing prior to ordering structural steel. A valid certification with annual endorsement shall be submitted with the request.

(b) Certification Categories

The fabricator of structural steel furnished under this section shall be certified in accordance with the AISC Certification Program for Steel Bridge Fabricators – Standard for Steel Bridges, to the certification category commensurate with the work to be fabricated. Fabricators producing fracture-critical members, intermediate bridges, or advanced bridges, shall also meet the applicable supplemental requirements of the certification program. For shop painting the Department will only accept an AISC-420-10/SSPC-QP 3 certification. It shall be the fabricator's responsibility to maintain a valid certification and annual endorsements thereto.

1. Simple Bridges

Fabricators of main load-carrying components for simple span bridges or bridges that do not have welded or bolted splices shall, as a minimum, be certified under the simple bridges category.

2. Intermediate Bridges

Fabricators of main load-carrying components for the following types of structures shall, as a minimum, be certified under the intermediate bridges category.

- a. rolled beam bridge with field or shop splices, either straight or with a radius greater than 500 ft,
- 100 b. a built-up I-shaped plate girder bridge with constant web depth, with or without splices, either straight or with a radius greater than 500 ft,
- c. a built-up I-shaped plate girder with variable web depth, either straight or with a radius greater than 1,000 ft,
- 110 d. a truss with a length of 200 ft or less that is entirely or substantially pre-assembled at the certified facility and shipped in no more than three subassemblies.

3. Advanced Bridges

Fabricators of main load-carrying components for the following types of structures shall be certified under the advanced bridges category.

- a. tub or trapezoidal box girders,
- b. closed box girders,
- 120 c. large or non-preassembled trusses,
- d. arches,
- e. bascule bridges,
- f. cable-supported bridges,
- g. moveable bridges, and
- 130 h. bridges with a curve radius equal or tighter than that specified for the intermediate bridges category above.

711.05 Working Drawings

Working drawings shall be submitted in accordance with 105.02.

Working drawings shall include a detailed bill of materials showing weights of materials completed in accordance with 711.73(b) if payment is on a unit weight basis. The working drawings shall indicate whether reaming is to be done in the shop or in the field. The working drawings shall indicate which splices are to be eliminated.

140

If the contract plans include detailed structural steel drawings, they may be used. Such drawings shall be checked. The Contractor shall provide notification in writing that it is assuming responsibility for their correctness.

711.06 Storage of Materials

Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept reasonably free from dirt, grease, and other foreign matter and shall be protected as far as practicable from corrosion.

150

711.07 Mill Orders and Shipping Statements

If requested, one copy of mill orders, change orders, and mill shipping statements for structural steel shall be furnished. The pertinent order, bill, or statement shall be furnished far enough in advance so that inspection may be provided.

711.08 Mill Test Reports

A copy of all mill test reports for all steel on hand that is to be used to fabricate

structural steel members shall be furnished prior to the start of fabrication. For steel not on hand when fabrication is started that arrives during fabrication, a copy of the mill test reports for that steel shall be provided within 24 h of receipt of the steel. If 160 copies of mill test reports are not provided within the specified timeframe, the Engineer may suspend the fabrication of all structural steel members until such time that copies of the missing mill test reports are provided. Delays due to suspension of fabrication will be considered non-excusable. If the manufacturer's mill test reports are not available, tests shall be made with no additional payment, and four certified copies of such tests shall be furnished. Four copies of an affidavit shall be furnished which shall state that the materials to be used for members not designated for 170 calculated stress and not to be marked in accordance with ASTM A6, article 18, are in accordance with the requirements of the specifications for the materials as shown on the plans. The fabricator shall have on file the mill test reports for the material from which these members were obtained.

Those items of structural steel which are considered as being in the category of members not requiring mill test reports and for which tests may not be required shall be listed on the working drawings. Approval of working drawings will indicate if it is satisfactory to waive testing of the items listed.

Mill test reports, reports from subsequent tests, and affidavits shall be marked in a manner to clearly identify them with the contract structure and also with the 180 particular member of the bridge for which these tests were made.

711.09 Notice of Beginning Work

Written notification shall be given 10 days in advance of the date on which fabrication is intended to start. Between the dates of such notification and the start of fabrication, a surface inspection of the proposed materials will be made. Any such materials cut or work done prior to this inspection may be rejected.

711.10 Facilities for Inspection

190 Facilities for the inspection of material and workmanship in the mill and shop shall be furnished, and the inspectors shall be allowed free access to the necessary parts of the works.

711.11 Straightening Material

Material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that do not injure the metal. Sharp kinks and bends will be cause for rejection of the material.

The straightening of plates, angles, other shapes, and built up members, when allowed, shall be done by methods that do not produce fracture or other injury. 200 Distorted members shall be straightened by mechanical means or, if approved, by the carefully planned and supervised application of a limited amount of localized heat. Heat straightening of ASTM A709 grade HPS 100W steel members will not be allowed. The temperatures of the heated area shall not exceed 1,200°F, a dull red, as

controlled by temperature indicating crayons, liquids, or bimetal thermometers. Parts to be heat straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat. They shall be allowed to cool very slowly. Water quenching will not be allowed. Following the straightening of a bend or buckle, the surface of the metal shall be inspected for evidence of fracture.

210

Short term application of heat to high performance steel for purposes of heat curving, heat straightening, camber and sweep adjustment, or for other reasons is limited and shall not exceed 1,100°F. Heat applications shall be in accordance with Department approved procedures.

711.12 Finish

Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping shall be done carefully and accurately.

220

All shop butt welds in flange plates shall be ground smooth and flush with the base metal on all surfaces. This shall apply to parts of equal thickness and parts of unequal thickness. Grinding shall be done in the direction of stress and in such a manner that the metal is kept below the blue brittle range. All defects exposed by grinding shall be cleaned, filled with weld metal, and reground to a uniform finish.

Curved surfaces of shoes shall be machined after weldments have been completed.

230

For cambered beams, the camber shall be to a smooth curve. Camber for beams shall be checked after shop welding is completed and while beams are supported so as to have no bending moment in the direction of camber. Beams which are not cambered shall be straight within a tolerance of 3/8 in. at center. If camber exists, beams shall be laid out with camber up. Beams shall be checked for camber while beams are supported so as to have no bending moment in the direction of camber.

711.13 Flame Cutting

240

Structural steel in accordance with these specifications may be flame cut, provided a smooth surface free from cracks and notches is secured and provided that an accurate profile is secured by the use of a mechanical guide. Hand cutting shall be done only where approved.

In all flame cutting, the cutting flame shall be so adjusted and manipulated as to avoid cutting inside the prescribed lines. Flame cut surfaces shall meet the ANSI surface roughness rating value of 1,000 except that flame cut surfaces of members not subject to calculated stress shall meet the surface roughness value of 2,000. Flame cut surfaces of members carrying calculated stress shall have their corners rounded to a 1/16 in. radius by grinding after flame cutting.

Re-entrant cuts shall be filleted to a radius of not less than 3/4 in.

711.14

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Surface roughness exceeding the above values and occasional gouges not more than 3/16 in. deep on otherwise satisfactory flame cut surfaces shall be removed by machining or grinding. Corrections of the defects must be faired with the surface of the cut on a bevel of 1:6 or less. Occasional gouges of flame cut edges more than 3/16 in. deep but not more than 7/16 in. deep may be repaired by welding with low hydrogen electrodes not exceeding 5/32 in. in diameter and with a preheat of 250°F. The completed weld shall be ground smooth and flush with the adjacent surface.

711.14 Edge Planing

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Edge planing will not be required on plates having rolled edges.

Sheared edges of plates more than 1/2 in. in thickness and carrying calculated stress shall be planed to a depth of 1/4 in. Re-entrant cuts shall be filleted before cutting.

Visually observed defects in sheared or flame cut edges of plates 4 in. or less in thickness, except ASTM A709 grade HPS 100W steel plates, shall be investigated or repaired in accordance with the following table. Repairs made by welding shall be in accordance with 711.32.

270

TABLE

Description of Discontinuity	Repair Required
All discontinuity of 1/8 in. max. depth.	None—depth shall be explored as directed.
Any discontinuity over 1 in. in length with depth over 1/8 in. but not greater than 1/4 in.	Remove and weld.
Any discontinuity over 1 in. in length with depth over 1/4 in. but not greater than 7/16 in.	Remove completely and weld. Aggregate length of welding not over 20% of plate edge length being repaired.
Any discontinuity over 1 in. in length with depth greater than 7/16 in.	Plate rejected. Defective portion may be removed and remainder may be used in 7/16 in. depth.

711.15 Abutting Joints

Abutting joints in compression members and girder flanges of trusses and arches, and in tension members where so specified on the plans, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed 1/4 in.

711.16 End Connection Angles

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Floorbeams, stringers, and girders having end connection angles shall be built to the exact length shown on the plans measured between the heels of the connection angles, with an allowable tolerance of +0 to -1/16 in. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall be no less than that shown on the working drawings after facing.

711.17 Blank**711.18 Blank****711.19 Bent Plates**

290 Cold bent, load carrying, rolled steel plates shall be in accordance with the following:

- (a) They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling.
- (b) The radius of bends shall be such that no cracking of the plate occurs. Generally accepted minimum radii, measured to the concave face of the metal, are shown in the following table:

Thickness, t, in inches	Up to 1/2 in.	Over 1/2 in. to 1 in.	Over 1 in. to 1 1/2 in.	Over 1 1/2 in. to 2 1/2 in.	Over 2 1/2 in. to 4 in.
All grades of structural steel in this specification	2 t	2 1/2 t	3 t	3 1/2 t	4 t

300

If a shorter radius is essential, the plates shall be bent hot at a temperature no greater than 1,200°F. Hot bent plates shall be in accordance with requirement (a) of 711.19.

- (c) Before bending, the corners of the plate shall be rounded to a radius of 1/16 in. throughout that portion of the plate at which the bending is to occur.

711.20 Fit of Stiffeners

310 Bearing stiffeners of girders and stiffeners intended as supports for concentrated loads shall have full bearing. This bearing shall consist of either milled, ground, or weldable steel in compression areas of flanges, welded as shown on the plans or as otherwise specified on the flanges to which they transmit load or from which they receive load. The opposite end of bearing stiffeners may have a gap between the end of the stiffener and the flange not exceeding six times the web thickness.

320 Stiffeners not intended to support concentrated loads, including transverse intermediate stiffeners and full depth diaphragm connection plates, shall be attached to the compression flange as shown on the plans. These stiffeners may bear on the tension flange or may have a gap between the end of the stiffener and the near face of the flange not exceeding six times the web thickness. Regardless of the gap dimension, the distance between the end of the stiffener weld and the near edge of the web-to-flange fillet weld shall not be less than four and not more than six times the web thickness.

711.21 Bolt Holes

(a) High Tensile Strength Bolts, and Unfinished Bolts

330 All holes for bolts shall be punched or drilled. Material forming parts of a member composed of not more than five thicknesses of metal may be punched 1/16 in. larger than the nominal diameter of the bolts whenever the thickness of the metal is no greater than 3/4 in. for structural steel or 5/8 in. for high-strength steel. If there are more than five thicknesses or when the main material is thicker than 3/4 in. for structural steel, or 5/8 in. for high strength steel, or if required in accordance with 711.24, all holes shall be subpunched or subdrilled 3/16 in. smaller and, after assembling, reamed 1/16 in. larger or drilled from the solid to 1/16 in. larger than the nominal diameter of the bolts.

(b) Ribbed Bolts, Turned Bolts, or other Approved Bearing-Type Bolts

340 All holes for ribbed bolts, turned bolts, or other approved bearing type bolts shall be subpunched or subdrilled 3/16 in. smaller than the nominal diameter of the bolt. They shall be reamed assembled, reamed to a steel template, or, after assembling, drilled from the solid at the option of the fabricator. The finished holes shall always provide a driving fit as shown on the plans or as specified.

711.22 Punched Holes

350 The diameter of the die shall not exceed the diameter of the punch by more than 1/16 in. If any holes need to be enlarged to admit the bolts, such holes shall be reamed. Holes shall be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection.

711.23 Reamed or Drilled Holes

360 Reamed or drilled holes shall be cylindrical, perpendicular to the member, and shall be in accordance with 711.21 as to size. Where practicable, reamers shall be directed by mechanical means. Drilled holes shall be 1/16 in. larger than the nominal diameter of the bolt. Diameters of holes in all material connecting top shoes to beam or girder flanges shall be 1/8 in. larger than the diameters of the bolts. Bolts connecting the flange to the top shoe shall extend into the top shoe a minimum of 1 in. Open holes for high strength bolts shall be 15/16 in. in diameter unless otherwise shown on the plans. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. If required, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and held securely while being reamed or drilled, and shall be match marked before disassembling.

370 If beams or girders are shop reamed or drilled, progressive beam or girder assembly will be allowed in accordance with 711.44 unless otherwise directed. Beams or girders spliced over the supports may be shop reamed or drilled with the webs either in a horizontal or vertical position. If the webs are vertical, they shall be supported

relative to their final erection position. If reamed with the webs horizontal, a minimum of one line of beams or girders shall be shop assembled and inspected for fit in accordance with the blocking diagram for webs vertical shown on the plans. Beams or girders spliced at the points of contraflexure shall be shop reamed or drilled while assembled in accordance with the no-load camber and reaming diagram shown on the plans. For hinged beams or girders, holes for pins shall be bored or reamed to the dimensions shown on the plans after the beams or girders are assembled in position in accordance with the no-load camber diagram shown on the plans. Flange splice bars shall be subdrilled and reamed or drilled full size while assembled.

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When girder sections are fit up in the shop for reaming or drilling of field splices, the centerlines of opposing flanges shall not deviate more than 1/8 in. with the webs in alignment.

711.24 Subpunching and Reaming of Field Connections

Holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, each face of towers, plate girders, and rigid frames shall be subpunched, or subdrilled if subdrilling is required in accordance with 711.21. These subsize holes shall subsequently be reamed while assembled, or reamed to a template, in accordance with 711.44. All holes for floor beams and stringer field end connections shall be subpunched and reamed to a steel template or reamed while assembled. Reaming or drilling full size of field connection holes through a steel template shall be done after the template has been located as to position and angle, and bolted firmly in place.

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Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be so accurately located that the parts or members are duplicates and require no match marking.

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711.25 Accuracy of Punched or Subdrilled Holes

Before any reaming is done, the punching, subpunching, or subdrilling shall be so accurate that after assembling, a cylindrical pin 1/8 in. smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces will be rejected. If a hole does not pass a pin which is 3/16 in. smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

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711.26 Accuracy of Reamed Holes and Holes Drilled Full Size

When holes are reamed or drilled full size, 85% of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 in. between adjacent thicknesses of metal. All steel templates shall have hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. The centerlines shall be used in locating accurately the template from the milled or scribed ends of the members.

711.27 Fitting for Bolting

420 Mating surfaces of steel shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends, and other deformation.

711.28 Filler Plates

430 Filler may be required at the connections due to the variation in depth of a given section or to the use of different sections at a connection point. Where filler plates are shown on the plans at such connections, the specified thickness is the theoretical thickness required. During fabrication the thickness of such fillers shall be adjusted to the actual clearances as determined by measurements of the members involved. The minimum thickness of any filler plate shall be 1/8 in., unless otherwise approved.

711.29 Toothed Expansion Plates

These plates in the roadway expansion joints shall be cut from a single plate by burning in such a way that, after the plate is cut and the toothed plates placed in the same relative position as before burning, no part of the cut shall be wider than 1/4 in. The cuts shall be straight enough that a 1/8 in. plate passes between the parts on any designated straightline cut.

440 **711.30 Blank****711.31 Peening Welds by Means of Ultrasonic Impact Treatment, UIT**

This work shall consist of removing existing paint, repairing existing cracked welds, peening existing and repaired welds, and painting in accordance with 105.03.

Equipment operators shall be American Society for Nondestructive Testing, ASNT, Level II technicians, trained in the use of the equipment for peening by ultrasonic impact methods. Proof of certification shall be furnished two weeks prior to commencing work.

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All welding shall be in accordance with the applicable section of the Bridge Welding Code. All welding shall be performed by AWS certified welders. Weld repair shall be in accordance with Bridge Welding Code section 3.7.

Paint removal shall be in accordance with 619.08(a) and 619.08(i). Painting shall be in accordance with 619.09 and 619.10.

460 Prior to beginning the peening process, all welds shall be inspected with a 10x magnifying glass and with either ultrasonic or magnetic particle non-destructive testing equipment. Welds needing repair shall be ground and repaired in accordance with the Bridge Welding Code. Peening using ultrasonic impact treatment methods shall be applied to all repaired welds in addition to the welds shown on the plans.

UIT shall be performed along the toe of the weld to cause the center of the treatment groove to be at the weld toe. UIT shall be performed to result in a uniform groove with a bright, metallic surface. All non-uniform areas shall be retreated.

711.32 Welds

470 Welding of steel shall be done only as shown on the plans or as specified and only with specific approval. Welding may be done to remedy minor defects, if approved. No temporary or permanent welds, if not shown on the plans or otherwise specified, shall be made without specific written authorization.

(a) AWS Requirements

Welding of steel bridges and bridge components shall be performed in accordance with AASHTO/AWS D1.5 Bridge Welding Code, hereinafter referred to as the Bridge Welding Code. Welders, welding operators, and tack welders shall be qualified in accordance with Bridge Welding Code, Chapter 5 Part B.

480 When welding steel structural or steel non-structural tubing or steel structural supports for highway signs, luminaires, or traffic signals, it shall be performed in accordance with AWS D1.1 Structural Welding Code – Steel, hereinafter referred to as AWS D1.1. Welders, welding operators, and tack welders shall be qualified in accordance with AWS D1.1, Chapter 4 Part C.

(b) Welding of High Performance Steel

All welding on high performance steel shall be in accordance with the Bridge Welding Code, except as modified herein and by the Guide Specification for Highway Bridge Fabrication with HPS 70W Steel, hereinafter referred to as the Guide.

490 Only submerged arc welding, SAW, and shielded metal arc welding, SMAW, processes will be allowed. Consumable handling requirements shall be in accordance with the Bridge Welding Code, Sections 12.6.5 and 12.6.6, when using reduced preheat as described in Table 3 of the Guide, except that SAW consumables for matching weld metal shall meet the hydrogen control level of H4 in accordance with Section 12, Article 12.6.2. Consumable handling requirements shall meet the provisions of the Bridge Welding Code, Section 4, when using the preheat requirements contained in Section 4, except that the diffusible hydrogen level shall never exceed H8. SMAW consumables may meet diffusible hydrogen levels of either
500 H4 or H8 except the higher preheat and interpass temperatures as noted in Table 3 of the Guide shall apply to H8 conditions.

Filler metals used to make single pass fillet welds for web to flange applications which join HPS 70W steel plates, HPS 70W to grade 50W plates and for attaching stiffeners and connection plates to grade HPS 70W webs and flanges, shall be in accordance with the Bridge Welding Code, Table 4.1 for ASTM A709, grade 50W base metal. Filler metals for single pass 5/16 in. fillet welds need not meet the requirements for exposed bare applications.

510 Filler metals used for all complete penetration groove welds joining grade HPS 70W plate to ASTM A709, grade HPS 50W or grade 50W plate shall conform to the requirements for welding grade 50W base metal.

Filler metals used for all complete penetration groove welds joining grade HPS 70W plates to grade HPS 70W plates shall conform to the requirements for HPS 70W base metal as follows:

1. Submerged Arc Welding process:

520 Wire - LA85 by Lincoln Electric Company
Flux - MIL800HPNi by Lincoln Electric Company

2. Shielded Metal Arc Welding process:

Matching - E9018MR*
Undermatching - E7018MR*

* The designator 'MR', for moisture resistant coating, is required for all SMAW electrodes used for welding HPS
530 70W steels.

The Contractor may request approval of alternate consumables for matching weld strengths in lieu of the above filler metals for SAW. The request for approval shall include documentation of successful welding and shall also include diffusible hydrogen tests, both in accordance with the Bridge Welding Code.

540 All welding procedures shall be qualified in accordance with the Bridge Welding Code Section 5, Qualification. In general, the provisions of Article 5.12 shall apply. Qualification tests shall measure strength, toughness and ductility, with results evaluated in accordance with Article 5.19. If specified on the plans, additional tests shall measure the Charpy V-notch toughness of the coarse grained area of the heat affected zone, HAZ. The notch in the specimens shall be carefully located in the coarse grained area of the HAZ, as determined by macro-etching the specimens prior to machining and testing. The toughness requirement for the HAZ shall be the same as the weld metal.

550 All procedure qualification tests shall be ultrasonically tested in accordance with the requirements of the Bridge Welding Code, Section 6, Part C. Evaluation shall be in accordance with Table 6.3, UT Acceptance – Rejection Criteria – Tensile Stress. Indications found at the interface of the backing bar may be disregarded regardless of the defect rating.

A representative of the Department will witness all welding procedure qualification tests.

Results of the welding procedure qualification tests and final welding procedure specifications shall be submitted to the Engineer for review and approval.

560 In general, post weld heat treatment will not be required. The use of such post weld heat treatment will require additional qualification testing.

Wherever magnetic particle testing is done, only the yoke technique will be allowed, as described in Section 6.7.6.2 of the Bridge Welding Code, modified to use alternating current only.

(c) Field Welding

570 Field welding shall be by the shielded metal arc welding, SMAW, process and shall be in accordance with the requirements herein. Magnetic particle testing will not be required on welded connections that do not carry calculated stresses. All field welding shall be preheated in accordance with Section 4 of the Bridge Welding Code. The Contractor shall provide a copy of the minimum preheat and interpass temperature table to the Engineer prior to beginning welding. Electrodes with a low hydrogen classification shall be used.

711.33 Stud Shear Connectors

Stud shear connectors shall be in accordance with 711.32 and as shown on the plans.

711.34 Annealing and Stress Relieving

580 Structural members which are indicated in the contract to be annealed or normalized shall have finished machining, boring, and straightening done subsequent to heat treatment. Normalizing and full annealing shall be in accordance with ASTM A941. The temperatures shall be maintained uniformly throughout the furnace during the heating and cooling so that the temperatures at two points on the member differ by no more than 100°F at any one time.

590 A record of each furnace charge shall identify the pieces in the charge and show the temperatures and schedule actually used. Proper instruments, including recording pyrometers, shall be provided for determining the temperature of members in the furnace. The records of the treatment operation shall be available and meet approval. Members, such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together shall be stress relieved in accordance with the procedure of the AWS when required by the plans or as otherwise specified.

711.35 Eyebars

600 Pin holes may be flame cut at least 2 in. smaller in diameter than the finished pin diameter. All eyebars that are to be placed side by side in the structure shall be securely fastened together in the order that they are placed on the pin and bored at both ends while so clamped. Eyebars shall be packed and match marked for shipment and erection. All identifying marks shall be stamped with steel stencils on the edge of one

head of each member after fabrication is completed so as to be visible when the bars are nested in place on the structure. The eyebars shall be straight and free from twists, and the pin holes shall be located accurately on the centerline of the bar. The inclination of any bar to the plane of the truss shall not exceed 1/16 in. in 1 ft.

The edges of eyebars that lie between the transverse centerline of their pin holes shall be cut simultaneously with two mechanically operated torches abreast of each other, guided by a substantial template, in such a manner as to prevent distortion of the plates.

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711.36 Facing of Bearing Surfaces

The top and bottom surfaces of steel slabs, base plates, and cap plates of columns and pedestals shall be planed, or the plates hot-straightened. Parts in contact with them shall be faced.

Sole plates of beams and girders shall have full contact with flanges. Sole plates and masonry plates shall be planed or heat straightened.

620 Cast pedestals shall be planed on surfaces to be in contact with steel and shall have surfaces to be in contact with masonry, rough finished.

Surfaces of bronze bearing plates intended for sliding contact shall be finished.

The surface finish of bearing plates, base plates, and other bearing surfaces that are to come in contact with each other or with concrete shall meet the following ANSI surface roughness requirements as defined in ANSI B 46.1:

	Bridge rollers and rockers	ANSI 250
	Heavy plates in contact with shoes to be welded.....	ANSI 1000
630	Milled ends of compression members, milled or ground ends of stiffeners and fillers	ANSI 500
	Pins and pin holes.....	ANSI 125
	Sliding bearings.....	ANSI 125
	Steel slabs.....	ANSI 2000

711.37 Pins and Rollers

640 Pins and rollers shall be turned to the dimensions shown on the working drawings and shall be straight, smooth, and free from flaws. Pins and rollers more than 9 in. in diameter shall be forged. Pins and rollers 9 in. or less in diameter may be forged or cold finished, carbon steel shafting. In pins larger than 9 in. in diameter, a hole no less than 2 in. in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling.

711.38 Boring Pin Holes

Pin holes shall be bored true to the specified diameter, smooth and straight, at

right angles with the axis of the member, and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut. The distance outside to outside of end holes in tension members, and inside to inside of end holes in
650 compression members shall not vary from that specified more than 1/32 in. Boring of holes in built-up members shall be done after the bolting is completed.

711.39 Pin Clearances

The diameter of the pin hole shall not exceed that of the pin by more than 1/50 in. for pins 5 in. or less in diameter, or 1/32 in. for larger pins.

711.40 Threads for Bolts and Pins

Threads for all bolts and pins for structural steel construction shall be in accordance with the United Standard Series UNC-ANSI B 1.1, Class 2A for external
660 threads and Class 2B for internal threads, except that pin ends having a diameter of 1 3/8 in. or more shall be threaded six threads per 1 in.

711.41 Pilot and Driving Nuts

Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified.

711.42 Finishing Cast Steel

The surface shall be finished as called for on the detail plans. Surfaces marked “finish” shall be made to exact size and shape and in such manner that removes all tool
670 marks. If marked “rough finish” the tool marks need not be removed. However, there shall be no irregularities greater than 1/32 in. in height on rough finished surfaces.

711.43 Finished Members

The several pieces forming a built-up member shall fit together closely and accurately, and the finished member shall be true to line and free from twists, bends, and open joints.

Cover plates on trusses, beams, and girders shall be so nearly straight that variations do not exceed 1/16 in. in 5 ft, with a maximum variation not to exceed 3/16
680 in. at the center of the plates.

711.44 Shop Assembling

The field connections of main members of trusses, arches, continuous beam spans, bents, tower faces, plate girders, and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing and then shall have their sub-size holes reamed to specified size while the connections are assembled. Assembly shall be full truss or girder assembly unless progressive beam or girder assembly, full chord assembly, progressive chord assembly, or special complete structure assembly is shown on the plans or otherwise specified.
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Each assembly including camber, alignment, accuracy of holes, and fit of milled joints will be approved before reaming is commenced.

A camber diagram shall be furnished by the fabricator showing the camber at each panel point of each truss, arch rib, continuous beam line, plate girder, or rigid frame. When the shop assembly is full truss or girder assembly or special complete structure assembly, the camber diagram shall show the camber measured in assembly. When any of the other methods of shop assembly are used, the camber diagram shall show calculated camber.

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(a) Full Truss or Girder Assembly

Full truss or girder assembly shall consist of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at one time.

(b) Progressive Beam or Girder Assembly

Progressive beam or girder assembly shall be accomplished by one of the following methods. In case the structure is on a horizontal curve, other assembly methods may be approved on the working drawings.

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1. This method shall consist of the assembly of at least three contiguous members, and no less than 150 ft. At least one beam or girder shall be added at the advancing end of the assembly before any member is removed from the rearward end so that the assembly portion of the structure is never shorter than that specified above. Each successive laydown assembly shall always include a previously reamed splice and the main member on each side of this splice.

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2. The alternate method shall consist of placing the required number of contiguous shop members so that two complete spans are assembled for the first laydown. Each successive laydown shall consist of the required number of contiguous members to complete the next two spans while retaining in the new laydown the last bearing member from the previous laydown. On laydowns for structures comprised of an odd number of spans, a laydown of one span will be allowed to complete the structure. This laydown shall be the last span unless otherwise approved on the working drawings. Each retained bearing member shall be reassembled in its second laydown with the same relative orientation to a common base line as it was in the first laydown.

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(c) Full Chord Assembly

Full chord assembly shall consist of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower, then reaming their field connection holes while the members are

740 assembled and reaming the web member connections to steel templates set at geometric, not cambered, angular relation to the chord lines.

Field connection holes in web members shall be reamed to steel templates. At least one end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member. The templates at both ends of the member shall be located accurately from one of the milled ends or scribed lines.

(d) Progressive Chord Assembly

750 Progressive chord assembly shall consist of assembling contiguous chord members in the manner specified for full chord assembly and in the number and length specified for progressive truss or girder assembly.

(e) Special Complete Structure Assembly

Special complete structure assembly shall consist of assembling the entire structure, including the floor system. This procedure is ordinarily needed only for complicated structures such as those having curved girders or extreme skew in combination with severe grade or camber.

711.45 Drifting of Holes

760 Except where drifting is specifically prohibited by this specification, the drifting done during assembly shall be only to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If a hole needs to be enlarged to admit the bolt, it shall be reamed.

711.46 Match Marking

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match marked and a diagram showing such marks shall be furnished.

711.47 Shop Cleaning and Painting

770 Shop cleaning and painting shall be in accordance with applicable requirements of 619.

711.48 Shop Cleaning and Storage of Weathering Steel

The fabricator shall protect bare steel sections and sub-assemblies so as not to damage or stain them. The use of paints, crayons, or other materials used for identification purposes shall be avoided on bare steel sections. Storage shall be such to enable free drainage to avoid moisture pockets.

780 A sound uniform surface for the formation of a protective oxide coating on all surfaces shall be prepared as follows.

(a) Hot Rolled Products

The entire length and perimeter of each fascia beam or girder shall be cleaned in accordance with 619.08(e). The entire length and perimeter of each interior beam or

711.49

girder shall be cleaned in accordance with 619.08(d). Unless otherwise specified, all components such as, but not limited to, diaphragms, cross frames, stiffeners, bearing assemblies, and sway bracing that are permanently incorporated into the structure shall be cleaned in accordance with 619.08(d). Contamination from grease, oil, or shop marking shall be avoided. If such contamination is unavoidable, such surfaces shall be
790 cleaned in accordance with 619.08(a).

(b) Welded Area

All exposed welds on fascia surfaces shall be prepared by means of power grinding in accordance with 619.08(i) or blast cleaning in accordance with 619.08(e) to remove welding flux, slag, scale, or spatter.

711.49 Furnishing Bolts

Sufficient field bolts shall be furnished to complete the entire structure.

800 **711.50 Weighing of Members**

If it is specified that part of the material is to be paid for by actual weight, finished work shall be weighed in the presence of the inspector, if practicable. Satisfactory scales shall be supplied, and all work involved in handling and weighing the various parts shall be performed.

711.51 Full Size Tests

When full size tests of fabricated structural members or eyebars are required by the contract, the plans or specifications shall state the number and nature of the tests, the results to be attained, and the measurements of strength, deformation, or other
810 performance that are to be made. Suitable facilities, material, supervision, and labor necessary for making and recording the tests shall be provided. The cost of testing, including equipment, handling, supervision, labor, and incidentals for making the tests shall be included in the contract price for structural steel, unless otherwise specified.

711.52 Acceptance

Acceptance of any material or finished member shall not preclude its rejection if found to be defective, either during fabrication or erection. Rejected material shall be replaced and poor workmanship corrected promptly.

820 **711.53 Shipping**

Structural members shall be loaded on trucks or cars in such manner that they can be transported to and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged.

If required, pins, nuts, bolts, and other small details shall be boxed or crated and the weight of each piece or box marked on it in plain figures.

Written permission shall be obtained prior to shipping plate girders with the webs horizontal.

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Splice plates shall not extend beyond the ends of beams or girders after bolting for shipment.

Member lengths shall be subject to the provisions of the current edition of the Oversize-Overweight Vehicular Permit Handbook.

The Contractor shall be responsible for obtaining all required transportation permits.

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ERECTION

711.54 General Requirements

The erection methods shall be those prescribed for the several parts which constitute the finished structure and shall be in accordance with the requirements set forth herein. Workmanship and finish shall be first-class and all work done in a substantial and workmanlike manner in accordance with these specifications and in reasonable close conformance with the lines, grades, dimensions, and details shown on the plans, or as directed.

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No erection shall be done without the approval of the Engineer. Before starting erection, information shall be fully given as to the erection methods and the amount and character of the equipment proposed to be used, which shall be subject to approval. Approval, if given, shall not be considered as relieving the Contractor of its responsibility for the safety of its methods or equipment or from carrying out the work in full accordance with the plans and specifications.

711.55 Delivery of Materials

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If the contract is for erection only, the materials entering into the finished structure will be provided free of charge at the place designated and loaded or unloaded as specified. Material, which is required to be unloaded, shall be unloaded promptly on delivery to the place designated. Otherwise, the Contractor shall be responsible for demurrage charges.

711.56 Handling and Storing

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Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. If the contract is for erection only, the material shall be checked against the shipping lists and all shortages or injuries discovered shall promptly be reported in writing. The Contractor shall be responsible for the loss or damage of material after receipt.

711.57 Falsework

The falsework shall be properly designed and substantially constructed and maintained for the loads which come upon it. Plans for falsework or for changes in an existing structure necessary for maintaining traffic shall be prepared and submitted for

711.58

approval. Approval of these plans shall not be considered as relieving the Contractor of any responsibility.

880 **711.58 Bearings and Anchorages**

Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed, or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing on the masonry.

The holes shall be drilled and the anchor bolts, except where the bolts or anchor plates are built into the masonry, shall be set. The bolts shall be set accurately and fixed with portland cement grout completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of the erection. The nuts on anchor bolts at the
890 expansion ends of spans shall be adjusted to enable the free movement of the span.

711.59 Field Straightening Material

If it is necessary to straighten beams, plate girders, plates, angles, and other shapes in the field, it shall be done in accordance with the applicable requirements of 711.11.

Before straightening a carrying member, a proposed method of straightening shall be submitted in writing. Approval shall be received prior to commencing the work.

711.60 Field Assembly of Steel

900 Parts assembled in the field shall be assembled accurately as shown on the plans. Matchmarks shall be followed. The materials shall be handled carefully so that no part is bent, broken, or otherwise damaged. Hammering which would injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned thoroughly before assembling.

Unless erected by the cantilever method, truss spans shall be erected on blocking so placed to give the trusses the required camber. Truss spans shall be completely bolted on the blocking except for stringers and bottom lateral connections which shall be bolted after the span is swung. In emergencies or special cases and with specific
910 approval, truss spans may be swung with main joints fully filled with bolts and drift pins.

Structural steel shall be erected using sufficient full size drift pins to enable placement of bolts without damage thereto and to facilitate setting splices to grade.

At the time of erection, no less than 50% of the holes in all connections shall be filled with bolts. The bolts shall not be tightened more than snug tight at this stage.

Any drifting required shall be only such that draws the parts into position but not
920 sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled.

All field splices are optional, except as shown on the plans. Splice elevations have been calculated to include structural steel dead load only, with falsework removed. The tops of beam or girder splice plates shall be adjusted to the splice elevations shown on the plans before bolting field splices.

Splices shall be set to grade with the steel unsupported by falsework and prior to final bolting. After bolting is complete, these elevations will be checked. Adjustment shall be made as directed, if steel elevations are not within allowable tolerances.

711.61 Misfits

The correction of minor misfits involving harmless amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting shall be reported immediately and approval of the method of correction shall be obtained. The correction shall be made in the presence of the inspector. If the contract provides for complete fabrication and erection, the Contractor shall be responsible for all misfits, errors, and injuries and shall make the necessary corrections and replacements. If the contract is for erection only, the inspector, with the cooperation of the Contractor, shall keep a correct record of labor and materials used. Within 30 days, an itemized bill shall be presented for approval.

711.62 Pin Connections

Pilot and driving nuts shall be used in driving pins. They shall be furnished without charge. Pins shall be driven so that the members take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

711.63 Blank

711.64 Diaphragm Connections

Diaphragm connections other than those shown on the plans may be allowed. If other connections are proposed, details shall be submitted for approval. The Contractor shall assume full responsibility for layout of all diaphragm connections and for the accuracy of all fitted parts. Connections will not be allowed which require welding to the web, except at supports.

711.65 Bolted Connections Using High Strength Bolts

(a) General

This subsection covers the assembly of structural joints using ASTM F3125, grade A325 high strength heavy hex bolts tightened to a high tension. The bolts are to be used in holes provided in accordance with 711.21, 711.22, and 711.23.

High strength bolts shall be 7/8 in. in diameter unless noted.

970 **(b) Bolts, Nuts, and Washers**

Bolts, nuts, and washers shall be in accordance with 910.02(g). All galvanized nuts shall be lubricated with lubricant containing a visible dye. Black bolts shall be oily to the touch when installed. Weathered or rusted bolts shall be cleaned and lubricated prior to installation.

(c) Bolted Parts

980 The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit together solidly when assembled and shall not be separated by gaskets or any other interposed compressible material. When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts, or washers, shall be free of scale, except tight mill scale, and shall also be free of dirt, loose scale, burrs, other foreign material, and other defects that would prevent solid seating of the parts. Contact surfaces within slip-critical joints shall be free of oil, grease, and any other material that reduces friction between the contact surfaces.

(d) Installation

1. Bolt Tension

990 Each fastener shall be tightened to provide, when all fasteners in the joint are tight, at least the minimum bolt tension shown in Table A for the size and grade of fastener used.

TABLE A

Bolt Tension for ASTM F3125, Grade A325 Bolts	
Bolt Size, in.	Minimum Bolt Tension,* lb
1/2	12,050
5/8	19,200
3/4	28,400
7/8	39,250
1	51,500
1 1/8	64,900
1 1/4	82,400
1 3/8	98,200
1 1/2	119,500
* Equal to the proof load given in ASTM F3125	

1000 Threaded bolts shall be tightened with properly calibrated wrenches or by the turn-of-nut method. If required because of bolt entering and wrench operation clearances, tightening by either procedure may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 s.

Installation of all high strength bolts shall be in accordance with AASHTO LRFD Bridge Construction Specifications. The snug tight condition as defined in AASHTO LRFD Bridge Construction Specifications shall be obtained for all final tightening.

1010 A Skidmore-Wilhelm calibrator or other acceptable bolt tension indicating devices will be required on the project site for use during bolt installation. Periodic tests shall be performed to ensure the installed bolt, nut, and washer assembly meets the above requirements. Such tests shall be performed each work day when calibrated wrench tightening is used. For short grip bolts, direct tension indicators with solid plates may be used to perform these tests. Direct tension indicators shall first be checked with a longer grip bolt in the Skidmore-Wilhelm calibrator.

2. Washers

1020 All fasteners shall have a hardened washer under the nut or bolt head turned in tightening. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.

3. Calibrated Wrench Tightening

1030 If calibrated wrenches are used to provide the bolt tension specified in 711.65(d)1, the settings shall be such as to induce a bolt tension of 5% to 10% in excess of this value. These wrenches shall be calibrated at least once each working day by tightening, in a device capable of indicating actual bolt tension, no less than three typical bolts of each diameter from the bolts to be installed. Power wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be turned to touch up bolts previously tightened which may have been loosened by the tightening of subsequent bolts. This shall be continued until all are tightened to the required amount.

4. Turn-of-Nut Tightening

1040 When the turn-of-nut method is used to provide the bolt tension specified in 711.65(d)1, there shall first be enough bolts brought to a snug tight condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in all remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table B with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE B

Nut Rotation ⁽¹⁾⁽²⁾ from Snug Tight Condition Disposition of Outer Faces of Bolted Parts		
Both faces normal to bolt axis, or 1 face normal to axis and other face sloped ⁽³⁾ (bevel washer not used)		Both faces sloped ⁽³⁾ from normal to bolt axis (bevel washers not used)
Bolt length ⁽⁴⁾ not exceeding 8 diameters or 8 in.	Bolt length ⁽⁴⁾ exceeding 8 diameters or 8 in.	For all lengths of bolts
1/2 turn	2/3 turn	3/4 turn
<p>(1) For coarse thread heavy hexagon structural bolts of all sizes and lengths and heavy hexagon semi-finished nuts.</p> <p>(2) Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation: 1/6 of a turn over and nothing under.</p> <p>(3) Slope 1:20 maximum.</p> <p>(4) Bolt length is measured from underside of head to extreme, end of point.</p>		

(e) Inspection

1050

1. It will be determined that requirements 2 and 3 of 711.65(e) are met in the work. When the calibrated wrench method of tightening is used, the Engineer shall be given full opportunity to witness the calibration tests prescribed in 711.65(d)3.
2. The installation and tightening of bolts will be observed to determine that the selected tightening procedure is properly used and that all bolts are tightened.

1060

3. The following inspection shall be used unless a more extensive or different inspection procedure is specified.
 - a. An inspection wrench which may be either a torque wrench or a power wrench that can be adjusted accurately in accordance with 711.65(d)3 shall be used.

1070

- b. Three bolts of the same grade, size and condition as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. Length may be any length representative of bolts used in the structure. There shall be a washer under the part turned in tightening each bolt.
 - c. When the inspecting wrench is a torque wrench, each bolt specified in requirement 3b of 711.65(e) shall be tightened in the calibration device by any convenient means to the minimum tension specified for its size in

- 1080 711.65(d)1. The inspecting wrench shall then be applied to the tightened bolt. The torque necessary to turn the nut or head 5°, or approximately 1 in. at a 12 in. radius, in the tightening direction shall be determined. The average torque measured in the tests of three bolts shall be taken as the job inspecting torque to be used in the manner specified in requirement 3e of 711.65(e).
- 1090 d. When the inspecting wrench is a power wrench, it shall be adjusted so that it shall tighten each bolt specified in requirement 3b of 711.65(e) to a tension at least 5% but no more than 10% greater than the minimum tension specified for its size in 711.65(d)1. This setting of wrench shall be taken as the job inspecting torque to be used in the manner specified in requirement 3e of 711.65(e).
- 1100 e. Bolts represented by the sample prescribed in requirement 3b of 711.65(e) which have been tightened in the structure shall be inspected by applying, in the tightening direction, the inspection wrench and its job inspecting torque to 10% of the bolts, but no less than two bolts, selected at random in each connection. If no nut or bolt head is turned by this application of the job inspecting torque, the connection shall be accepted as properly tightened. If a nut or bolt head is turned by the application of the job inspecting torque, this torque shall be applied to all bolts in the connection. All bolts whose nut or head is turned by the job inspection torque shall be tightened and reinspected, or alternatively, the fabricator or erector, at his option, may retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.
- 1110

711.66 Bolted Connections Using Other Than High Strength Bolts

Bolts for these connections shall be in accordance with 910.02(h).

711.67 Final Clean-Up

Final clean-up shall be conducted in accordance with 104.07.

1120 711.68 Structural Steel Cutting, Rivet and Bolt Removal, and Drilled Bolt Holes in Repair Projects

Field cutting of structural steel shall be done as shown on the plans or as directed.

Rivets or bolts connecting steel at locations shown on the plans or as directed shall

711.69

be removed. This work shall be done in a manner that does not damage the surrounding steel. If necessary, such work shall be done by drilling.

Bolt holes shall be drilled as directed in the field. A bolt hole is a hole required for one bolt drilled through any number and thicknesses of metal plates.

1130

711.69 Jacking and Supporting Beams

When jacking and supporting a beam is required on a bridge repair project, the proposed method for jacking and supporting shall be submitted for approval. This work shall not be performed until a method is approved.

711.70 Field Cleaning and Storage of Weathering Steel

1140 Cleaning of structural steel specified to be left unpainted shall be in accordance with 619.08(a) or 619.08(c) or as determined by the Engineer, depending on the severity of the soilage. Foreign matter which adheres to the steel after it has been blasted, and which inhibits formation of the oxide film shall be removed as soon as practical. The use of acids to remove scale and stains will not be allowed.

Storage shall be such to enable free drainage to avoid moisture pockets.

711.71 Painting

After erection is complete, the structure shall be painted unless otherwise provided. Painting shall be in accordance with the applicable requirements of 619.

711.72 Method of Measurement

1150 Structural steel shapes, fabricated steel, steel castings, iron castings, bolts, pins, rollers, rockers, anchor bolts, and threaded rods will be measured by the pound. If the Schedule of Pay Items includes a lump sum item for structural steel, all of the materials listed above shall be included in such pay item. No measurement will be made.

Stud shear connectors placed on new structural steel will not be measured. Stud shear connectors placed on existing structural steel will be measured by the number installed.

1160 Bronze plates will be measured by the pound. Pay weight will be based on a theoretical density of 536 lb/cu ft. Volume will be computed based on finished dimensions. No deductions will be made for drilled holes.

Field cutting of structural steel will be measured by the square inch as determined by the multiplication of the length times the depth of the cut. Removal of rivets and removal of bolts will be measured by the number of each removed. Drilled holes for bolts on repair work will be measured by the number of drilled holes.

Jacking and supporting structural members will not be measured for payment.

1170 Peening will be measured by the linear inch of peened weld. The length of weld

peened will be measured once per weld regardless of the number of passes necessary to complete the work as specified.

Repair welds will be measured by the linear inch of repaired weld.

711.73 Basis of Payment

1180 The accepted quantities of structural steel shapes, fabricated steel, steel castings, iron castings, bolts, pins, rollers, rockers, anchor bolts, and threaded rods will be paid for at a contract lump sum price if the Schedule of Pay Items includes a lump sum pay item for structural steel. Changes from the estimated quantities shall be in accordance with 711.73(a).

If the Schedule of Pay Items does not include a lump sum pay item for structural steel, the accepted quantities of structural steel will be paid for at the contract unit price per pound for structural steel. Such pay item will include all work listed above, complete in place. Payment will be in accordance with 711.73(b).

1190 Stud shear connectors placed on existing structural steel will be paid for at the contract unit price per each, complete in place and accepted.

The accepted quantities of bronze plates will be paid for at the contract unit price per pound. The accepted quantities of field structural steel cutting will be paid for at the contract unit price per square inch for structural steel, field cut. The accepted quantities of rivet removal, bolt removal, and drilled holes will be paid for at the contract unit price per each for rivet, remove; per each for bolt, remove; and per each for drilled hole.

1200 Jacking and supporting structural members, if specified as a pay item, will be paid for at the contract lump sum price for jacking and supporting the types of structural members shown in the Schedule of Pay Items.

The accepted quantities of peened weld will be paid for at the contract unit price per inch. The accepted quantities of repaired weld will be paid for at the contract unit price per inch.

Bolts, including anchor bolts and threaded rods, will be paid for as the full weight computed on the basis of 490 lb/cu ft, including nuts and washers, for the actual number of bolts in the structure.

1210 If welding is shown on the plans, the weights of the structural steel parts will be computed as described above.

The weight of castings will be computed on the basis of 490 lb/cu ft for cast steel, and 450 lb/cu ft for cast iron, based on the net volume of the finished castings as shown on the plans, including fillets at angles. No deductions will be made for holes required to be drilled in castings or for rounding the corners of castings.

(a) Lump Sum Basis

1220 An estimated weight of structural steel will be shown on the plans. Such weight will be computed by the same method as that used when computing the estimated weight when paid for on a unit price per pound basis from semi-detailed plans. This weight will include all structural steel and miscellaneous metals unless otherwise included in specific pay items.

The weight of structural steel shown on the plans is approximate only. For a lump sum pay unit, the Contractor shall determine the weight on which the bid is based.

1230 If there is a discrepancy between the plan weight and the actual weight, no decrease or increase in the payment for the work will be made on account of such discrepancy.

1240 If a change in the plans is made which will affect the weight of material to be furnished, payment for the addition or reduction of structural steel quantities required as a result of such change in plans will be made at a unit price per pound obtained by dividing the lump sum amount for structural steel by the total estimated weight of structural steel shown on the plans. Such unit price may be adjusted in consideration of the fabricating and connection cost. Changes in the plans involving classifications of structural steel may increase the pay quantities. Such additional quantities will be paid for on comparison of evidence of invoice prices.

(b) Unit Weight Basis

The weight of materials will be shown in the bill of materials on the plans when this information is included in such plans, or as computed from the fabricator's approved working drawings when this information is not included in the plans. In either case, such weight shall include all changes ordered.

1250 For rolled sections, the gross weight of the steel will be considered. The weight will be figured on the basis of 490 lb/cu ft. The weight of each piece will be the weight of the smallest regular shape from which the detail piece can be cut, not deducting cuts or holes. When so shown on the contract plans or on the approved working drawings, the weight of groups of two or more pieces shall be the weight of the smallest regular shape from which the given group of detail pieces may be cut by properly arranging the cuts.

Payment will be made under:

	Pay Item	Pay Unit Symbol
1260	Bolt, Remove.....	EACH
	Bronze Plates.....	LBS
	Drilled Hole.....	EACH
	Jacking and Supporting _____ structural member type	LS

	Peening Weld, UIT	INCH
	Repair Weld.....	INCH
	Rivet, Remove	EACH
	Structural Steel	LS
		LBS
	Structural Steel, Field Cut	SIN
1270	Stud Shear Connectors	EACH

The cost of paint removal, painting, non-destructive testing, equipment, labor, materials, access, permits, and necessary incidentals shall be included in the cost of peening weld, UIT.

The cost of drilling holes for anchor bolts, elastomeric bearings, bridge bearing pads, fabrication, painting, erecting falsework, welding material, Charpy V-Notch toughness tests, and necessary incidentals shall be included in the cost of the pay items in this section.

1280

The cost of stud shear connectors placed on new structural steel will be included in the cost of structural steel.

No increase in pay weight will be considered if diaphragm connections other than those shown on the plans are approved and used.

1290

Shims between beams and top shoes of the thicknesses necessary to adjust the steel to planned elevations shall be furnished using either the plan datum or another datum as established. No adjustment will be made to the pay quantities as long as the total weight of shims required does not exceed that planned. No shim shall be less than 1/8 in. in thickness.

No allowance in weight will be made for work which is done at the option of the Contractor. No payment will be made for material used at the convenience of the Contractor in excess of the quantities shown on the plans.

SECTION 712 – TIMBER STRUCTURES

712.01 Description

This work shall consist of furnishing the materials for and the construction of timber structures, such parts of other structures which are of timber, and wood plank floors for structures in accordance with 105.03.

MATERIALS

10

712.02 Materials

Materials shall be in accordance with the following:

	Iron Castings.....	910.05(b)
	Lumber and Timber (Treated).....	911.02
	Lumber and Timber (Untreated).....	911.01
	Malleable Iron Castings.....	910.05(d)
	Preservatives.....	911.02(h)
	Steel Castings	910.05(a)
	Structural Steel	910.02
20	Waterborne Finish Paint.....	909.02(d)

Machine bolts, drift bolts, and dowels shall be medium steel. Machine bolts shall have square heads and nuts, unless otherwise specified. Nails shall be full-barbed, heavy, bright, flat-head, car nails. Lumber and timber shall be treated or untreated. Rods, plates, bars, and shapes shall be structural steel. Castings shall be steel or iron. Washers may be cast O. G. or malleable castings or they may be cut from medium steel plates. Spikes shall be cut, wire, or boat spikes. Spikes, bolts, dowels, washers, and lag screws shall be black or galvanized.

30

CONSTRUCTION REQUIREMENTS

712.03 General Requirements

The ground underneath and in the immediate vicinity of all stored material shall be cleaned of weeds and rubbish and kept well drained. Lumber and timber at the site of the work shall be stored in piles. Untreated lumber shall be open stacked at least 12 in. above the ground surface, arranged to shed water and prevent warping, and protected by a weatherproof covering when so required. Creosoted timber and piling shall be closed-stacked so that warping is prevented and the tops of the stacks are covered. Treated timber shall be handled carefully without sudden dropping, breaking of outer fibers, bruising, or penetrating surfaces with tools. It shall be handled with rope slings. Canthooks, peaveys, spikes, or hooks shall not be used. Creosoted piling may be handled with chains.

40

Workmanship shall be first-class throughout. Competent bridge carpenters shall be employed. All framing shall be true and exact. Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces will be considered evidence of poor workmanship and sufficient cause for the dismissal of a worker causing them.

50

In structures of untreated timber the ends, tops, and all contact surfaces of sills, caps, floor beams, stringers, end joints, contact surfaces of bracing, the back faces of bulkheads, and all timber which is to be in contact with earth, road material, or other timber shall be coated with two coats of hot creosote oil before being assembled. Countersinking shall be done where smooth faces are required. The recesses formed by countersinking shall be painted with hot creosote oil and filled with hot pitch after the bolt or screw is in place.

All cuts in treated piles or timber and all abrasions, after having been trimmed,

shall be covered with two applications of a mixture of 60% creosote oil and 40% roofing pitch, or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch. Insofar as practicable, cutting, framing, and boring of timber to be treated, except pile cut-offs, shall be done before treatment.

All lumber and timber shall be cut accurately and framed to a close fit in such manner that joints will have even bearing over the entire contact surfaces. Mortises shall be true and even for their full depth and tenons shall fit snugly. Shimming will not be allowed in making joints nor will open joints be accepted. Timbers requiring an exact fit shall be matchmarked.

70 Holes for bolts, dowels, rods, and lag screws shall be bored as follows:

- (a) machine bolts shall be the same diameter as the bolt;
- (b) round drift bolts and dowels shall be 1/16 in. less in diameter than that of the bolt or dowel to be used;
- (c) square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel;
- 80 (d) rods shall be 1/16 in. larger than the rod; and
- (e) lag screws shall be the screw diameter to the base of thread, and 1/2 the screw diameter to the point of the screw.

Before driving bolts, hot creosote oil shall be poured into all bolt holes so that the entire surface of the hole is coated. Any unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

90 A washer of the size and type specified shall be used under each bolt head and under each nut which would otherwise come in contact with wood. Any portion of a bolt projecting more than 1/4 in. beyond the nut shall be cut off. The threads of each bolt shall be checked at the face of the nut after the nut has been finally tightened. The ends of bracing shall be bolted through the pile, post, or cap with bolts of no less than 5/8 in. in diameter. Intermediate intersections shall be bolted or spiked with wire or boat spikes as shown on the plans.

712.04 Caps

100 Timber caps shall have an even and uniform bearing over the tops of supporting posts or piles and shall have their ends evenly aligned. All caps shall be secured by drift bolts of no less than 3/4 in. in diameter extending at least 9 in. into the approximate center of posts or piles. Pile heads, after being cut to receive the caps and prior to placing the caps, shall be treated to prevent decay. The sawed surfaces of creosoted piles shall be covered with three applications of a mixture of 60% creosote oil and 40% roofing pitch or brush coated with three applications of hot creosote oil

712.05

and covered with hot roofing pitch. A covering of medium weight roofing felt or galvanized iron shall be placed on this treatment, bent over the sides of the pile, and fastened securely. Edges shall be trimmed to present a satisfactory appearance. The sawed surfaces of untreated piles shall be brush coated with two applications of hot creosote oil.

110

712.05 Stringers

Stringers shall be sized at bearings and so placed in position that any knots at or near edges are in the top portion. Outside stringers may have butt joints with the ends cut on a taper. Interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least 1/2 in. for the circulation of air and shall be securely fastened to the cap by drift bolting where specified. Where stringers are two panels in length, the joints shall be staggered. Cross-bridging between stringers shall be neatly and accurately framed and securely toenailed with at least two nails in each end.

120

712.06 Bents

Untreated timber, if used for mudsills shall be heart cedar, heart cypress, redwood, or other approved durable timber. Mudsills shall be embedded firmly and evenly to solid bearing and tamped in place. Concrete pedestals for the support of framed bents shall be carefully finished so that the posts or sills take even bearing on them. The sills or posts shall be anchored to pedestals with dowels and the dowels set when the pedestals are poured. They shall be no less than 3/4 in. in diameter and shall project at least 6 in. above the top of each pedestal. Sills shall have true and even bearing on mudsills, grillages, piles, or pedestals. They shall be drift-bolted to mudsills or piles with bolts no less than 3/4 in. in diameter and extend into the mudsills or piles at least 6 in. When feasible, all earth shall be removed from contact with sills to enable free circulation of air around them.

130

Posts shall be fastened to pedestals with dowels of no less than 3/4 in. in diameter extending at least 6 in. into the posts. Posts shall be fastened to sills, as shown on the plans, by means of drift bolts of not less than 3/4 in. in diameter driven diagonally through the base of the post, and extending at least 9 in. into the sill, or by means of dowels of no less than 3/4 in. in diameter extending at least 6 in. into posts and sills. Pile bents shall be driven in accordance with 701.

140

712.07 Wheel Guards and Railings

These shall be framed and erected true to line and grade. Wheel guards and rails shall be surfaced as shown on the plans. Wheel guards shall be laid in sections of no less than 12 ft in length.

712.08 Painting

Paint shall be applied to untreated lumber and timber as shown on the plans or as otherwise specified. Lumber or timber treated with preservative shall not be painted, unless otherwise specified. The color shall be as specified.

150

Surface preparation shall be the removal of all contamination such as oil, grease, dirt, foreign matter, rust, mold, mildew, and sealers. Knots and pitch streaks shall be scraped or burned, and sanded. All nail holes or small openings shall be caulked with a general purpose caulking compound.

160 The surfaces shall be painted with one coat of waterborne finish paint. The paint shall be applied by brush or roller only and at the rate recommended by the manufacturer. All finishes shall be uniform in texture and color. If a painted surface is unsatisfactory, the paint shall be removed and the surface shall be cleaned and repainted or corrected as may be directed.

At the end of each work day, paint stains and splatters shall be removed from all surfaces not intended to receive the paint applied for that day.

712.09 Single-Ply Plank Floors

170 These floors shall consist of a single thickness of plank supported by stringers or joists. The planks shall be laid heartside down with 1/4 in. openings for seasoned material and with tight joints for unseasoned material. Each plank shall be fastened securely to each joist or stringer. The planks shall be carefully selected for thickness and laid so that a smooth riding surface is obtained.

712.10 Two-Ply Plank Floors

These floors shall consist of two layers of wood planks supported by stringers or joists. Both courses shall have been pressure treated with creosote oil. The top course shall be laid parallel to the roadway centerline with each piece fastened securely to the lower course. The lower course shall be fastened as provided above for single-ply. Joints shall be staggered at least 3 ft. Ends shall be fastened securely. If required, the outer ends of the top planks shall be beveled at each end of the bridge.

180 712.11 Method of Measurement

Structural timber and lumber, both treated and untreated, will be measured by the 1,000 board foot measure. Planks for floors will be measured by the square foot. Computation of the amount of lumber and timber will be based on full size for rough lumber and nominal size for dressed lumber on the shortest commercial lengths which may be used.

Metal parts, other than hardware, will be measured by the pound computed in accordance with 711.73(b). Bolts, dowels, washers, nails, spikes, and lag screws will be classed as hardware.

190

712.12 Basis of Payment

The accepted quantities of lumber and timber will be paid for at the contract unit price per 1,000 board foot measure for lumber and timber, either treated or untreated as specified. Plank floors will be paid for at the contract unit price per square foot for plank floors of the ply specified. Metal parts will be paid for at the contract unit price per pound.

713.01

Payment will be made under:

200	Pay Item	Pay Unit Symbol
	Lumber and Timber, Treated.....	MFBM
	Lumber and Timber, Untreated	MFBM
	Metal Parts.....	LBS
	Plank Floors, ____ Ply	SFT

The cost of preservative treatment, hardware, painting, and necessary incidentals shall be included in the cost of the pay items.

210

SECTION 713 – TEMPORARY BRIDGES AND APPROACHES

713.01 Description

This work shall consist of the construction and maintenance of temporary pile or timber trestle bridges and approaches in accordance with 105.03.

MATERIALS

713.02 Materials

10 Materials shall be in accordance with the following:

Delineator Posts.....	910.15
Delineators.....	926.02
Fence	910.18
Piling	701

CONSTRUCTION REQUIREMENTS

713.03 General Requirements

20 Unless otherwise provided, the right-of-way will be furnished for temporary bridges and approaches.

Information indicating the details of the temporary bridge proposed to be built shall be submitted for approval. If this information is not in accordance with the plans, details of the proposed temporary bridge signed by and bearing the seal of a registered professional engineer shall be submitted. These details shall be supplied in triplicate or in such form that may be reproduced readily. Information or details, or both if required, regarding temporary bridges shall be submitted and approved before work is started.

30

Where it is necessary to remove existing fence, a temporary fence shall be erected along the temporary right-of-way line, if so directed. This fence shall be substantially

as good as the existing fence. It shall be built and maintained satisfactorily.

713.04 Temporary Bridge

Unless otherwise provided, the temporary bridge shall have a clear roadway of no less than 28 ft and be designed to carry an HS20 truck loading. The bridge shall be provided with substantial railings which shall be kept painted white. Backwalls shall be built at each end bent to hold the approach fills. Each bent shall have at least four
40 piles or four substantial posts on an adequate mudsill. The temporary bridge shall be built to an elevation of not less than that shown on the plans. It shall have a clear length opening no less than shown or otherwise designated. Unless otherwise specified, all timber and piles may be treated or untreated.

713.05 Temporary Pipe

The minimum thickness required for the temporary pipe or pipe-arch shall be as follows:

(a) Corrugated Steel Circular Pipe

50

Thickness, in.	Pipe Diameter, in.
0.064	48 or less
0.079	54 or less
0.109	72 or less
0.138	78 or less
0.168	84 or less

(b) Corrugated Steel Pipe-Arch, 3 in. by 1 in. Corrugations

Thickness, in.	Pipe-Arch Area, sq ft
0.109	40 or less
0.138	58 or less

(c) Structural Plate Pipe-Arch 6 in. by 2 in. Corrugations

Thickness, in.	Pipe-Arch Area, sq ft
0.111	38 or less
0.140	71 or less
0.170	122 or less
0.188	131 or less

For thicknesses, diameters, or areas not listed above, the Engineer shall be contacted for approval.

60

713.06 Temporary Approaches

Temporary approaches shall be constructed to a line and grade which will provide

a reasonably convenient and safe connection between the temporary bridge and the existing road. The grade and crown elevation shall be as shown on the plans. The roadway and slopes shall be as shown on the plans. All necessary drainage shall be provided. Embankment shall be compacted in accordance with 203. If it becomes necessary to reconstruct the connection of the approaches with the existing roadway, either because of the operations or other cause, such adjustment shall be made as directed.

70

HMA pavement for temporary approaches shall be in accordance with 402. Temporary pavement markings in accordance with 801.12 shall be placed as shown on the plans. Delineators in accordance with 804 shall be placed as shown on the plans.

Guardrail and guardrail end treatment shall be provided at each corner of the temporary bridge as shown on the plans or as directed. The furnishing of materials and installation shall be provided in accordance with 601. After removal, the guardrail and guardrail end treatment will remain the property of the Contractor.

80 **713.07 Maintenance**

Unless otherwise provided, where a temporary bridge is required, traffic over the existing bridge shall not be prohibited until the temporary bridge and approaches are satisfactorily completed and opened to traffic. They shall be so maintained until the new structure is opened to traffic. The necessary material and labor shall be furnished to repair or replace any portion of the temporary bridge and approaches which may have deteriorated under traffic. During the winter months, salt or other equivalent materials shall be used as directed to prevent slippery conditions.

713.08 Removal

90 When the new work which made the temporary bridge and approaches necessary is opened to traffic, all the temporary work shall be removed and the temporary right-of-way shall be restored as nearly as possible to its original or satisfactorily altered state. All bents in the stream shall be removed entirely or down to the bed of the stream and all other bents either removed entirely or to 2 ft below the ground surface, unless the property owner of the temporary right-of-way consents in writing to have them cut at the ground line. Temporary bituminous HMA pavement, when no longer required for maintenance of traffic, shall be removed and shall be disposed of in accordance with 203.10.

100 **713.09 Method of Measurement**

Temporary bridges, temporary pipes, and approaches will not be measured for payment unless otherwise specified. HMA mixtures for temporary pavement will be measured by the ton. Guardrail of the type specified will be measured by the linear foot along the top of rail. Guardrail end treatments will be measured per each of the type specified. Temporary pavement markings will be measured in accordance with 801.17. Seeding and sodding will be measured in accordance with 621.13. The removal and disposal of temporary HMA pavement will not be measured for payment.

The Contractor may be allowed to substitute a three-sided structure in accordance with 723 which shall be subject to a revision of the waterway permits, and shall be as approved by the Engineer.

MATERIALS

714.02 Materials

Materials shall be in accordance with the following:

	Chemical Anchor System	901.05
	Coarse Aggregates, Class A or Higher, Size No. 91	904.03
	Concrete	702
20	Epoxy Coated Reinforcing Bars	910.01
	Flowable Backfill	213
	Geotextile	918.02(b)
	Hydrated Lime.....	913.04(a)
	Joint Membrane System for Precast Reinforced Concrete Box Structure Sections.....	907.07
	Masonry Cement	901.01(c)
	Mortar Sand.....	904.02(e)
	Natural Sand.....	904.02(a)
	Non-Epoxy PCC Sealer.....	909.10
30	Pipe Joint Sealant	907.11
	Portland Cement.....	901.01(b)
	Precast Reinforced Concrete Headwalls, Wingwalls, Footings, and Spandrel Walls.....	907.06
	Precast Reinforced Concrete Structure Sections	907.05
	Reinforcing Bars.....	910.01
	Riprap	904
	Structure Backfill	904.05
	WWR, Smooth and Deformed.....	910.01

40 Cast-in-place concrete for a reinforced concrete box structure, or splices between an existing culvert structure and a precast reinforced concrete box structure section extension shall be class A or higher in accordance with 707.04(c). It shall have a 28-day minimum concrete compressive strength of 5,000 psi. Cast-in-place concrete for headwalls or wingwalls shall be class A or higher in accordance with 707.04(c). It shall have a 28-day minimum concrete compressive strength of 4,000 psi.

50 When the Contractor elects to provide a cast-in-place structure, acceptance of the structure will be based on tests for relative yield, air content, slump, water/cementitious ratio, and compressive strength. Relative yield and air content shall be in accordance with 702.05. The slump and concrete temperature shall be in accordance with 707.04(c). The amount of time from the introduction of mixing water to the cement and aggregates to the completion of the discharge of the concrete shall

not exceed 90 minutes. The water/cementitious ratio shall be in accordance with 707.04(d). The 28-day compressive strength shall be equal to or greater than the specified concrete compressive strength and otherwise shall be in accordance with 707.04(c)3. The Contractor shall provide the necessary 6 in. diameter by 12 in. cylinder molds for the Department's use.

60 For plastic concrete sampling, acceptance testing procedures and casting cylinders will be in accordance with 505.01. Except for footings, concrete flexural strength or results from beam breaks will not be accepted in lieu of concrete compression cylinder test results.

Cast-in-place concrete used to seal existing culverts shall be class A. Cast-in-place concrete for footings shall be class B.

70 Unless otherwise specified herein, reinforcement may consist of either reinforcing bars or WWR. If specified to be coated, WWR shall be coated with either galvanized coating or epoxy coating, and reinforcing bars shall be coated with epoxy coating. For WWR, material with minimum yield strength of 65 ksi shall be used.

CONSTRUCTION REQUIREMENTS

714.03 General Requirements

80 Unless otherwise specified, the applicable requirements of 702 and 703 shall apply to the construction of box structures, structure extensions, and concrete parts of similar structures. Excavation and disposal shall be in accordance with the applicable requirements of 206. Areas designated for waterproofing shall be waterproofed in accordance with 702.23. All underground drains encountered during excavation for the structure shall be perpetuated as dictated by field conditions. Drainage openings through masonry shall be in accordance with 702.16. Handling of box structures shall be in accordance with 907.05. Handling of wingwalls shall be in accordance with 907.06.

When riprap is specified, geotextile shall first be placed on the in-situ soil in accordance with 616.11. Riprap shall then be placed in accordance with 616.

714.04 Design Requirements

90 Where reinforcing bars are used, reinforcing bar splicing and spacing shall be in accordance with the AASHTO LRFD Bridge Design Specifications, except as modified herein.

(a) Box Structure

A box structure may be designed in accordance with ASTM C1577 if the box section is listed therein. A box structure section not listed therein shall be designed in accordance with the AASHTO LRFD Bridge Design Specifications with the following exceptions.

714.04

100 The box structure shall be designed in accordance with the soil parameters shown in the contract documents.

Minimum structural reinforcement area shall be at least 0.002 of the gross concrete area, A_g , or 0.125 sq in./ft, whichever is greater. The allowable variation in diameter of reinforcement shall be in accordance with the tolerances prescribed in the AASHTO specification for that type of reinforcement.

If coated reinforcement is specified, reinforcement, including support devices, in that structure shall be coated. In lieu of coating, the support device may be manufactured of a non-corrosive material.

110

(b) Concrete Headwalls, Wingwalls, and Footings

Headwalls, wingwalls, and footings may be precast or cast-in-place. Headwalls and wingwalls shall be designed based on a minimum equivalent fluid pressure of 40 lb/cu ft. If flowable backfill is to be used, the Contractor shall consider the effects of hydrostatic pressure on the wingwalls. Weep holes shall be provided in all wingwalls. Horizontal pressures shall be increased for sloping backfill surfaces and live-load surcharge. Headwall connections and wingwall footings shall be checked for sliding and for overturning.

120 Wingwalls and wingwall footings shall be designed in accordance with the soil parameters shown in the contract documents.

A headwall with guardrail mounted on top, the anchorage of the headwall to the box structure section, or a moment slab with bridge railing shall be designed for the bridge railing test level shown on the plans.

130 Reinforcement in headwalls shall consist of reinforcing bars and shall be epoxy coated. Tension splices in circumferential reinforcement shall be made by means of lapping. Where reinforcing bars are used in wingwalls, the maximum spacing for wingwall reinforcing bars shall be 18 in. for horizontal bars and 12 in. for vertical bars.

Concrete cover for headwall and wingwall reinforcement shall be a minimum of 2 in. Concrete cover for footing reinforcement shall be 3 in. for the top and sides, and 4 in. for the bottom.

(c) Working Drawings

140 Working drawings shall be submitted in accordance with 105.02 for fabrication of a precast reinforced concrete box structure greater than 12 ft span, a box structure of a size not described in ASTM C1577, headwalls, wingwalls, and footings. Design calculations shall be submitted with the working drawings. Detailed plans for falsework and centering will not be required. Working drawings shall include all details, dimensions, and quantities necessary to construct the structure, headwalls, wingwalls, or footings and shall include, but not be limited to, the following information.

1. Structure span and rise.
2. Structure section details showing all concrete dimensions and reinforcement requirements.
- 150 3. Headwall details, showing all concrete dimensions, elevations, reinforcing bar sizes, reinforcing bar bending diagrams, lengths, spacings, and anchorage details. Headwall elevation and section views shall be provided.
4. Wingwall design calculations and details showing all concrete dimensions, elevations, reinforcement sizes, bending diagrams, lengths, spacings, and anchorage details. Wingwall plan, elevation, and section views shall be provided.
- 160 5. Wingwall backfill type and limits.
6. Footing details showing all concrete dimensions, elevations, reinforcing bar sizes, reinforcing bar bending diagrams, lengths, and spacings indicated. Footing plan and section views shall be provided. The actual soil bearing pressure shall be shown on the footing detail sheets.
- 170 7. Structure backfill type and limits for the structure and wingwalls.
8. Minimum concrete strength for all concrete portions of the structure.
9. Bridge load rating calculations and load rating summary shall be submitted with the working drawings where the structure span length measured along the roadway centerline is greater than 20 ft, except where the height of cover is greater than 8 ft and exceeds the perpendicular span length. The structure shall load rate greater than 1.0 for the loading described herein or as shown on plans. The load rating methodology shall be in accordance with the AASHTO Manual of Bridge Evaluation using the LRFR methodology.
- 180

714.05 Erection Requirements

The soils in the bottom of the excavation shall be compacted in accordance with 203.23.

190

An 8 in. layer of coarse aggregate No. 8 in accordance with 301 shall be placed under the full width of the footing. All cast-in-place footings shall be given a smooth float finish. The footing concrete shall reach a compressive strength of 2,000 psi or flexural strength in accordance with 702.24(c) before placement of the wingwalls. The surface shall not vary more than 1/4 in. in 10 ft if tested with a 10 ft straightedge.

200 Structure backfill shall be placed and compacted in accordance with 211. Structure backfill shall be placed and compacted on each side of the structure to the fill line shown on the plans. During the backfill operation, the difference in elevations of the fill on each side of the structure shall not exceed 24 in.

Unless otherwise specified by the manufacturer on the working drawings, once the level of structure backfill reaches the top of the structure, two lifts shall be spread and hand compacted over the structure without traversing the structure with heavy equipment. Compaction with heavy equipment will not be allowed until a minimum of two lifts have been placed, hand compacted, and accepted.

210 The operation of equipment over a structure shall be in accordance with the structure manufacturer's recommendations.

714.06 Precast Concrete Headwalls, Wingwalls, and Footings

(a) Headwall Reinforcement Placement Relative to Top of Structure

The headwall shall be a single precast piece which spans from sidewall to sidewall of a span. The vertical headwall reinforcement shall be attached to the top of the structure by either drilling holes or precasting holes. A chemical anchoring material, if used, shall be from the QPL of Chemical Anchor Systems.

(b) Wingwall Placement

220 Each wingwall that is not precast as one unit with the footing shall be set on masonite or steel shims. A minimum gap of 1/2 in. shall be provided between the footing and the bottom of each wingwall. Once the wingwalls are placed, the space underneath the wingwall section to the top of the keyway sides shall be filled with prepackaged grout in accordance with ASTM C1107, or conventional or self-consolidating fine grout in accordance with ASTM C476, except as modified herein. If conventional fine grout is used, it shall be troweled into the keyway and mounded on one side of the wingwall. The mound of conventional fine grout shall be vibrated until it passes through to the other side of the wingwall. After completing this process on one side, if the conventional fine grout has not passed through to the other side, the process shall be repeated on the other side. Conventional or self-consolidating fine grout shall be from a prepackaged source or composed of one of the following mixtures.

230

1. 930 lb/cu yd Type I portland cement with No. 23 natural sand or mortar sand.

- 240
2. 930 lb/cu yd Type M masonry cement with No. 23 natural sand or mortar sand.
 3. 828 lb/cu yd Type I portland cement and 75 lb/cu yd hydrated lime with No. 23 natural sand or mortar sand.

The maximum water/cement ratio shall be 0.446 for both conventional and self-consolidating fine grout. An air entraining agent from the QPL of PCC Admixtures and Admixture Systems may be used. A type F or G chemical admixture from the QPL of PCC Admixtures and Admixture Systems shall be used in self-consolidating fine grout in order to achieve the slump flow and visual stability index requirements. Filling procedure B of ASTM C1611 will be used for measuring slump flow. Appendix X1 of ASTM C1611 will be used for determining the visual stability index value.

250

Acceptance of conventional fine grout will be based on an air content of 12% \pm 4%. Acceptance of self-consolidating fine grout will be based on tests for air content, slump flow, and visual stability index. Air content shall be 12% \pm 4%. Slump flow shall be 27 in. \pm 3 in. Visual stability index value shall not exceed 1.

A type C certification in accordance with 916 shall be provided for the prepackaged grout.

260 Wingwalls shall be connected to the outside box structure sections with bolted steel plates.

714.07 Rejection

Structure sections, headwalls, wingwalls, or footings will be rejected due to the following conditions:

- 270
- (a) fractures or cracks passing through the section or wall, except for a single end crack which does not exceed one-half the thickness of the section or wall;
 - (b) defects which indicate proportioning, mixing, or molding which are not in accordance with this specification;
 - (c) honeycombed or open texture; or
 - (d) damaged section ends, where such damage prevents making a satisfactory joint.

714.08 Repairs

280 Structure sections, headwalls, wingwalls, and footings shall be repaired, if necessary, due to imperfections in manufacture, or damage caused by handling or construction. Repairs will be acceptable if it is determined that the repairs are sound, properly finished and cured, and if the repaired structure section, headwall, wingwall, or footing is in accordance with the requirements herein.

714.09 Extension of Existing Structure

All applicable requirements of this specification shall apply to the extension of an existing box structure, slab-top structure, or arch structure. Such portions of the existing structure designated for removal shall be removed. All portions of the existing structure which are to remain in place and are damaged shall be repaired or replaced as directed. Those portions left in place which are wholly or partially filled with debris shall be cleaned out. Material removed shall be disposed of in accordance with the applicable requirements of 202.02.

Before removing concrete from an existing structure with wingwalls, the Contractor shall saw around the perimeter of the removal area on the interior and exterior of the existing structure a depth of 1 in. All existing reinforcement in the top slab, bottom slab, and sidewalls exposed after concrete removal shall be cleaned and straightened in preparation for lapping with reinforcement from adjacent new work. Where existing reinforcement has deteriorated or been damaged during the removal operation, holes shall be drilled into the face of the existing structure to provide embedment for replacement reinforcing bars. The holes shall be of the diameter and depth required by the manufacturer of the chemical anchor system. The holes shall be cleaned prior to placing the chemical anchor system and the reinforcing bars.

No concrete shall be removed from an existing structure that has a headwall but no wingwalls. Reinforcing bars to tie the existing structure to the new structure section shall be installed by drilling holes into the face of the existing structure to provide embedment for reinforcing bars. The diameter and depth of the holes shall be according to the recommendations of the manufacturer of the chemical anchor system. The holes shall be cleaned prior to placing the chemical anchor system and the reinforcing bars.

An existing structure shall be extended by one of the following methods.

(a) Precast Reinforced Concrete Box Structure Extension

A cast-in-place concrete splice shall be constructed as a transition between the existing structure and the precast structure extension. The splice reinforcement in the precast structure extension section that will abut the existing structure shall be exposed 18 in. on the tongue end of the precast structure extension section. It shall be lapped 18 in. with either exposed existing structure reinforcement, in the case of an existing structure with wingwalls, or newly installed reinforcing bars in the existing structure, in the case of an existing structure with a headwall only as shown on the plans. Existing exposed structure reinforcement from an existing structure with wingwalls shall be cut off 1 in. from the face of the new precast extension.

If the existing tongue or groove joint end is acceptable and matches the mating joint on the new precast reinforced concrete box structure extension, the new extension may be installed using the mating joint of the existing box structure. No cutting of the box structure or splicing of reinforcement is then required. The joint between the new

330 precast box structure extension and the existing structure shall be sealed as directed below.

(b) Cast-In-Place Concrete Structure Extension

The reinforcement for the structure extension shall be lapped with the exposed reinforcement of the existing structure as shown on the plans.

714.10 Precast Reinforced-Concrete Box Structure Section Joints

340 Precast reinforced concrete box structure section joints shall be sealed as shown on the plans. Pipe joint sealant shall be applied once the concrete surface temperature is above 40°F or above the minimum application temperature recommended by the pipe joint sealant manufacturer. The concrete surfaces shall be clean and dry prior to application of the pipe joint sealant. Heat may be applied to the concrete surfaces until they are in accordance with the temperature and dryness requirements. The pipe joint sealant shall be centered on both sides of the joint as it is being applied. After application, the geotextile or membrane material shall be rolled to avoid wrinkling. If the roll of geotextile or membrane material does not cover the full length of the joint, an overlap of at least 2 1/2 in. will be required to start the next roll of material. The manufacturer's application instructions shall apply in addition to the above requirements.

350

714.11 Method of Measurement

Precast reinforced concrete box structures or structure extensions, precast coated reinforced concrete box structures or structure extensions, precast headwalls, precast wingwalls, cast-in-place reinforced concrete box structures or structure extensions, cast-in-place coated reinforced concrete box structures or structure extensions, cast-in-place headwalls, and cast-in-place wingwalls will not be measured. The accepted quantities for payment will be the quantities shown on the plans.

360 Geotextile and riprap will be measured in accordance with 616.12. Structure backfill will be measured in accordance with 211.09. Flowable backfill will be measured in accordance with 213.08. Field drilled holes will be measured in accordance with 702.27.

Plain or coated reinforcement or WWR used in precast reinforced concrete box structures or structure extensions, precast headwalls, precast wingwalls, cast-in-place reinforced concrete box structures or structure extensions, cast-in-place headwalls, or cast-in-place wingwalls will not be measured for payment.

370 If the Contractor elects to provide a three-sided structure in lieu of the box structure shown on the plans, it will be measured in accordance with 723.17. Additional geotextile and riprap placed within the limits of the three-sided box structure will not be measured for payment.

Additional excavation required for a culvert when the culvert is placed at an elevation that is more than 1 ft below the elevation shown on the plans will be

The cost of plain or coated reinforcement or WWR used in precast reinforced concrete box structures or structure extensions, precast headwalls, precast wingwalls, cast-in-place reinforced concrete box structures or structure extensions, cast-in-place headwalls, or cast-in-place wingwalls shall be included in the cost of the structure or structure extension.

The cost of concrete used in a cast-in-place splice shall be included in the cost of the structure extension.

430

The cost of designing a box structure, box structure extension, headwalls, and wingwalls shall be included in the cost of the structure or structure extension.

The costs of coring, testing, excavation, repairs, plugging core and handling holes, mortar, grout, sealer, cylinder molds, and necessary incidentals shall be included in the cost of the structure. The cost of wingwall footing and the aggregate base shall be included in the cost of the structure or structure extension.

440 No additional payment will be made for carrying an underground drain through a structure or structure extension. However, no deduction will be made for the volume of concrete occupied by the drain pipe in a cast-in-place structure or structure extension.

No additional payment will be made for the repair or replacement of existing concrete damaged by Contractor operations.

SECTION 715 – PIPE CULVERTS, AND STORM AND SANITARY SEWERS

715.01 Description

This work shall consist of the construction or reconstruction of pipe culverts, storm or sanitary sewers, slotted drain pipe, or slotted vane drain pipe in accordance with 105.03.

MATERIALS

10 715.02 Materials

Pipe materials, minimum thickness or strength classification, and protective treatments for pipes except underdrains and drain tile will be determined based on height of cover, required service life, site abrasiveness, and structure pH criteria shown on the plans. Pipe with material thickness, strength classification, or protective coatings in excess of the minimum required by the above noted criteria may be used. When metal pipe is selected, the same base metal and coating shall be used for the structure or a pipe extension.

20 Concrete used for anchors, collars, grated box end sections, encasements, and sealing existing pipes shall be class A. Corrugated polyethylene pipe, type S has a

smooth interior liner with a corrugated outer wall. Type SP pipe is a type S pipe with perforations.

Materials shall be in accordance with the following:

	B Borrow	211
	Concrete	702
	Flowable Backfill	213
	Geotextiles.....	918.02
30	Pipe Joint Sealant	907.11
	Reinforcing Bars.....	910.01
	Rubber Type Gaskets	907.13
	Straps, Hook Bolts, and Nuts.....	908.12
	Structure Backfill	904

The maximum particle size of backfill material for corrugated pipe shall be less than 1/2 the corrugation depth.

(a) Type 1 Pipe

40 Type 1 pipe shall be used for culverts under mainline pavement and public road approaches and shall be in accordance with the following:

	Clay Pipe, Extra Strength	907.08
	Corrugated Aluminum Alloy Pipe and Pipe-Arches	908.04
	Corrugated Polyethylene Pipe, Type S.....	*
	Corrugated Polypropylene Pipe.....	*
	Corrugated Steel Pipe and Pipe-Arches.....	908.02
	Non-Reinforced Concrete Pipe, Class 3	907.01
50	Polymer Precoated Galvanized Corrugated Steel Pipe and Pipe-Arches.....	908.08
	Profile Wall Polyethylene Pipe, Closed.....	*
	Profile Wall Polyethylene Pipe, Ribbed	*
	Profile Wall PVC Pipe.....	*
	Reinforced Concrete Horizontal Elliptical Pipe	907.03
	Reinforced Concrete Pipe.....	907.02
	Smooth Wall Polyethylene Pipe	*
	Smooth Wall PVC Pipe	*
	Spiral Rib Steel Pipe.....	908.02
	Structural Plate Pipe and Pipe-Arches.....	908.09
60	* All thermoplastic pipes shall be from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.	

(b) Type 2 Pipe

Type 2 pipe shall be used for storm sewers and shall be in accordance with the following:

	Clay Pipe, Extra Strength	907.08
--	---------------------------------	--------

	Corrugated Polyethylene Pipe, Type S.....	*
	Corrugated Polypropylene Pipe.....	*
70	Fully Bituminous Coated and Lined Corrugated Steel	
	Pipe and Pipe-Arches.....	908.07
	Non-Reinforced Concrete Pipe, Class 3	907.01
	Polymer Precoated Galvanized Corrugated Steel	
	Pipe and Pipe-Arches Type IA and Type IIA.....	908.08
	Profile Wall Polyethylene Pipe, Closed	*
	Profile Wall Polyethylene Pipe, Ribbed	*
	Profile Wall PVC Pipe.....	*
	Reinforced Concrete Horizontal Elliptical Pipe	907.03
	Reinforced Concrete Pipe.....	907.02
80	Smooth Wall Polyethylene Pipe	*
	Smooth Wall PVC Pipe	*
	* All thermoplastic pipes shall be from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.	

(c) Type 3 Pipe

Type 3 pipe shall be used for culverts under all drives and field entrances. All Type 1 pipe materials are acceptable.

(d) Type 4 Pipe

90 Type 4 pipe shall be used for drain tile and longitudinal underdrains and shall be in accordance with the following:

	Clay Pipe**	907.08
	Corrugated Polyethylene Drainage Tubing	*
	Corrugated Polyethylene Pipe, Type S**	*
	Corrugated Polyethylene Pipe, Type SP.....	*
	Drain Tile**	907.10
	Non-Reinforced Concrete Pipe.....	907.01
	Perforated Clay Pipe**	907.09
100	Perforated PVC Semicircular Pipe	*
	Profile Wall PVC Pipe.....	*
	* All thermoplastic pipes shall be from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.	
	** These materials shall be used for drain tiles only.	

(e) Type 5 Pipe

Type 5 pipe shall be used for broken-back pipe runs where coupled or jointed pipe is desirable and shall be in accordance with the following:

110	Corrugated Aluminum Alloy Pipe and Pipe-Arches	908.04
	Corrugated Polyethylene Pipe, Type S.....	*
	Corrugated Polypropylene Pipe.....	*
	Corrugated Steel Pipe and Pipe-Arches.....	908.02

	Fully Bituminous Coated and Lined Corrugated Steel Pipe and Pipe-Arches.....	908.07
	Polymer Precoated Galvanized Corrugated Steel Pipe and Pipe-Arches.....	908.08
	Profile Wall Polyethylene Pipe, Closed.....	*
	Profile Wall Polyethylene Pipe, Ribbed	*
120	Profile Wall PVC Pipe.....	*
	Smooth Wall Polyethylene Pipe	*
	Smooth Wall PVC Pipe	*
	Spiral Rib Steel Pipe.....	908.02
	* All thermoplastic pipes shall be from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.	

(f) Slotted Drain Pipe

Slotted drain pipe shall be used to drain paved median and concrete gutter areas. Slotted drain pipe shall be in accordance with 908.14.

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(g) Slotted Vane Drain Pipe

Slotted vane drain pipe shall be used to drain driveway areas. Slotted vane drain pipe shall be in accordance with 908.14.

(h) End Bent Drain Pipe

End bent drain pipe shall be perforated profile wall PVC pipe, perforated smooth wall PVC pipe, or corrugated polyethylene drainage tubing Type SP from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.

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(i) Underdrain Outlet Pipe

Pipe shall be profile wall PVC pipe or smooth wall pipe for outlets from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.

(j) Grated Box End Sections

Grating for box end sections shall be in accordance with 910.22. Threaded inserts for type II grated box end sections shall have a minimum pull-out capacity of 6,000 lb. The 1/2 in. round bolts shall have hex heads, cut washers, and where necessary, shall be furnished with the grating. The aggregate leveling bed required for precast units shall be coarse aggregate No. 8 in accordance with 904.03. The hardware cloth used to cover the weep holes, may be plastic with 1/4 in. mesh or galvanized steel wire No. 4 mesh with a minimum wire diameter of 1/32 in. It shall be firmly anchored to the outside of the structure and shall be centered on the holes.

150

A type C certification in accordance with 916 shall be provided for the materials in this section unless otherwise specified.

(k) Pipe End Sections

Metal pipe end sections shall be in accordance with 908.06. Precast concrete pipe end sections shall be in accordance with 905.06.

160

(l) Roadway Drain Casting Extensions

Pipe used for extending roadway drain castings located in a bridge deck shall be in accordance with 907.23, 907.28, or 908.10. Pipe support brackets and all hardware shall be galvanized in accordance with ASTM A153, class D or ASTM B695, class 40, type I. A type C certification in accordance with 916 shall be provided for the pipe brackets.

(m) Drainage Pipe through Concrete Masonry

170 Pipe used as drainage pipe through concrete masonry as described in 702.16 shall be either profile wall or smooth wall PVC from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16, or steel in accordance with 908.11.

(n) Bridge Deck Drain System

180 Pipe and fittings used in an enclosed bridge deck drainage system shall be cast iron soil pipe in accordance with 908.10 or reinforced thermosetting resin pipe in accordance with 907.28. All mounting hardware shall be installed in accordance with the pipe manufacturer's recommendations. All mounting hardware shall be galvanized in accordance with ASTM B695, class 40, type I. A type C certification in accordance with 916 shall be provided for the pipe brackets.

CONSTRUCTION REQUIREMENTS**715.03 General Requirements**

The construction requirements, method of measurement, basis of payment, and pay items described herein shall apply, except for the following, which are described in their respective sections.

	Drain Tile	719
	Structural Plate Pipe and Pipe-Arches	717
190	Underdrains	718

A pipe order shall be prepared and submitted prior to delivery of pipe to the project site. The order shall include the following:

- 200
- (a) structure number and location;
 - (b) manhole, inlet, or catch basin type, if applicable;
 - (c) pipe length, as determined by construction engineering;
 - (d) pipe size, as shown on the plans;
 - (e) pipe material including all information required to verify conformance with cover and service life criteria; and
 - (f) number and type of end sections or quantity of concrete, A, structures.

210 When riprap is specified, geotextile shall first be placed on the in-situ soil in accordance with 616.11. Riprap shall then be placed in accordance with 616.

715.04 Excavation

Unless otherwise directed, the trench cross sectional dimensions shall be as shown on the plans. The trench bottom shall give full support to the pipe as shown on the plans. Recesses shall be cut to receive any projecting hubs or bells.

Where pipe is to be placed in fill sections, a portion of the fill shall be constructed prior to installation of the pipe as shown on the plans.

220 Where rock or boulder formation is encountered at or above the proposed trench bottom elevation, the trench shall be excavated at least 8 in. below the proposed grade, backfilled with structure backfill, and compacted in accordance with 211.04.

In case a firm foundation is not encountered at the required grade, the unstable material shall be removed to such depth that when replaced with suitable material, usually B borrow, compacted, and properly shaped, it will produce a uniform and stable foundation along the entire length of the pipe. A timber mat shall be placed to hold the pipe to line and grade if it is necessary.

230 All trenches shall be kept free from water until any joint filling material has hardened sufficiently not to be harmed.

715.05 Laying Pipe

Each section of pipe shall have a full firm bearing throughout its length, true to the line and grade given. All pipes which settle or which are not in alignment shall be taken up and re-laid. Pipe shall not be laid on a frozen trench bottom. Fully bituminous coated and lined pipe and pipe-arches shall only be placed when the ambient temperature is 35°F or above.

240 Concrete and clay pipe shall be laid with hub up, with the spigot end fully extended into the adjacent hub, and with all ends fitted together tightly.

Concrete pipe shall not be laid in muck or sulphate soils.

Except for circular concrete pipe, pipe joints designed to accommodate seals or pipe joints requiring seals shall be sealed with rubber type gaskets, caulking, pipe joint sealant, elastomeric material, or sealing compound. Circular concrete pipe joints shall utilize rubber type gaskets.

250 If the infiltration of water is a factor, each joint, regardless of the type used, shall be sealed with a compression type joint sealer in accordance with ASTM C425 or ASTM C443, whichever is applicable.

Joints and stub-tee connections for thermoplastic pipe shall be in accordance with the requirements of the respective material specifications for each type of pipe.

Connections of thermoplastic pipe to manholes, catch basins, and inlets shall be in accordance with the manufacturer's recommendations.

260 Prior to being lowered into the trench, corrugated metal pipe sections shall be examined closely and so fitted that they will form a true line of pipe when in place. Sections which do not fit together properly shall not be used.

At the time of acceptance, all pipe shall have been cleaned and be free from silt and other foreign matter.

270 Prior to constructing a pipe extension, the existing structure shall be cleaned of all foreign materials. Existing anchors, end sections, or headwalls shall be removed as shown on the plans or as directed. All existing pipes which are damaged by the removal operation shall be replaced. Removed materials shall be disposed of in accordance with 202.

715.06 Joining Pipe

280 Band couplers for AASHTO M 36 type I and type II corrugated steel pipe and pipe-arches shall have corrugations that mesh with the corrugations of the pipe sections being joined or the annular rerolled ends of those pipe sections. Band couplers with projections or dimples may be used with pipe having either annular or helical corrugations only when corrugated band couplers will not provide a matching connection to both pipes. Band couplers for AASHTO M 36 type IA and IIA corrugated steel pipe and pipe-arches shall have corrugations that mesh with the corrugations of the pipe or shall be gasketed flat bands. Couplers for AASHTO M 36 type IR ribbed steel pipe shall be in accordance with AASHTO M 36 and the manufacturer's recommendations.

290 At the connection of a pipe extension to an existing structure where the joint system of the pipe extension differs from that in place, or if a satisfactory joint cannot be obtained between the two structures, a concrete collar shall be constructed. Portions of the existing structure shall be removed as shown on the plans, or as necessary, to ensure proper fit of the extension to the existing pipe. If not shown on the plans, the collar shall have a width of at least 18 in. and a thickness of at least 6 in. around the entire joint.

If rigid pipe connections are of lesser strength than that of the main barrel of a pipe structure, these connections shall be encased with concrete at least 6 in. thick.

Any pipe which is damaged during installation shall be repaired or replaced as directed.

Slotted drain pipe or slotted vane drain pipe shall be constructed in 20 ft sections

- 300 with shop fabricated elbows. The upgrade end of slotted drain pipe shall be plugged with a metal cap before backfilling. The upgrade end of slotted vane drain pipe shall be plugged with class A concrete. Such concrete shall extend 6 in. inside the upgrade end of the pipe.

715.07 Tee and Stub-Tee Connections

At locations shown on the plans, or where directed, a stub-tee connection of the size specified shall be furnished and placed as a tee connection to corrugated metal pipe, corrugated metal pipe-arch, concrete pipe, reinforced concrete pipe, or reinforced concrete horizontal elliptical pipe.

310

The stub-tee connection to a corrugated metal pipe, ribbed metal pipe, or corrugated metal pipe-arch shall be constructed of corrugated or ribbed metal and the length of the stub shall be no less than that which readily accommodates the connecting band. It shall be made by shop welding a stub of corrugated or ribbed metal pipe to the respective corrugated metal pipe or pipe-arch or ribbed metal pipe at the time of fabrication. Where field conditions warrant, stub-tee or other connections may be field connected by using shop fabricated saddle connectors. Welds, flame cut edges, and damaged spelter coating shall be regalvanized or painted with zinc dust-zinc oxide paint in accordance with Federal Specification TT-P-641, type II or MIL-P-21035.

- 320 Where applicable, damaged bituminous coating shall be repaired with asphalt mastic in accordance with AASHTO M 243. The pipe connection to the stub shall be made by means of connecting bands of required size or by means of concrete collars as directed.

The stub-tee connection to concrete pipe, reinforced concrete pipe, or reinforced concrete horizontal elliptical pipe may be field constructed or factory constructed. The concrete used in the stub shall be of the same proportions as that used in the construction of such pipe. The length of the concrete stub shall be no less than 6 in. and no more than 12 in. The pipe connection to the concrete stub shall be made by

- 330 means of a cement mortar bead or concrete collar or as directed.

715.08 Blank

715.09 Backfilling

All pipe trenches shall be backfilled with structure backfill or flowable backfill. Structure backfill shall be placed in accordance with 211. Flowable backfill shall be placed in accordance with 213.07 as shown on the plans or as directed.

- 340 Prior to placing flowable backfill, all standing water shall be removed from the trench. If the water cannot be removed from the trench, structure backfill shall be used in lieu of flowable backfill to an elevation 2 ft above the groundwater. The remainder of the trench shall be backfilled as shown on the plans.

All pipes, except underdrains, will be visually inspected for acceptance a minimum of 30 days after the completion of backfill operations. Pipes that cannot be

visually inspected shall be video inspected for acceptance using equipment in accordance with 718.07. The Engineer will determine the sections of pipe to be video inspected.

- 350 For pipes that were video inspected, a copy of the video inspection shall be provided in a format acceptable to the Engineer. The video inspection shall be provided prior to performing the mandrel testing or if mandrel testing is not required, prior to acceptance of the pipe.

For pipe not requiring mandrel testing that is determined to be unacceptable by the Engineer, the unacceptable pipe shall be replaced between the nearest pipe joints or to the nearest structure, or a remediation plan shall be prepared by a professional engineer and submitted to the Engineer for final determination.

- 360 After the visual or video inspection, the Contractor shall check pipe deflection by performing a mandrel test as directed on pipes manufactured from materials listed in the following table. The Engineer will determine the runs of pipe installations to be mandrel tested with a minimum of 10% of the total length of each material to be inspected.

Pipes Required to Be Mandrel Tested	
Pipe Material	Standard Specifications
Corrugated Polyethylene Pipe	907.17(b)
Corrugated Polypropylene Pipe	907.19
Profile Wall Polyethylene Pipe	907.20
Smooth Wall Polyethylene Pipe	907.21
Profile Wall PVC Pipe	907.22
Smooth Wall PVC Pipe	907.23

The mandrel shall have a minimum of nine arms or prongs and a diameter that is 95% of the nominal pipe diameter. The Contractor shall provide a proving ring that is 95% of the nominal pipe diameter for each mandrel.

- 370 The Contractor shall pull the mandrel through the pipe by hand. If the mandrel does not pass through the pipe, the Contractor shall measure and report the minimum diameter of the deficient pipe to the Engineer.

- 380 If the minimum diameter of the deficient pipe is between 92.5% and 95.0% of the nominal pipe diameter, the Contractor shall provide an evaluation of the deficient pipe prepared by a professional engineer. The evaluation shall consider the severity of the deflection and its effects on structural integrity, environmental conditions, and the design service life of the pipe. A report summarizing the evaluation and including the professional engineer's recommendation for acceptance, remediation, or replacement of the pipe shall be submitted to the Engineer for final determination.

If the minimum diameter of the deficient pipe is equal to or less than 92.5% of the nominal pipe diameter, the deficient pipe shall either be replaced or a remediation plan shall be prepared by a professional engineer and submitted to the Engineer for final determination.

390 The deficient pipe shall be replaced if the professional engineer's remediation plan recommends replacement of the pipe or if the pipe has been damaged.

Deficient pipe shall at a minimum be replaced between the nearest pipe joints or to the nearest structure. Replaced or remediated pipe sections shall be mandrel tested a minimum of 30 days after the completion of backfill operations.

Commercial and private drive pipes are excluded from the mandrel testing and video inspection requirements.

400 Where material other than structure backfill or flowable backfill is allowed and used for backfilling, it shall be of such nature that compacts readily. That portion around and for 6 in. above the top of the pipe shall be free from large stones. This material shall be placed in layers not to exceed 6 in., loose measurement, and each layer compacted thoroughly by means of mechanical tamps. Where coarse aggregate is used for structure backfill, geotextile shall be installed.

An adequate earth cover, as shown on the plans, shall be placed over the structure before heavy equipment is operated over it.

410 Backfill for slotted drain pipe and slotted vane drain pipe shall consist of class A concrete on both sides of the pipe. During the backfilling and paving operations, the slot shall be covered to prevent infiltration of material into the pipe.

715.10 Pipe End Sections, Anchors, Grated Box End Sections, and Safety Metal End Sections

Pipe end sections, anchors, grated box end sections, and safety metal end sections shall be constructed as shown on the plans or as directed.

420 Straps or hook bolts required for anchors shall be as shown on the plans. Anchor straps shall be placed at both the upstream and downstream end of each corrugated aluminum alloy, corrugated steel, structural plate pipe, or pipe-arch with a diameter or span of 42 in. or greater. Hook bolts and anchor straps shall be placed at both the upstream and downstream end of each corrugated aluminum alloy, corrugated steel, structural plate pipe, or pipe-arch with a diameter or span of 84 in. or greater.

A dimpled connection band shall be used for connecting pipe end sections and safety metal end sections to ends of corrugated metal pipe whose end corrugations are not perpendicular to the centerline of the pipe.

Grated box end sections shall be constructed according to the required pipe size and surface slope of the grated box end section specified at each location. Precast units

430 shall be cast as a single complete unit, except for the toewall which shall be cast in place. They shall be set and leveled on a 6 in. thick bed of coarse aggregate. If precast units are used and the adjoining pipe is to be field connected directly to the precast unit, the connection shall be made using a class A concrete collar of 6 in. minimum longitudinal and radial thickness. Inserts for approved lifting devices may be cast in the bottom slab of the precast sections. The number and location of lifting devices needed for handling shall be determined by the fabricator. All reinforcement shall have a minimum cover of 1 1/2 in. and shall have a minimum lap of 21 in. The type A construction joint between the floor and the wall is optional for cast in place units.

440 **715.11 Re-Laid Pipe**

Where shown on the plans or as directed, existing pipe shall be taken up, re-laid, and if necessary, extended. Removal of the pipe shall be in accordance with 202.04 and the operations involved in its relaying shall be in accordance with similar operations contained herein for laying new pipe.

715.12 Pavement Replacement

Where a structure is to be placed under an existing pavement, the pavement removal and replacement shall be as shown on the plans.

450 The pavement replacement areas in asphalt pavements shall be filled with HMA for Structure Installation of the mixture type specified in the pay item in accordance with 402 except OG mixtures shall be in accordance with 401.05. An MAF in accordance with 402.05 will not apply. Mixtures will be accepted in accordance with 402.09. Each course shall be compacted by approved mechanical equipment in accordance with 409.03(d).

The pavement replacement areas in Portland Cement Concrete pavements shall be filled with PCCP in accordance with 502 except utilization of the Department provided spreadsheet is not required for the CMDS.

460

Partial loads of HMA or PCCP left over from structure installation processes shall not be incorporated into other work.

715.13 Method of Measurement

The accepted quantities of circular pipe, deformed pipe, slotted drain pipe, slotted vane drain pipe, end bent drain pipe, sanitary sewer pipe, and pipe extensions will be measured by the linear foot, complete in place.

470 The length of pipe to be measured for payment will be based on the net length of pipe used, which will be obtained by multiplying the nominal length of each pipe section by the number of sections used. If the pipe connects to manholes, inlets, or catch basins, the terminal sections will be field measured to the outside face of the structure. The length of beveled or skewed terminal sections of circular corrugated or ribbed metal pipe to be measured for payment will be the average of the top and bottom centerline lengths for beveled ends or of the sides for skewed ends. Measurement of

715.13

deformed pipe will be made along the bottom centerline of the pipe.

Where used other than as a roadway drain extension pipe or as a bridge deck drain system, cast iron soil pipe will be measured by the pound based on the theoretical weight shown on the plans.

Roadway drain extension pipe will be measured per each drain extended.

Pipe used as drainage pipe through concrete masonry or pipe used for bridge deck drainage system will not be measured for payment.

Reinforcing bars, straps, and hook bolts used in anchors will not be measured for payment. Concrete used for backfill of slotted drain pipe and slotted vane drain pipe will not be measured for payment.

490

Excavation above the trench bottom elevation shown on the plans will not be measured for payment. Additional excavation below the proposed trench bottom elevation required to install the pipe at a lower elevation or to remove rock or unsuitable material will be measured in accordance with 203.27(b).

Pipe end sections, concrete anchors, and safety metal end sections will be measured by the number of units of each size installed. The size of the end section, concrete anchor, and safety metal end section will be considered as the nominal diameter of the pipe to which they are attached. A concrete anchor attached at one end of twin pipes will be measured as two concrete anchors. A concrete anchor attached at one end of triple pipes will be measured as three concrete anchors.

500

Tee, stub-tee, and wye branch connections will be measured along the centerline of the barrel. An additional 5 lft of the smaller diameter pipe will be included for making such connection.

Elbow connections will be measured along the centerline of such connection. An additional 2 lft of pipe of the same diameter as that of the elbow will be included for each such connection.

510

If increaser or reducer connections are made, measurement will be made on the basis of the larger diameter pipe for the full length of the section forming such connections.

Structure backfill will be measured in accordance with 211.09. Flowable backfill will be measured in accordance with 213.08.

Pavement replacement and subbase necessary due to structure placement under an existing pavement will be measured to the neat lines shown on the plans.

520

For structures for which the plans show pipes of differing sizes for either smooth,

semi-smooth or corrugated interiors, and either the semi-smooth corrugated interior alternate is installed, measurement of structure backfill or flowable backfill will be based on the neat line dimensions shown on the plans for the smooth interior alternate.

Grated box end sections will be measured per each for the specified type, surface slope, and pipe size.

530 Video inspection for pipe will be measured by the linear foot as determined by the electronic equipment.

Geotextile used to wrap backfill material will not be measured for payment.

715.14 Basis of Payment

540 The accepted quantities of pipe and pipe extensions will be paid for at the contract unit price per linear foot for pipe of the type, shape, and size specified, complete in place. Where used other than as a roadway drain casting extension pipe or as a bridge deck drain system, cast iron soil pipe will be paid for at the contract unit price per pound for the diameter specified.

Pipe end sections, concrete anchors, and safety metal end sections will be paid for at the contract unit price per each for the size specified, complete in place. A concrete anchor attached at one end of twin pipes will be paid for as two concrete anchors. A concrete anchor attached at one end of triple pipes will be paid for as three concrete anchors.

Roadway drain casting extension pipe will be paid for at the contract unit price per each.

550 Pavement replacement necessary due to structure installation under an existing pavement will be paid for at the contract unit price per ton of HMA for structure installation of the type specified and per square yard for PCCP for structure installation. Subbase will be paid for in accordance with 302.09.

Structure backfill will be paid for in accordance with 211.10. Where used as a substitute for structure backfill, flowable backfill will be paid for as structure backfill. When specified for pipe backfill, flowable backfill will be paid for in accordance with 213.09.

560 If a pipe structure is lowered, relocated, or if unsuitable material is encountered so that additional excavation is necessary over and above that shown on the plans at the original location, such additional excavation will be paid for at three times the contract unit price for the class of excavation involved. If the contract does not include rock excavation or unclassified excavation, rock removal below the proposed trench bottom elevation will be paid for at three times the contract unit cost for common excavation. However, in each of the above cases, such excavation will not be paid for if the additional amount involved at such structure is 10 cu yds or less.

570 For structures for which the plans show pipes of differing sizes for smooth, semi-smooth or corrugated interiors, and either the semi-smooth or the corrugated interior alternate is installed, payment for pipe backfill will be made based on the neat line dimensions shown on the plans for the smooth interior alternate.

Grated box end sections will be paid for at the contract unit price per each for the specified type, surface slope, and pipe size.

Video inspections for pipe will be paid for at the contract unit price per linear foot completed.

580 Payment will be made under:

	Pay Item	Pay Unit Symbol
	Concrete Anchor, _____ in.....	EACH
	diameter	
	Concrete Anchor, Min. Area ____ sq ft	EACH
	Grated Box End Section, _____, _____, _____ in.	EACH
	type slope diameter	
590	Grated Box End Section, _____, _____, Min. Area ____ sq ft	EACH
	type slope	
	HMA for Structure Installation, Type _____	TON
	mixture type	
	PCCP for Structure Installation	SYS
	Pipe End Section, _____ in.....	EACH
	diameter	
	Pipe End Section, Min. Area ____ sq ft	EACH
	Pipe Extension, Circular, _____ in., _____	LFT
	diameter material	
600	Pipe Extension, Deformed, Min. Area ____ sq ft, _____	LFT
	material	
	Pipe, Bridge Deck Drain System.....	LS
	Pipe, Drainage through Concrete Masonry	LS
	Pipe, End Bent Drain, _____ in.....	LFT
	diameter	
	Pipe, Relaid, _____ in. x _____ in.	LFT
	span rise	
	Pipe, Relaid, _____ in.	LFT
	diameter	
	Pipe, Roadway Drain Casting Extension.....	EACH
610	Pipe, Sanitary Sewer, _____ in.....	LFT
	diameter	
	Pipe, Slotted Drain, _____ in., _____ in.....	LFT
	diameter thickness	
	Pipe, Slotted Vane Drain, _____ in.	LFT
	diameter	

	Pipe, Type _____, Circular, _____ in.....	LFT
	diameter	
	Pipe, Type _____, Deformed, Min. Area _____ sq ft	LFT
620	Pipe, Underdrain Outlet, _____ in.....	LFT
	diameter	
	Safety Metal End Section, _____, _____ in.	EACH
	slope diameter	
	Safety Metal End Section, _____, Min. Area _____ sq ft	EACH
	slope	
	Soil Pipe, Cast Iron, _____ in.....	LBS
	diameter	
	Video Inspection for Pipe.....	LFT

630 The cost of reinforcing bars, straps, and hook bolts used in anchors shall be included in the cost of the concrete anchor.

The cost of the toe plate anchor and galvanized bolts required for pipe end sections and safety metal end sections shall be included in the cost of the pay items.

The cost of pipe support brackets and all hardware used to attach the roadway drain casting extension pipe to the drain casting and the pipe support bracket to the structural member and to the drain extension pipe shall be included in the cost of the pay items.

640 The cost of the pipe, all necessary fittings, all mounting hardware, design costs, and all other costs to provide the bridge deck drain system shown on the plans shall be included in the lump sum cost of the bridge deck drain system.

The cost of concrete backfill for slotted drain pipe and slotted vane drain pipe shall be included in the cost of the pay items.

B borrow obtained from planned excavation may be used to backfill culverts. No deduction will be made from the excavation or borrow quantities.

650 If existing concrete building foundations, concrete walls, concrete columns, or concrete steps not visible and not shown on the plans are encountered within the limits of the trench, the removal of such items, as required, will be paid for in accordance with 203.28.

660 The cost of sawing of pavement, excavation above the trench bottom elevation shown on plans, backfilling with material other than structure backfill or flowable backfill, dewatering, shoring, timber mats, class A concrete required for collar construction or sealing existing pipe, joint materials, replacing pipe which is damaged during installation or re-laying operations, sanitary sewer testing required by the local utility, and all other necessary incidentals shall be included in the cost of the pay items in this section.

716.01

The cost of removal of pavement, existing pipe, end sections, anchors, or headwalls, concrete collars, encasements, and the disposal of surplus materials shall be included in the cost of the pay items.

The cost of concrete, grating, pipe tubing, reinforcing bars, aggregate leveling bed, hardware cloth, and necessary incidentals, for construction of grated box end sections will be included in the cost of the grated box end section.

670

Geotextile required for coarse aggregate structure backfill material will not be paid for separately. The cost of the geotextile shall be included in the cost of the structure backfill.

The cost of providing video inspection equipment, technician, and a copy of the video inspection shall be included in the cost of video inspection for pipe.

680

No additional payment will be made for repair, remediation, or replacement of pipes, backfill, video inspection of the repaired, remediated, or replaced pipe, and all other work associated with the repair, remediation, or replacement of unacceptable pipes.

The cost of mandrel testing shall be included in the cost of the pipe.

SECTION 716 – TRENCHLESS PIPE INSTALLATION

716.01 Description

This work shall consist of installing pipes underground using construction techniques that eliminate open cutting of the pavement or of the ground in accordance with 105.03. This specification addresses auger boring, guided boring, horizontal directional drilling using a reamer diameter up to and including 24 in., pipe jacking, and pipe ramming, as defined below.

10 Installations by means of directional drilling which require a reamer larger than 24 in., microtunneling, or other tunneling methods, may be utilized if approved by the Engineer. The Contractor shall submit a detailed proposal prepared by a professional engineer for installations other than auger boring, guided boring, horizontal directional drilling using a reamer diameter less than 24 in., pipe jacking, and pipe ramming.

The following definitions apply to trenchless pipe installation.

(a) Auger Boring

20 Technique for forming a bore from a drive shaft to a reception shaft, by means of a rotating cutting head. Spoil is removed back to the drive shaft by helically wound auger flights rotating in a steel casing.

(b) Carrier Pipe

The tube which carries the product being transported and which may pass through casings at highway or railroad crossings. It may be made of steel, concrete, clay, thermoplastic, ductile iron, or other materials.

(c) Casing Pipe

A pipe installed as external protection to a carrier pipe.

30

(d) Drive Shaft

Excavation from which trenchless technology equipment is launched. It may incorporate a thrust wall to spread reaction loads to the soil.

(e) Guided Boring

A trenchless tunneling method that utilizes small diameter pilot tubes that are installed and steered through the ground utilizing a slanted face at the cutting head containing a target with light emitting diodes, LEDs, and a camera mounted theodolite located in the shaft to achieve high accuracy in line and grade. The hole is enlarged to the same outside diameter of the final product pipe after the installation of the pilot tubes, which is then jacked into place.

40

(f) Horizontal Directional Drilling

A steerable system for the installation of pipes, conduits, or cables in a shallow arc using a surface launched drilling rig.

(g) Microtunneling

A remote controlled trenchless construction method that simultaneously installs pipes as the soil is excavated. This method provides continuous support of the excavation face with slurry pressure to balance groundwater and earth pressures.

50

(h) Pipe Jacking

A system of directly installing pipes behind a shield machine by means of hydraulic jacking from a drive shaft such that the pipes form a continuous string in the ground.

(i) Pipe Ramming

A non-steerable system of forming a bore by driving an open ended steel casing using a percussive hammer from a drive shaft. The soil may be removed from the casing by augering, jetting, or compressed air.

60

(j) Reception Shaft

Excavation into which trenchless technology equipment is driven and recovered following the installation of the pipe.

(k) Response Levels

Pre-established levels of instrument readings of settlement or of other monitored behavior such as lateral movement or vibrations, which trigger the implementation of

70 mitigative measures. Response levels consist of the initial review level, at which mitigative measures must be implemented, and the alert level, at which construction must be halted and actions taken to ensure the alert level will not be exceeded in subsequent construction.

(I) Spoils

Earth, rock, or other materials displaced by a tunnel or casing, and removed as the tunnel or casing is installed.

MATERIALS

80 **716.02 Materials**

Materials shall be in accordance with the following:

Cellular Grout.....	725
Clay Pipe, Extra Strength	907.08
PVC Pipe	*
Reinforced Concrete Pipe.....	907.02
Smooth Wall Polyethylene Pipe	*
Steel Pipe.....	908.11
Water	913.01

90 * All thermoplastic pipes shall be from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.

Concrete pipe shall be from the QPL of Certified Precast Concrete Producers.

Concrete pipe installed by means of pipe jacking shall be designed with sufficient concrete strength and steel reinforcement to resist jacking forces and shall have tongue and groove joints. All reinforced concrete pipes shall have steel reinforcement concentric with the pipe wall.

100 Steel pipe used as a carrier pipe shall have the following minimum wall thickness. Steel pipe used as a casing pipe, but not used as a carrier pipe, shall be selected by the Contractor to have minimum wall thickness sufficient to resist jacking forces. For installations where the casing is not used as a carrier but only as a casing for a carrier pipe, the thickness of the casing shall be determined by the Contractor.

Outside Diameter, in.	Wall Thickness, in.
18 or less	1/4
19 – 20	5/16
21 – 26	3/8
27 – 30	1/2
31 – 42	1/2
43 – 48	9/16

CONSTRUCTION REQUIREMENTS

716.03 General Requirements

110 The Contractor shall submit a Quality Control Plan, QCP, in accordance with ITM 803. The QCP shall be submitted to the Engineer for review and acceptance, at least 15 days prior to the start of trenchless pipe installation operations.

Where groundwater is known or anticipated, and where the technique selected for trenchless pipe installation does not provide positive support at the trenchless excavation face, such as by slurry support in microtunneling, then trenchless pipe installation shall not proceed without dewatering in advance of trenchless pipe installation. A dewatering system of sufficient capacity to handle the flow shall be maintained at the site until its operation can be safely halted. The dewatering system shall be equipped with screens or filter media sufficient to prevent the displacement of fines.

Where the use of explosives is necessary for performing the work, their use shall be in accordance with 107.13.

Bentonite or other suitable lubricants may be applied to the outside surface of the pipe to reduce frictional forces.

130 Joints in steel pipe shall be watertight. Where welded joints are utilized, they shall be welded in accordance with 711.32. Joints in concrete pipe or other jacking pipe materials, including clay pipe, shall be designed to withstand the additional forces that are created in the joints during the installation process. The joints in concrete pipe or other pipe jacking materials shall be protected with a resilient material around the circumference of the pipe. Resilient material shall also be used between the pipe and the thrust ring.

140 Pavement or ground surface heave or settlement resulting in damage to pavement, existing utilities, or structures above the installation will not be allowed. To confirm if heave or settlement is occurring, the Contractor shall undertake surface monitoring.

Installations shall have a bored hole essentially the same diameter as the outside of the installed pipe. If voids develop or if the bored diameter is greater than the outside diameter of the pipe by more than 1 in., grouting shall be used to fill such voids.

When the installation is 4 in. or larger and the casing is used as the carrier pipe, a visual or a video inspection shall be performed using a high resolution, high sensitivity color video camera and recording equipment. The pipe shall be cleaned of debris prior to the inspection. Cleaning shall be accomplished by means of water jetting or other approved methods.

150 The camera and recording equipment shall be specifically designed for continuous viewing and recording of detailed images of the interior wall of pipes and transitions

716.04

of the specified sizes. The equipment shall include sufficient lighting to view the entire periphery of the pipe. The equipment shall have appropriate attachments to maintain a position in the center of the pipe and an electronic counter to continuously record the location of the equipment in the pipe. A copy of the video inspection shall be submitted to the Engineer.

160 All sections of pipe found to be damaged or where joint failure is evident shall be repaired or replaced as approved by the Engineer.

If an obstruction is encountered during installation which stops the forward progress of the pipe, and it becomes evident that it is impossible to advance the pipe, the Engineer shall be notified. For installations utilizing tunnel shields or tunnel-boring machines or other methods that allow access to the face, the obstruction shall be removed in accordance with the QCP. For installations utilizing methods that do not allow access to the face, at the direction of the Engineer, the pipe shall be abandoned in place and filled with grout or other approved materials.

170 Where a gravity-flow carrier pipe is placed inside a casing pipe, the gravity-flow carrier pipe shall be shimmed to proper line, elevation, and grade and then the void between the two pipes shall be grouted with cellular grout.

Upon completion of the installation of the pipe, all excavated areas not occupied by the pipe shall be backfilled and compacted with suitable material in accordance with 203.

716.04 Method of Measurement

180 Pipe installed by means of trenchless installation methods will be measured by the linear foot along the center line of the pipe installed.

716.05 Basis of Payment

Pipe installed by means of trenchless installation methods will be paid for by the linear foot for pipe installation, trenchless, of the size specified, complete and in place including all incidentals.

Removal of boulders, concrete, or other obstructions will be paid in accordance with 104.03.

190 Payment will be made under:

Pay Item	Pay Unit Symbol
Pipe Installation, Trenchless, _____ size	LFT

The cost of the QCP, excavating and backfilling of the drive shaft and reception shaft, video inspection, camera and recording equipment, bentonite or other lubricant,

200 grout, and the casing if installed shall be included in the cost of pipe installation, trenchless.

If a partial installation has to be abandoned in place and filled with grout due to the encountering of an obstruction, the abandoned work will be paid for at 75% of the contract unit price of the pipe installed.

No payment will be made to repair or replace sections of pipe that have been damaged or show evidence of joint failure.

SECTION 717 – STRUCTURAL PLATE PIPE, PIPE-ARCHES, AND ARCHES

717.01 Description

This work shall consist of furnishing and placing structural plate pipe, pipe-arches, or arches in accordance with 105.03.

MATERIALS

10 **717.02 Materials**

Materials shall be in accordance with the following:

Concrete, Class A	702
Flowable Backfill	213
Pipe Joint Sealant	907.11
Reinforcing Bars.....	910.01
Structural Plate Arches.....	908.09
Structural Plate Pipe and Pipe-Arches.....	908.09
Structure Backfill	904.05

20

Structural plate pipe and pipe-arches are part of the pipe classification system described in 715.02. The minimum material thickness and required protective treatments will be determined in accordance with 715.02. When metal pipe is selected, the same base metal and coating shall be used for the structure or a pipe extension.

CONSTRUCTION REQUIREMENTS

717.03 General Requirements

30 Forming, punching, and assembling shall be in accordance with AASHTO LRFD Bridge Construction Specifications. The radius of the arc joining the top to the bottom shall be in accordance with 908.09(a)1. Excavation shall be in accordance with the applicable requirements of 715 for pipe and pipe-arches and 206 for arches. Concrete shall be placed in accordance with 702 and reinforcing bars shall be placed in accordance with 703.

Each side of an arch shall rest in a groove formed into the masonry or shall rest on a galvanized angle or channel securely anchored to or embedded in the structure. Where the span of the arch is greater than 14 ft, or the skew angle is more than 20°, a metal bearing surface having a width at least equal to the depth of the corrugations shall be provided.

Metal bearings may be either rolled structural or cold-formed galvanized angles or channels no less than 3/16 in. in thickness with the horizontal leg securely anchored to the substructure on 24 in. maximum centers. When the metal bearing is not embedded in a groove in the substructure, one vertical leg shall be punched to allow bolting to the bottom row of plates.

If it is necessary to make a tee-connection to a structural plate pipe, pipe-arch, or arch, a stub-tee connection of the size and at the locations shown on the plans shall be furnished and placed, and its length shall be no less than 12 in. and no more than 24 in. The stub shall be connected in the field and the stub connection bituminous coated. The stub connection to the entering pipe shall be made by means of a connecting band of the required size or by means of concrete collars, as directed.

Structures on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship, shall be rejected unless it can be repaired satisfactorily. This requirement applies not only to the individual plates but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship. The presence of defects in an individual culvert plate or in a shipment shall constitute sufficient cause for rejection.

- (a) uneven laps;
- (b) elliptical shaping, unless specified;
- (c) variation from a straight centerline;
- (d) ragged edges;
- (e) loose, unevenly lined, or unevenly spaced bolts;
- (f) illegible brand;
- (g) bruised, scaled, or broken spelter coating;
- (h) dents or bends in the metal itself; and
- (i) twisted so that ends do not lay on bedding satisfactorily.

717.04 Backfill

All structural plate pipe and pipe arches shall be backfilled with structure backfill or flowable backfill. Arch backfill shall be structure backfill. The amount of camber on the invert of the pipe or pipe-arch shall be varied to suit the height of fill and supporting soil, except the camber grade shall not be above level. Structure backfill shall be placed in accordance with 211. Flowable backfill shall be placed in accordance with 213.

An adequate earth cover shall be provided over the structure, as shown on the plans, before heavy construction equipment is operated over it. This earth cover shall be free of stones.

Where backfilling at arches before headwalls are placed, the material shall first be placed midway between the ends of the arch, forming as narrow a ramp as possible, until the top of the arch is reached. The ramp shall be built up evenly on both sides and the backfilling material compacted as it is placed. After both ramps have been built to the top of the arch, the remainder of the backfill shall be deposited in both directions from the center to the ends and evenly on both sides of the arch.

90

If the headwalls are built before the arch is backfilled, the backfill material shall first be placed adjacent to one headwall until the top of the arch is reached, after which the fill material shall be placed from the top of the arch towards the other headwall. The material shall be deposited evenly on both sides of the arch.

In multiple installations the above procedure shall be followed. The backfill shall be brought up evenly on both sides of each arch so that unequal pressures are avoided.

100 Compaction by saturation will not be allowed, except below the free water table, then the provisions of 203.23 do not apply.

717.05 Relaid Pipe and Pipe-Arch

When required, any existing structural plate pipe or pipe-arch shall be taken up, re-laid, and extended. Removal shall be in accordance with 202.04 and the operations involved in its relaying shall be in accordance with similar operations contained herein for new structural plate pipe or pipe-arch.

717.06 Blank

110 717.07 Concrete Paved Inverts

Structural plate pipe and pipe-arches with concrete field paved inverts shall be constructed in accordance with and at locations shown on the plans or where directed.

The paved inverts for these structures shall be reinforced with WWR and sealed with pipe joint sealant as shown on the plans. The concrete for paving the invert shall not be placed until such time as the backfilling and embankment procedures have been completed satisfactorily.

717.08 Method of Measurement

120 Structural plate pipe and pipe-arch, new, extended, and re-laid, will be measured in accordance with 715.13. Structural plate arches will be measured by the linear foot, complete in place. Metal bearings and other hardware required to attach the structural plate arch to its substructure will not be measured for payment.

Concrete for headwalls and substructures will be measured in accordance with 702.27. Volumes occupied by a structural plate arch extending through the headwall will be deducted. Reinforcing bars used in substructures will be measured in accordance with 703.07. Concrete anchors will be measured in accordance with

717.09

130 715.13. Reinforcing bars, straps, and hook bolts used in anchors will not be measured for payment.

Structural backfill will be measured in accordance with 211.09. Flowable backfill used for backfill will be measured in accordance with 213.08.

717.09 Basis of Payment

140 The accepted quantities of new, extended, or re-laid structural plate pipe, or pipe-arch will be paid for in accordance with 715.14. Structural plate arches will be paid for at the contract unit price for arch, structural plate, of the size specified. Concrete, A, structures will be paid for in accordance with 702.28. Reinforcing bars in substructures will be paid for in accordance with 703.08. Concrete anchors will be paid for in accordance with 715.14.

If a pipe or pipe-arch is lowered or relocated, or if rock or unsuitable material is encountered which requires additional excavation, such excavation will be paid for in accordance with 715.14.

150 Structure backfill will be paid for in accordance with 211.10. Where used as a substitute for structure backfill, flowable backfill will be paid for as structure backfill. Where specified for backfill, flowable backfill will be paid for in accordance with 213.09.

Stub-tee connections including the connecting bands, concrete collars, or cement mortar beads will be paid for in accordance with 715.14.

Payment will be made under:

Pay Item	Pay Unit Symbol
Arch, Structural Plate, Min. Area ____ sq ft	LFT

160

The cost of excavation, concrete field paved inverts, disposal of surplus materials, reinforcing bars, straps, and hook bolts used in anchors, and necessary incidentals shall be included in the cost of the pay item.

The cost of metal bearings and other hardware needed to attach the structural plate arch to its substructure shall be included in the cost of the arch.

SECTION 718 – UNDERDRAINS

718.01 Description

This work shall consist of constructing underdrains using pipe, granular aggregates, outlet protectors, or geotextiles in accordance with 105.03.

MATERIALS

718.02 Materials

10 Materials shall be in accordance with the following:

Coarse Aggregate, Class E or Higher, Size No. 8 or 9	904.03
Concrete, Class A	702
Geotextile for Underdrains	918.02(b)
Reinforcing Bars.....	910.01
Sod, including Nursery Sod.....	621
Structure Backfill	904.05
Underdrain Outlet Pipe.....	*
Underdrain Pipe.....	715.02(d)

20 * All thermoplastic pipes shall be from the QPL of Thermoplastic Pipe and Liner Pipe Sources in accordance with 907.16.

Transition pipes, 45° elbows, elbow connector pipes, and increasers shall be of the same material as the underdrain outlet pipe.

Rodent screens shall be woven stainless steel wire mesh or galvanized hardware cloth. Coarse aggregate No. 8 or 9 shall be used for 6 in. underdrain installations and for underdrains for MSE walls. Coarse aggregate No. 9 shall be used for 4 in. underdrain installations.

30

The mixture for HMA for underdrains shall be Intermediate OG19.0 mm in accordance with 401. An ESAL Category 4 in accordance with 401.04 and a PG Binder 76-22 shall be used. A MAF in accordance with 401.05 will not apply. Acceptance of the HMA for underdrains will be in accordance with 402.09, except the air voids tolerance shall be $\pm 3.5\%$.

CONSTRUCTION REQUIREMENTS

718.03 Pipe Installation

40

(a) Locations Outside MSE Wall Ground Reinforcement Limits

Trenches shall be excavated to the dimensions and grade shown on the plans. Each longitudinal underdrain trench shall be cut continuously across all twin outlet areas and all single outlet areas. Such pipeless portions of the trench shall be backfilled with aggregate for underdrains. Pipes shall be secured to ensure that the pipe's required grade and horizontal alignment are maintained. Perforated pipe shall be placed with the perforations down. The pipe sections shall be joined securely with the appropriate couplings, fittings, or bands. The pipe shall be installed in the underdrain trench such that a minimum clearance of 2 in. exists between the pipe and the trench walls.

50 Aggregate for underdrains shall be placed in a manner which minimizes contamination. HMA for underdrains shall be placed and compacted separately from mainline mixtures. HMA for underdrains may be placed in one lift and shall be compacted with equipment in accordance with 409.03(d).

If plain end concrete pipe is being laid, the joint width shall not exceed 1/4 in.

(b) Underdrains Within MSE Wall Ground Reinforcement Limits

Underdrains for MSE walls shall be as shown on the plans. Coarse aggregate used as underdrains for MSE walls shall be compacted in accordance with 706.04.

60

718.04 Geotextile

Storage and handling of geotextiles shall be in accordance with the manufacturer's recommendations. Each geotextile roll shall be labeled or tagged. Damaged or defective geotextile shall be replaced as directed. The geotextile shall be placed loosely, but with no wrinkles or folds. The ends of subsequent rolls of geotextile shall be overlapped a minimum of 1 ft. The upstream geotextile shall overlap the downstream geotextile. Placement of aggregate shall proceed following placement of the geotextile. HMA for underdrains shall be placed and compacted separately from mainline mixtures. HMA for underdrains may be placed in one lift and shall be compacted with equipment in accordance with 409.03(d).

70

718.05 Underdrain Outlets

If the underdrain pipe and the outlet pipe are of different sizes, an increaser of the same material as the outlet pipe shall be installed 2 ft from the 45° elbow and prior to the transition pipe. If a single outlet pipe is to be skewed at 45°, a second 45° elbow and an elbow-connector pipe are not required.

The outlet pipe or pipes shall be located as close as possible to the center of the outlet protector.

80

After the outlet pipe installation, the trench shall be backfilled as shown on the plans. Structure backfill shall not extend into the limits of the underdrain trench. The trench outside the limits of structure backfill shall be filled with materials suitable for growing vegetation. Aggregate and stabilized materials removed from an existing shoulder shall not be used as backfill and shall be disposed of in accordance with 206.07. At the time of installation, a rodent screen shall be placed on the outlet pipe or the ends of the underdrain pipe when located in inlets or catch basins.

718.06 Underdrain Outlet Protectors

90

Underdrain outlet protectors shall be constructed as shown on the plans.

718.07 Video Inspection

Underdrains and outlets shall be inspected using high resolution, high sensitivity, waterproof color video camera/recording equipment.

The camera/recording equipment shall be specifically designed for continuous viewing/recording of detailed images of the interior wall of pipes and transitions of the specified sizes. The equipment shall have the capability of viewing a minimum of 450 ft into the pipes and shall be designed to include sufficient lighting to view the

- 100 entire periphery of the pipe. The equipment shall have appropriate attachments to maintain a position in the center of the pipe and an electronic counter to continuously record the location of the equipment in the pipe. The recording equipment shall record video of a quality and in a format acceptable to the Engineer. A color video printer shall be included in the equipment for printing observations during inspection.

The Engineer will determine the runs of the underdrain installations to be inspected. Video inspection shall be conducted after guardrail, lighting, sign installation, and final seeding or sodding operations are completed.

- 110 Damage discovered by the video inspection shall be repaired. Damage shall include but is not limited to; crushed or partially crushed pipe that impedes the progress of the camera, blockages, vertical pipe sags filled with water to a depth of $d/2$ or greater, 90° connections, connector separations, cracks or splits in the pipes. All repaired sections shall be video reinspected prior to acceptance. A copy of the video inspection shall be submitted to the Engineer.

718.08 Patching Underdrains

- 120 Underdrains that are disturbed shall be repaired such that the underdrain is perpetuated. This repair shall include the construction of new outlets where the existing configuration prior to the damage cannot be reinstalled. The repairs shall be as approved by the Department. Once the repairs are completed, a video inspection may be required by the Department to verify that the repairs have been successfully completed.

Geocomposite edge drains that are disturbed shall be outletted as approved and not perpetuated.

718.09 Method of Measurement

- 130 Underdrain and outlet pipe will be measured by the linear foot, complete in place. If the pipe connects to structures such as manholes, inlets, or catch basins, the pipe will be field measured to the outside face of the structures. Outlet protectors will be measured by the number and type of units installed.

Measurement of outlet pipe will be made along the centerline of the pipe from the point of connection with the underdrain pipe to the downstream end of the outlet pipe and will include all transitions, elbows, and increaser or decreaser connections.

- 140 Structure backfill will be measured in accordance with 211.09. HMA for underdrains will be measured by the ton.

Aggregate for underdrains and underdrains for MSE walls will be measured by the cubic yard, complete in place. The pay limits will not extend beyond the neat lines shown on the plans.

Geotextiles for underdrains will be measured by the square yard, for the type specified, based on the neat line limits shown on the plans.

Video inspections for underdrains will be measured by the linear foot as determined by the electronic equipment.

150

Patching of underdrains will not be measured.

Rodent screens and other incidentals will not be measured for payment.

Concrete, reinforcing bars, or sod for underdrain outlet protectors will not be measured for payment.

718.10 Basis of Payment

160 The accepted quantities of underdrains and underdrain outlet pipe will be paid for in accordance with 715.14. Aggregate for underdrains will be paid for at the contract unit price per cubic yard. Underdrains for MSE walls will be paid for as aggregate for underdrains.

Geotextile for underdrains will be paid for at the contract unit price per square yard for the type specified. Outlet protectors will be paid for at the contract unit price per each of the type of unit installed, complete in place. The accepted quantities of HMA for underdrains will be paid for at the contract unit price per ton.

170 Underdrain patching for structure installation will be paid for at the contract unit price per linear foot of underdrain, patching and shall be equal to the length of the theoretical pavement replacement as shown on the plans.

Structure backfill will be paid for in accordance with 211.10.

The final accepted quantity video inspection for underdrain will be paid for at the contract unit price per linear foot.

Payment will be made under:

180	Pay Item	Pay Unit Symbol
	Aggregate for Underdrains	CYS
	Geotextile for Underdrains, _____ type	SYS
	HMA for Underdrains	TON
	Outlet Protector, _____ type	EACH
	Underdrain, Patching	LFT
	Video Inspection for Underdrain	LFT

190

Geotextile for underdrains which has been rejected due to contamination or other reasons shall be replaced with no additional payment.

The cost of excavation, forming, reinforcing bars, concrete, curing materials, and sod shall be included in the cost of outlet protector.

200 The cost of providing the video inspection equipment, technician, and a copy of the video inspection shall be included in the cost of the underdrain video inspection. The cost of repair of underdrain pipes, aggregates, backfill, outlet protectors, geotextile fabric, providing video re-inspection of the repairs, and other incidentals shall be included in the cost of the other pay items in this section.

Where underdrain repair for structure installation is required, the cost of underdrain pipe, aggregate for underdrains, geotextile for underdrains, HMA for underdrains, outlet protectors if required, video inspection for underdrains, and all other incidentals for underdrains shall be included in the cost of underdrain, patching. The cost of repairing underdrains damaged by activities other than for structure installation, or as defined above, shall be at no additional cost to the Department.

210 The cost of disposal of unsuitable excavated materials, installation of pipe end caps, rodent screens, and other incidentals shall be included in the cost of the pay items in this section.

SECTION 719 – TILE DRAINS

719.01 Description

This work shall consist of the installation of drain tile in accordance with 105.03.

MATERIALS

719.02 Materials

Materials shall be in accordance with the following:

10	Concrete, Class A	702
	Drain Tile Terminal Pipe.....	907.24
	Flowable Backfill	213
	Reinforcing Bars.....	910.01
	Riprap	616.02
	Structure Backfill	904
	Rodent Screen.....	718.02

Drain tile materials shall be in accordance with 715.02(d).

20

CONSTRUCTION REQUIREMENTS

719.03 Trench Excavation

The trench excavation shall begin at the outlet end and proceed towards the upper end, true to the required line and grade. The trench shall be as shown on the plans. If

719.04

no trench details are shown on the plans, the trench shall be of sufficient width to provide ample working space on each side of the drain tile to enable compaction of the backfill around the tile. Recesses shall be cut into the trench bottom to accommodate any projecting hubs or bells.

30

If excavation is made too deep, proper bearing shall be secured by backfilling to the required elevation with sand, clay, or other approved material which shall be tamped into place and shaped properly.

If a firm foundation is not encountered at the required trench bottom grade, the unstable material shall be removed to such depth that provides ample support after being backfilled, compacted, and shaped to the required elevation or the drain tile shall be laid on composite planking which is not less than 1 in. thick, 10 in. wide, and 10 ft long.

40

If rock is encountered at or above the required trench bottom grade, the trench shall be excavated at least 8 in. below the pipe and backfilled, compacted, and shaped as described above.

Where excavation is made for installing drain tile across private property, the topsoil and sod, if present, shall be kept in separate stockpiles. After completion of the backfill operation, the topsoil and sod shall be placed so that the area is restored as closely as possible to its original condition.

50 **719.04 Laying Tile**

Tile shall not be laid on a frozen or muddy trench bottom. It shall be laid true to line and grade, starting at the outlet end. Each tile shall have a firm bearing for its entire length and joints left as tight as practicable by turning the individual sections until the ends fit closely. A joint which does not close to within 1/4 in. shall be covered with pieces of broken tile. If laid on composite planking, the joints shall be covered with pieces of broken tile and then entirely covered with clay and tamped.

Drain tile installed on private property shall be perforated pipe in accordance with 715.02(d).

60

When an existing tile drain is encountered on permanent right-of-way, it shall be replaced in the following manner. If the tile is intercepted by a side ditch prior to crossing proposed pavement, it shall be replaced between the right-of-way line and the ditch with non-perforated drain tile and a 10-foot long terminal pipe section of drain tile with a rodent screen. If the tile is to outlet into a storm sewer, it shall be replaced between the right-of-way line and the storm sewer with pipe in accordance with 715.02(b). If the tile is to outlet at a side ditch after crossing the proposed pavement, it shall be replaced between the right-of-way line and the ditch with pipe in accordance with 715.02(a) with a rodent screen. If the tile is to be maintained across the right-of-way, it shall be replaced from right-of-way line to right-of-way line with pipe in accordance with 715.02(a).

70

719.05 Backfilling

Pipe replacing drain tile shall be backfilled in accordance with 715.09.

719.06 Blank

719.07 Method of Measurement

80 Drain tile and replacement pipe of the type and size specified will be measured in accordance with 715.13. Terminating pipe sections of the type and size specified will be measured per linear foot. Structure backfill will be measured in accordance with 211.09. Flowable backfill will be measured in accordance with 213.08. Riprap will be measured in accordance with 616.12.

Tee or wye branch connections will be measured per each along the centerline of the barrel. An additional allowance of 5 lft of the smaller diameter pipe will be made for making such connections.

90 Elbow connections will be measured along the centerline of such connection. An additional allowance of 2 lft of pipe of the same diameter as that of the elbow will be made for each such connection.

Increaser and reducer connections will be measured by the linear foot as the larger diameter pipe over the length of the connection.

719.08 Basis of Payment

100 The accepted quantities of drain tile and replacement pipe will be paid for in accordance with 715.14. Terminating pipe sections will be paid for at the contract unit price per linear foot for pipe, drain tile terminal section, of the size specified, complete in place. Structure backfill will be paid for in accordance with 211.10. Flowable backfill will be paid for in accordance with 213.09. Riprap will be paid for in accordance with 616.13.

Tee and wye connections will be paid for by means of the allowance of an additional 5 lft of the smaller pipe at the connection. Elbow connections will be paid for by means of the allowance of an additional 2 lft of the pipe at the connection.

110 If increaser or reducer connections are made, payment will be made on the basis of the larger diameter of the connection for the full length of the section forming such connections.

Payment will be made under:

Pay Item	Pay Unit Symbol
Pipe, Drain Tile Terminal Section, _____ in.....	LFT
diameter	

720.01

120 The cost of excavating, backfilling with suitable excavated material, disposal, planking, removal of existing tile, and necessary incidentals shall be included in the cost of this work.

SECTION 720 – MANHOLES, INLETS, AND CATCH BASINS

720.01 Description

This work shall consist of the construction, reconstruction, or adjustment to grade of manholes, inlets, and catch basins in accordance with 105.03.

MATERIALS

720.02 Materials

10 Materials shall be in accordance with the following:

	Castings	910.05
	Clay or Shale Brick	905.01
	Clay Pipe	907.08
	Concrete Brick.....	905.02
	Concrete Masonry Blocks	905.03
	Concrete	702
	Hydrated Lime.....	913.04
	Joint Filler.....	906.01
20	Joint Mortar	901.08, 907.12
	Non-Reinforced Concrete Pipe.....	907.01
	Precast Concrete Manholes, Inlets, and Catch Basins	907.04
	Reinforced Concrete Pipe.....	907.02
	Reinforcing Bars.....	910.01
	Water	913.01

CONSTRUCTION REQUIREMENTS

720.03 General Requirements

30 The construction of the items listed in this specification shall be in accordance with 203.14.

Excavation shall be to the established bottom of the foundations. The finished surface shall be firm and smooth. If soft or yielding spots are encountered at this elevation, they shall be removed, backfilled with suitable material, and tamped into place. If rock is encountered at the bottom elevation, the excavation shall be carried down 6 in. further and backfilled with approved material tamped to the required elevation.

40 Concrete construction shall be in accordance with the requirements for structural

concrete. Masonry shall be in accordance with the requirements for the respective type. Exposed corners of concrete shall be rounded to a 1/4 in. radius. Air-entrained concrete will not be required in the precast portions of concrete manholes or catch basins.

Frames for castings and bearing plates for manholes shall be set in full mortar beds and secured as shown on the plans or as otherwise approved. The mortar shall be composed of 1 part cement to 2 parts No. 23 fine aggregate, by volume. Castings shall be set to the finished pavement elevation so that subsequent adjustments are not necessary.

50

Iron hood traps in catch basins shall be installed in walls as shown on the plans and so placed that a 6 in. seal is formed. Joints between hoods and walls shall be made gas tight.

Mortar for laying brick and masonry units shall be composed of 1 part masonry cement and 2 parts mortar sand. Mortar for plastering may be the same or it may be composed of 1 part of a combination of portland cement and hydrated lime and 2 parts mortar sand. The lime shall not exceed 10% of the cement. In any case, proportioning shall be by volume. Ingredients, except water, shall be dry mixed, after which water shall be added to bring the mortar to a stiff paste and mixing continued until a uniform mixture results.

60

Required plaster coats on the inside and outside shall be at least 1/2 in. thick and shall be smooth, clean, and watertight.

Inlet and outlet pipes shall extend through walls a sufficient distance to allow for connections on the outside and the concrete or mortar carefully placed around them to prevent leakage around their outlet surfaces. Unless otherwise shown, the inside ends shall be flush with the inside walls. The pipe shall be of the same size and kind as that with which it connects on the outside.

70

Where castings are adjacent to or are surrounded by cement concrete construction, each casting shall be entirely separated from the concrete by a preformed joint filler not less than 3/8 in. thick. The cost of each joint, including the material, shall be included in the price for the structure. Grates shall be placed with the maximum dimension of the rectangular opening parallel to the direction of flow.

The surface of the grate shall be flush with the top edge of the frame, wingwall, and headwall. The frame shall be galvanized and anchored into concrete. The frame shall be factory assembled. All joints shall be fully welded.

80

Adjusting slots for curb boxes shall be of the dimensions shown on the plans. One slot shall be located at each end of the curb box, and one slot shall be located at the approximate centerline on the back of the curb box. Galvanized or stainless steel 3/8 in. UNC x 3 1/2 in. round head, square shoulder bolts with one flat washer, one lock washer, and one nut each shall be used in each slot to anchor the curb box to the frame

such that the top of the curb box is flush with the top of the curb. Bolts shall be torqued to a minimum of 120 ft lb.

- 90 Steel grating type 12 shall be a galvanized grating which shall be of sufficient strength to support a 12,000 lb wheel load with a maximum fiber stress of 20,000 lb/sq in. The grating shall seat firmly in, but shall not be secured to, the frame. The length and width of the grating shall be so as to leave not more than 3/8 in. clearance on each side when in place in the frame. The grating shall be cut such that all riveted or welded connections are left intact.

- 100 If a manhole is constructed within the pavement area or within an area that may be paved at some future date, the height of the casting used shall be based on the depth of pavement constructed or proposed and a bearing plate for such casting will also be required. Adjusting rings or steps of alternate types to those shown on the plans may be used subject to approval.

If a manhole is constructed outside the proposed pavement area and outside an area that may be paved at some future date, the height of the casting used shall be at least 7 in. and a bearing plate for such casing will not be required.

- 110 The manhole bottom shall be constructed of a precast bottom section, or of class A concrete formed in place. A precast cover shall be placed on a manhole in which headroom is limited.

Only competent masons shall be employed in laying units. Brick or other masonry units shall be laid in courses with full and close joints of mortar and finished properly as the work progresses. No joint shall exceed 3/8 in. in width. All units shall be wetted thoroughly immediately prior to being laid. Broken or chipped units will not be allowed in the face of the structure. No spalls or bats shall be used except for shaping around irregular openings or where necessary to finish out a course. As nearly as practicable, adjoining courses shall break joints at a 1/2 unit. Courses shall be level except where otherwise necessary. If brick is used, at least one course in each seven shall be composed of headers.

- 120 The pipe used in pipe catch basins shall be of the bell-and-spigot type.

Reinforced concrete spring boxes shall be constructed of class A concrete to the dimensions and at locations shown on the plans or as otherwise specified.

- 130 If the completed structure is partially or completely under or at its nearest point is within 5 ft of pavement, sidewalks, curbs, gutters, or similar miscellaneous existing or proposed structures, the excavated space not occupied by the newly completed structure shall be filled to the required subgrade elevation with material in accordance with 211.02. Placement of this material shall be in accordance with 211.04. If the completed structure is not located as set out above, the backfill shall be with approved material which, when compacted, shall meet the required subgrade density.

Material excavated for the structure shall, if suitable, be utilized as backfill. If, in excess for that purpose, the excess shall be used in embankment where locations are available or otherwise disposed of as directed. If the excavated material is unsuitable or is in excess for use in the work, it shall be disposed of in accordance with 201.03. When finally accepted, all structures shall be free from any accumulation of silt, debris, or other foreign matter.

140

The Contractor may precast inlets, catch basins, or manholes, subject to approval. If precast concrete inlets, catch basins, or manholes are used, a layer of structure backfill of minimum thickness of 4 in. shall be used under each unit for ease in positioning. If holes are formed or field cut in precast inlets or catch basins to receive the pipe structures, the pipes shall be connected directly to the precast unit, by means of a class A concrete collar of a minimum longitudinal and radial thickness of 6 in. Holes formed or cut in the wrong place shall be plugged satisfactorily with a class A concrete mixture.

150

Horizontal joints may be used in the construction of precast catch basins. A sketch of the type, location, and sealing material planned for each joint shall be submitted for approval. No joints shall be closer than 3 in. above standing water for those catch basins requiring hoods.

Grade and location adjustments to precast inlets and catch basins caused by unforeseen conditions shall be handled as if the units were being cast-in-place. All additional adjustments required due to precasting will not be paid for directly, but the cost thereof shall be included in the cost of the inlet or catch basin.

160

720.04 Grade Adjustment of Existing Structures

When grade adjustment of existing structures is specified, the frames, covers, and gratings shall be removed and the walls reconstructed as required. The cleaned frames shall be reset at the required elevation. If so specified or if it is determined that the existing casting and supporting walls are in good condition, an approved device may be used to adjust the manhole casting cover to the correct grade without reconstructing the walls or resetting the frame.

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Upon completion, each structure shall be cleaned of any accumulations of silt, debris, or foreign matter of any kind and shall be kept clear of such accumulation until final acceptance of the work.

Excavation and backfill shall be done in accordance with 720.03.

If an existing casting is unfit for further use, a new casting shall be furnished with payment at the contract unit price per each for castings of the type specified, furnished, and adjusted to grade. This payment shall include and be full compensation for furnishing the new casting, placing and adjusting it to grade, including any necessary removal, construction, or reconstruction of not to exceed 12 in. average height of the

720.05

upper portion of the masonry.

180

When manholes, catch basins and inlets are adjusted to grade and are to abut existing concrete construction, the castings shall be entirely separated from the adjacent concrete by a preformed expansion joint no less than 3/8 in. in thickness. The cost of furnishing and placing the preformed expansion joint material will not be paid for directly, but shall be included in the payment for reconstructed catch basin, or reconstructed inlet, or castings furnished and adjusted to grade. The preformed expansion joint material shall be in accordance with 906.01.

190 On resurface contracts the castings shall, unless otherwise directed, be adjusted to grade after the last binder course has been laid and before placing the surface course.

720.05 Capping Existing Structures

All structures directed to be capped shall be as shown on the plans or by filling the structure with class A concrete after the existing drainage has been maintained. The flow of water through pipes or underdrains in structures shall be perpetuated. Alternate methods for capping shall be submitted for approval before they may be used.

720.06 Method of Measurement

200 Manholes, inlets, spring boxes, and catch basins, both new and reconstructed as applicable, will be measured per each unit, complete in place.

Castings adjusted to grade and castings furnished and adjusted to grade will be measured per each unit complete in place, if the average adjustment height does not exceed 12 in. If corrections to the structure involve portions exceeding an average adjustment height of 12 in., the additional work will be measured by the linear foot for the type of structure involved.

210 The capping of existing structures will be measured by the number of structures capped.

720.07 Basis of Payment

The accepted quantities of manholes, inlets, spring boxes, catch basins, castings adjusted to grade not exceeding 12 in., and castings furnished and adjusted to grade not exceeding 12 in. will be paid for at the contract unit price per each, complete in place.

220 That portion of a reconstructed structure which exceeds 12 in. in average height will be paid for at the contract unit price per linear foot, for structure, of the type specified, reconstruct, complete in place.

The capping of inlets and other structures will be paid for at the contract unit price per each for cap inlet.

SECTION 721 – AUTOMATIC DRAINAGE GATES

721.01 Description

This work shall consist of furnishing and placing cast-iron, automatic, hinged, flap-gate valves to the outlet ends of pipe or headwalls in accordance with 105.03.

721.02 Materials

The cast-iron flap and seat shall be machined accurately to ensure watertightness. They shall be in accordance with the applicable requirements of 910.05(b).

10

721.03 Construction Requirements

The gate shall be constructed to offer minimum resistance to water flowing through it. When the water elevation in the outlet stream is 1/2 in. or more above or below the bottom of the valve, the valve shall close or open, as the case may be. The valve shall be able to resist a head of at least 10 ft.

The end of the pipe, or headwall, to which the flange is attached shall be vertical and the flange attached thereto either with rivets, bolts, or other approved means.

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721.04 Method of Measurement

Automatic drainage gates will be measured by the number of units installed.

721.05 Basis of Payment

The accepted quantities of this work will be paid for at the contract unit price per each for automatic drainage gate, of the size specified, complete in place.

Payment will be made under:

30

Pay Item	Pay Unit Symbol
Automatic Drainage Gate, _____ in. x _____ in.	EACH
width height	
Automatic Drainage Gate, _____ in.	EACH
diameter	

If the gate is fastened to the end of a pipe, no additional payment will be allowed for that portion of pipe extending beyond the outside face of the headwall.

SECTION 722 – CONCRETE BRIDGE DECK OVERLAYS

722.01 Description

This work shall consist of the surface preparation and construction of a bridge deck overlay consisting of latex modified portland cement concrete, LMC, latex modified concrete very early strength, LMC-VE, or silica fume modified concrete, SFMC, on an existing or new bridge deck, or it shall consist of patching an existing

concrete overlay on a bridge deck in accordance with 105.03.

10 **722.02 Quality Control**

LMC-VE overlays shall be placed in accordance with the QCP, which shall be prepared and submitted in accordance with ITM 803. The QCP shall include the Contractor's experience placing LMC-VE overlays within the last three years. The QCP shall be submitted to the Engineer at least 14 days prior to commencing overlay operations. Approval of the QCP by the Department's Division of Materials and Tests is required.

MATERIALS

20 **722.03 Materials**

Materials shall be in accordance with the following:

	Admixtures	912.03
	Coarse Aggregate, Class A or Higher, Size No. 11*	904.03
	Epoxy Resin Adhesive	909.11
	Fine Aggregate	904
	Fly Ash	901.02
	Latex Modifier.....	912.04
	PCC Sealer/Healer.....	901.06
30	Portland Cement.....	901.01(b)
	Rapid Hardening Hydraulic Cement	901.01(d)
	Silica Fume.....	901.04
	Water	913.01

* Crushed stone only.

Evaporation retardant shall be a product that produces a monomolecular film. A type D certification in accordance with 916 shall be provided for the evaporation retardant.

40 Citric acid shall be marked "food grade" on the packaging.

722.04 Storage and Handling of Materials

Fine and coarse aggregates shall be stored and handled avoiding contamination and maintaining uniform moisture content. Fine and coarse aggregates which are stored in piles or bins shall remain separated and shall be covered with a moisture proof material which prevents variations in moisture content of the aggregates. The maximum variation of moisture content in successive concrete batches shall be 0.5%.

Cement shall be shipped and stored in accordance with 702.04 and 901.01.

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The latex modifier, liquid silica fume slurry, and dry condensed silica fume shall be stored in accordance with the manufacturer's recommendations. Latex modifier shall be strained to remove solid particles during transfer of the material from storage drums to the mobile mixer tank.

722.05 Proportioning

(a) Latex Modified Concrete

60 A mix design shall be submitted a minimum of 14 days prior to use and calibration of the mobile mixer in accordance with 722.09. The proportioning of the ingredients for the LMC shall be in accordance with 702.05 except as modified herein.

The amount of fine aggregate shall be 60% \pm 5% by dry weight of the total aggregate and shall be considered as the amount of aggregate blend passing the No. 4 (4.75 mm) sieve. The coarse aggregate shall be No. 11, class A crushed stone. The cement content shall be a minimum of 658 lb/cu yd of concrete. The same brand of cement shall be used throughout a bridge structure. The amount of latex modifier shall be 3.5 gal. per 94 lb of cement. The net water added shall produce a slump of 5 in. \pm 1 in. at 4 to 5 minutes after discharge from the mixer. The moisture content of the
70 aggregates shall be controlled such that the slump is within the specified limits. The maximum water/cement ratio shall be 0.400 including the water in the latex. The air content shall be a maximum of 6%, by volume, of the plastic mix.

The yield will be checked using the 1/4 cu yd box method as follows. The chute shall be cleaned and the box shall be positioned to receive the discharged concrete. The mixer shall be operated until the cement counter indicates that 1/4 cu yd of concrete has been produced. The contents of the box shall be consolidated and struck off. Where the box is not essentially full, the gates shall be adjusted and the procedure shall be repeated until the actual and calculated volumes of concrete agree. Yield tests
80 shall be run on the first load of each truck and every third load per truck thereafter. The air content shall be tested on the first load of each truck prior to placing concrete onto the deck. Additional tests will be required after making any adjustments.

Slump and air content tests will be performed after each acceptable yield test. The slump test shall be in accordance with AASHTO T 119 and will be performed 4 to 5 minutes after the concrete is discharged from the mixer. The water flow meter reading will be recorded at the time the slump test is taken. The concrete shall not be disturbed during the waiting period for the slump test. The air content test shall be in accordance with 505. Any concrete mixture which is not properly proportioned or does not
90 conform to the specified slump will be rejected.

Class F or class C fly ash may be used in the latex modified portland cement concrete. The maximum cement reduction shall be 15% and the minimum replacement ratio by weight of fly ash to cement shall be 1.25:1. Where portland pozzolan cement, type IP is to be used in the concrete mix design, the cement content shall be increased by a multiplier of 1.06 times the specified cement content.

(b) Latex Modified Concrete, Very Early Strength

100 Proportioning of ingredients for LMC-VE shall be in accordance with 722.05(a) except as follows.

Cement shall be a rapid hardening hydraulic cement. Fly ash or other pozzolanic materials shall not be used. Citric acid may be used as a retardant. The maximum content of citric acid shall be 1% of the cement weight. The minimum compressive strength shall be 2,500 psi at 3 h and 3,500 psi at 24 h. The net water added shall produce a minimum slump of 7 in. and maximum slump of 10 in. at 4 to 5 minutes after discharge from the mixer. The maximum water-cement ratio shall be 0.440 including the water in the latex.

110 **1. Trial Batch Demonstration**

A trial batch shall be produced to verify that the mix design complies with the physical properties specified, as well as, simulating the placement properties unique to the conditions of the contract such as profile grade, cross slope, delivery time, discharge rate, slump loss with time, air content and target compressive strength. All testing of the trial batch concrete shall be performed by an American Concrete Institute, ACI, certified concrete field testing technician, grade I.

120 The trial batch demonstration shall include a meeting between the Contractor, material suppliers, and Department to discuss LMC-VE, mixing, delivery, placement, finishing, curing and compressive testing. Representatives from the rapid hardening cement manufacturer shall be present for trial batch demonstrations and the start-up for initial bridge deck placement. The Department's Division of Materials and Tests may waive the required attendance for these representatives where the Contractor provides sufficient evidence of adequate experience with producing and placing LMC-VE. The trial batch demonstration may be conducted in conjunction with calibration of the mobile mixer in accordance with 722.13.

2. Blank

130 **(c) Silica Fume Modified Concrete**

A concrete mix design submittal, CMDS, shall be submitted a minimum of 14 days prior to the trial batch utilizing the Department provided spreadsheet. The proportioning of ingredients for each batch of SFMC shall be in accordance with 702.05 except as modified below and shall meet the mix design, trial batch demonstration, and job-use requirements as specified.

The portland cement content shall be 658 lb/cu yd. Silica fume shall be added at 50 lb/cu yd.

140 The SFMC shall utilize a type F or G admixture to be combined with an air entraining admixture, AEA, a HRWR admixture system or a HRWRR admixture system and shall be selected from the QPL of PCC Admixtures and Admixture Systems.

The water/cement ratio shall be no less than 0.370 and shall not exceed 0.400. Portland cement and silica fume shall be included in the total amount of cementitious material.

The same brand of cement and silica fume shall be used throughout the structure.
150 The HRWR or HRWRR admixture system shall not be changed during any individual contiguous pour.

The Contractor shall obtain a written statement from each admixture manufacturer stating the compatibility of the HRWR admixture system and satisfactory performance in SFMC.

The SFMC shall have a relative yield and air content in accordance with 702.05. The slump will be tested in accordance with AASHTO T 119 at the time of placement and shall be at least 4 1/2 in. but shall not exceed 7 1/2 in. The SFMC shall have a
160 minimum compressive strength of 4,500 psi at 7 days and 5,500 psi at 28 days. The compressive strength shall be in accordance with 702.24.

1. Trial Batch Demonstration

A trial batch shall be produced to verify that the mix design complies with the physical properties specified, as well as, simulating the placement properties unique to the conditions of the contract such as profile grade, cross slope, delivery time, discharge rate, slump loss with time, air content and target compressive strength. All testing of the trial batch concrete shall be performed by an American Concrete Institute, ACI, certified concrete field-testing technician, grade I.

170

The trial batch demonstration shall include a meeting between the Contractor, material suppliers, and Department to discuss SFMC, batching, mixing, delivery, placement, finishing, curing and compressive testing. Representatives from the silica fume and chemical admixture manufacturer shall be present for trial batch demonstrations and the start-up for initial bridge deck placement. The Department's Division of Materials and Tests may waive the required attendance for these representatives where the Contractor provides sufficient evidence of adequate experience with producing and placing SFMC.

180

2. Batching

Batching shall be in accordance with 702.06 except the minimum batch shall be 4 cu yds and the maximum shall not exceed 80% of the truck rated capacity. Dry condensed silica fume shall be either sacked or bulk and it shall be batched in accordance with the requirements for cement as specified in 702.06. No partial sack of dry condensed silica fume shall be used in a batch of SFMC. Dry condensed silica fume shall be typically added after the initial water and aggregates, with premixing prior to the addition of cement and fly ash, to facilitate dispersion. An alternate batching sequence will be allowed as recommended by the manufacturer of the silica fume and as approved by the Engineer. Liquid silica fume slurry shall be batched as
190 required by the manufacturer and as approved by the Engineer. The AEA shall be added initially with either the first portion of mix water or the fine aggregate. Where a type A or D chemical admixture is used as part of the HRWR admixture system, it shall be added separately with a portion of the mix water, after the AEA is premixed

in the concrete. A type F or G chemical admixture shall be added separately at the end of the batching sequence with some mix water held in reserve to aid dispersion.

A change in the sequence of batching may be approved if it is in accordance with the chemical admixture and silica fume manufacturer's recommendations, and is agreed to in writing prior to any trial batch demonstration.

200

722.06 Preparation of the Bridge Floor

(a) Removal of Existing Concrete Overlay

When an existing deck overlay is to be removed, the removal shall be performed with a milling machine. The milling shall include the depth of the existing deck overlay and an additional depth as shown on the plans. If no additional depth is shown on the plans, the additional depth shall be 1/2 in. Removal in areas that are inaccessible to the milling machine, shall be performed by chipping hammers or handchipping in accordance with 722.06(b)3.

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(b) Surface Preparation of Existing Concrete Deck

1. Removal of Existing Concrete Deck Surface

When an existing concrete deck without an overlay surface is to be removed, the removal shall be performed with a milling machine. The milling shall be to a depth shown on the plans. If no depth is shown on the plans, the milling shall be 1/2 in. depth. The surface removal operation shall be limited to that portion of the bridge deck that is closed to traffic at any one time. After this initial surface removal, additional milling may be required as directed.

220

The milling machine shall uniformly remove the required depth of concrete surface in a satisfactory manner. Surface removal, which is in areas adjacent to the curb that are inaccessible to milling, shall be done by handchipping in accordance with 722.06(b)3. All surface removal residue, including water, dust and concrete, shall be immediately removed.

Where the milling operation results in the snagging of the top mat of steel reinforcing bars, the milling operation shall cease and the depth of removal adjusted. Damaged reinforcing bars shall be repaired as directed with no additional payment.

230

2. Hydrodemolition

When shown on the plans, removal of unsound concrete shall be performed by hydrodemolition. Following the cleanup from the surface removal operation, areas of unsound concrete to be removed will be marked. The hydrodemolition equipment shall consist of a self-propelled computerized machine that utilizes a high pressure water jet stream capable of removing concrete as specified, as well as, removing rust and concrete particles from exposed reinforcing bars.

Prior to hydrodemolition, the equipment shall be calibrated on an area of sound original deck concrete as designated by the Engineer.

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The initial settings shall be verified on an area of unsound concrete. The initial settings may need to be adjusted in order to achieve total removal of unsound concrete. Equipment shall be calibrated each day prior to operation. Where directed, equipment shall be recalibrated to ensure removal of known areas of unsound concrete and to guard against removal of sound concrete. The Engineer shall be notified of the final equipment settings resulting from the calibration process.

250 After calibration of the equipment, concrete removal by hydrodemolition shall be performed on the bridge deck. The removal will be verified as necessary, every 30 ft along the cutting path. Handchipping shall be used in areas that are inaccessible to the hydrodemolition equipment. Handchipping tools may be handheld or mechanically driven. The removal operation shall cease where it is determined that sound concrete is being removed. Equipment shall be recalibrated, or approved changes to equipment and methods shall be performed, prior to resuming the removal operation.

260 The Contractor shall submit a waste water control and disposal plan for approval seven days prior to commencing hydrodemolition activities. The waste water control and disposal plan shall detail how all waste water generated by the hydrodemolition activities shall be contained, tested for pH, stored, and transported to a disposal facility in accordance with 202.

The Contractor shall provide sufficient shielding to ensure containment of all dislodged concrete during hydrodemolition operations and to prevent damage to surrounding property from flying debris, both on and under the work site.

270 Cleaning of the hydrodemolition debris and slurry shall be performed with a vacuum system equipped with fugitive dust control devices and capable of removing wet debris and water in the same pass. The vacuum equipment shall be capable of washing the deck with pressurized water during the vacuum operation to dislodge all debris and slurry from the bridge deck surface. Debris and slurry shall not be allowed to dry prior to vacuuming.

After hydrodemolition has been completed, the deck will undergo sounding to identify remaining areas of unsound concrete. Ponded or standing water shall be removed from the deck prior to sounding.

280 Additional concrete removal of remaining unsound concrete, shall be as directed by the Engineer and shall be performed by handchipping or hydrodemolition.

3. Handchipping

When hydrodemolition is not shown on the plans, all removal of unsound concrete shall be performed by handchipping. Following the cleanup from the surface removal operation, areas of unsound concrete to be removed will be marked. Handchipping tools may be hand or mechanically driven. Jackhammers shall not be heavier than nominal 45 lb class and chipping hammers shall not be heavier than nominal 15 lb

class. Only chipping hammers shall be used when removing concrete within 1 in. of reinforcing bars. Mechanically driven tools shall be operated at a maximum angle of 45° from the bridge floor surface.

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Regardless of the method of removal, the removal operation shall cease where it is determined that sound concrete is being removed. Agreed upon changes in equipment and methods shall be performed prior to resuming the removal operation.

4. Additional Surface Preparation around Reinforcing Bars

Where reinforcing bars have been exposed for a length greater than 2.0 ft and the bond between the existing concrete and reinforcing bars has been destroyed, the concrete adjacent to the bars shall be removed to a minimum clearance of 1 in. around the entire periphery of the exposed bars.

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5. Additional Construction Requirements

Regardless of the method used for unsound concrete removal, where the deck is unsound for more than 1/2 of its original depth, the concrete shall be removed full depth, except for limited areas as determined by the Engineer. Forms for areas of up to 4 sq ft may be suspended from wires attached to the reinforcing bars. For areas greater than 4 sq ft, the forms shall be supported from the structural members of the superstructure or by shoring from below.

310 Prepared cavities which are deeper than the level of the adjacent prepared deck surface, but are not full depth, shall require partial depth patching in accordance with 722.07(b). Prepared partial depth cavities shall be made full depth when directed. Exposed reinforcing bars shall not be damaged by the removal operation. Any damaged reinforcing bars shall be repaired as directed with no additional payment.

320 The removal areas shall be thoroughly cleaned of all dirt, foreign materials and loose concrete to the extent necessary to produce a firm solid surface for adherence of the new concrete. A minimum 1 in. vertical surface shall remain, or be cut, 1 in. outside and around the entire periphery of each removal area after removal of all loose and unsound concrete. The 1 in. vertical cut may be waived where it is determined that a cut will damage the reinforcing bars. Where hydrodemolition is utilized on the adjacent surface, the 1 in. vertical surface will not be required.

(c) Cleaning

330 After the concrete removal operation is completed and just prior to placing the patches or the overlay, the entire deck shall be heavily sandblasted to expose fine and coarse aggregates and to remove unsound concrete or laitance layers from the surface. Exposed reinforcing bars and the concrete under and around the exposed bars shall be thoroughly cleaned by sandblasting. The surface shall be then cleaned free of all dust, chips, water, and foreign material to the extent necessary to produce a firm, solid surface for adherence of the new concrete.

The air lines for sandblasting and air cleaning shall be equipped with oil traps.

When hydrodemolition is utilized, water blasting may be used in lieu of sandblasting. The sandblasting or water blasting shall be performed using two passes with the second pass being at a right angle to the first pass or a cross-blasting technique. The minimum pressure of the water blast shall be 6,000 psi.

722.07 Patching of the Bridge Floor

340 A vacuum device shall be used to remove all water from the prepared cavities.

(a) Full Depth Patching

The material used for full depth patching shall be either bridge deck patching concrete, overlay concrete, or concrete patching material from the QPL of Rapid Setting Patch Materials.

350 Full depth patching shall be performed prior to the overlay operation. The patching material shall be consolidated by internal vibration at the time of placement. Equipment shall not be operated on the repaired deck areas until the test beams indicate a minimum modulus of rupture of 550 psi.

1. Patching with Bridge Deck Patching Concrete

Epoxy resin adhesive shall be used to coat the surfaces of the prepared cavities and all the exposed reinforcing bars within the cavities. The epoxy coating shall be tacky at the time that the patching concrete is placed. Where the epoxy coating has cured beyond the obvious tacky condition, it shall be re-applied prior to patching. The coated cavities shall then be filled with the patching concrete to the level of the adjacent deck surface. Curing of the patching concrete shall be as directed.

360 Bridge deck patching concrete shall be composed of the following:

- a. Fine aggregate shall be 35% to 45% of the total weight of aggregate used.
- b. The cement shall be 564 lb/cu yd of portland cement type III or type IIIA, or 846 lb/cu yd of portland cement type I or type IA.
- 370 c. Air entraining admixture shall be added to produce 5% to 8% entrained air.
- d. The net water added shall produce a slump of no more than 6 in. and a maximum water/cement ratio of 0.450.

2. Patching with Overlay Concrete

The surfaces of the prepared cavities shall be coated with a bond coat in accordance with 722.10. The cavities shall then be filled with the overlay concrete to the level of the adjacent deck surface.

380

3. Patching with Rapid Setting Patch Materials

Concrete patching materials shall be as approved by the overlay supplier for compatibility with the overlay material. Concrete patching materials shall be placed and cured in accordance with the manufacturer's recommendations.

(b) Partial Depth Patching

The material used for partial depth patching shall be either bridge deck patching concrete, overlay concrete, or concrete patching material from the QPL of Rapid Setting Patch Materials. The patching material shall be consolidated by internal vibration at the time of placement.

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1. Patching with Bridge Deck Patching Concrete

Partial depth patching with bridge deck patching concrete shall be in accordance with 722.07(a) and 722.07(a)1. Curing of the patching concrete shall be as directed.

2. Patching with Overlay Concrete

The surfaces of the prepared cavities shall be coated with a bond coat in accordance with 722.10 except where hydrodemolition is utilized. The cavities shall be filled with the overlay concrete at the time that the overlay is placed. Concrete overlay material used for patching shall be cured in accordance with 722.12.

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3. Patching with Rapid Setting Patch Materials

Concrete patching materials shall be as approved by the overlay supplier for compatibility with the overlay material. Concrete patching materials shall be placed and cured in accordance with the manufacturer's recommendations.

722.08 Overlay Dam

An overlay dam shall consist of the removal of existing concrete from the bridge floor and replacing it with new concrete as shown on the plans or as otherwise directed. Overlay dam material shall be in accordance with 722.05.

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The existing concrete shall be removed as required in accordance with 722.06(b). Exposed reinforcing bars shall not be cut or otherwise damaged.

Power driven hand tools for removal by handchipping will be allowed. Pneumatic hammers with a maximum weight of 69 lb may be used for the tops of mudwalls. Where, during the removal process, the tools or methods being used appear to cause damage such as cracks or spalling on the concrete which is to remain, the work shall cease immediately and agreed upon changes in equipment and methods shall be performed prior to resuming the removal operation.

420

The surface to be repaired, the reinforcing bars, and the concrete under and around the bars shall be cleaned in accordance with 722.06(c). The cavity shall be coated with an epoxy resin adhesive in accordance with 722.07(a)1, then filled with class C concrete in accordance with 702.

722.09 Mixing**(a) Latex Modified Concrete and Latex Modified Concrete,
Very Early Strength**

430 Proportioning and mixing of the latex modified concrete shall be performed in a self-contained, self-propelled continuous mixer. The mixer shall be calibrated to accurately proportion the specified mix prior to starting the work. The calibration shall be in accordance with 722.13. Sufficient mixing capacity or mixers shall be provided to enable the intended pour to be placed without interruption. The mixer shall carry sufficient quantities of unmixed ingredients to produce at least 6 cu yds of latex modified concrete at the site.

440 The mixer shall measure and control the flow of ingredients being introduced into the mix and shall record these quantities on an approved visible recording meter equipped with a ticket printer. Water flow shall be readily adjustable to compensate for minor variations in aggregate moisture content, and shall be displayed by an approved flow meter. The flow of the latex modifier shall also be displayed by an approved flow meter. The manufacturer's inspection plate shall clearly show the serial number, proper operating revolutions per minute, and the approximate number of counts on the cement meter to deliver 94 lb of cement.

450 The mixer shall automatically proportion and blend simultaneously all the ingredients of the specified mix on a continuous or intermittent basis as required by the finishing operation. The latex modified concrete shall be discharged through a conventional chute directly in front of the finishing machine. The surface ahead of the deposited mixture shall be kept damp by spraying it with water. Where the water is applied by the mixer, it shall be dispensed ahead of the water flow meter.

(b) Silica Fume Modified Concrete

460 Mixing shall be in accordance with 702.09(a), 702.09(b), and 702.09(c), except mixing time shall be a minimum of 84 s. Retempering SFMC by adding water or by other means will not be allowed after 30 minutes from initial batching and mixing. When concrete is delivered in transit mixers, additional water may be allowed to increase a marginally low slump. Water shall not be added once 10% of the load has been discharged. Additional mixing shall be performed as directed and all operations completed within the time limits in accordance with 702.09(c). The amount of water shall be determined accurately and noted on the batch ticket. Such addition of water will not be allowed as a continuing operation. The total of all water included in the mix shall not exceed the maximum allowable water/cement ratio.

722.10 Placing and Finishing

470 Existing expansion joints shall be maintained throughout the overlayment unless otherwise shown on the plans. A construction dam or bulkhead, equal in thickness to the joint width, shall be installed to the required grade and profile prior to placing the overlay. Screed rails for the finishing machine shall be placed to the required profile,

and stably anchored vertically and horizontally. Screed rails shall not be treated with a bond breaking compound.

The overlay shall be placed only when the ambient temperature is 45°F and rising, unless otherwise approved by the Department in writing. The maximum allowable ambient temperature during placement is 85°F. The overlay shall not be placed if rain is expected within 4 h. Adequate precautions shall be taken to protect freshly placed overlay material from sudden or unexpected rain. Damaged material shall be removed and replaced with no additional payment. A construction dam or bulkhead shall be installed in case of a delay in placement of 1 h or more. During delays of less than 1 h, the end of the placed overlay material shall be protected from drying with layers of wet burlap.

After the surface has been cleaned, and immediately before placing the overlay material, the surface shall be thoroughly soaked and covered with plastic sheeting for a period of 1 h. The surface shall not be allowed to dry before placing the overlay material and there shall be no standing water at the time of placement. The surface shall then be thoroughly and evenly coated with a brush applied bond coat of overlay concrete, except a bond coat shall not be applied to surfaces where the removal was performed by hydrodemolition. The progress of the bond coat application shall be controlled to ensure that the bond coat does not dry before the overlay is placed to the required grade. Aggregate segregated in the brush application of the bond coat shall be removed before the overlay is placed. Surface irregularities shall be filled to approximately three-quarters of their depth sufficiently ahead of the overlay operation to allow the material to stiffen and resist rolling back during the finishing.

Following the bond coat application and partial filling of any surface irregularities, the concrete overlay shall be placed to an elevation approximately 1/2 in. above final grade. The mix shall then be consolidated and machine finished to the required grade. The machine finishing shall be to within 12 in. of the curb line or coping line unless otherwise directed. Supplemental hand finishing with a wood float shall be performed as needed to produce the required tight, uniform surface.

The finishing machine shall be self-propelled and capable of positively controlled forward and reverse motion. The machine shall be equipped with at least two finishing devices. The first finishing device shall be a vibrating mechanism, such as a vibrating pan, for consolidating the deposited mix. The vibrating pan shall be metal and of sufficient dimensions to ensure proper consolidation. The second finishing device shall be either a rotating cylindrical drum, at least 45 in. in length, or a vibrating oscillating metal faced screed of 4 in. minimum in width. The vertical position of the finishing devices shall be positively controlled and the devices shall be raised clear of the finished surface when the machine is operated in the reverse direction. The vibration frequency of any vibrating finishing device shall be variable, with positive control between 3,000 and 6,000 vibrations per minute. Alternate finishing machines may be considered for approval subject to a written request.

520 Screed rails and construction dams shall be separated from the newly finished overlay by passing a pointing trowel along the rail-to-overlay and dam-to-overlay interfaces after the overlay has sufficiently set such that it does not flow back. This trowel cut shall be made for the entire length and depth of the rail or dam. The rails may be removed any time after the overlay has initially set. Adequate precautions shall be taken during and subsequent to the rail removal to protect the edge of the new overlay from damage.

Protection shall be provided to prevent rapid drying of concrete. The rate of water evaporation shall be determined both prior to placement based on forecasted conditions and during placement based on actual conditions in accordance with ACI 308, section 5.2.1 or the following equation:

530
$$E = (T_c^{2.5} - rT_a^{2.5})(1 + 0.4V) \times 10^{-6}$$

where:

E = Evaporation rate, lb/sq ft/h

T_c = Concrete mix temperature, °F

T_a = Ambient temperature, °F

r = (Percent of Relative Humidity)/100

V = Wind velocity, mph.

540 Measurement of T_a, r, and V shall be obtained from readings made by the local weather bureau or the Contractor's measurements made on site. Measurement of T_c shall be determined from the concrete on site at the point of placement. Fog misting shall be performed after the finishing operation and prior to the wet cure, where the evaporation rate exceeds or is expected to exceed 0.05 lb/sq ft/h. Fog misting shall keep the environment above the concrete surface at high humidity to protect against plastic shrinkage cracks and shall not be used to apply water directly to the surface to facilitate finishing. Evaporation retardants shall not be substituted for fog misting where the evaporation rate exceeds 0.05 lb/sq ft/h.

550 An evaporation retardant shall be applied in a fine mist immediately after the finishing is complete to ensure that the surface remains wet until covered. The evaporation retardant shall be used as such and not as a finishing aid. These products consist primarily of water and excessive amounts of evaporation retardant shall not be applied and the product shall not be worked into the overlay surface. Evaporation retardant shall only be used on SFMC overlays. Evaporation retardant shall not be used in any other applications.

722.11 Texturing

The overlay surface shall be textured with a double thickness burlap drag or a minimum 4 ft wide turf drag immediately following the placement of the overlay material. Areas where the texture is disturbed by other finishing operations shall be immediately restored to a burlap drag finish.

560 Grooving or tining in the plastic concrete of the concrete overlay will not be allowed. Transverse grooving, when specified, shall not commence until the curing requirements have been met in accordance with 722.12. Grooves shall be cut into the hardened concrete surfaces perpendicular to the centerline using a mechanical cutting device. For curved bridges, grooves shall be cut transverse to the curve chord within the spans. Grooving shall be done before traffic is allowed on the surface except as follows.

570 The Contractor shall have the option of cutting the transverse grooves at the end of each phase of construction or waiting until all phases have been completed. If the Contractor elects to delay the grooving process until completion of all phases, the concrete overlay surface for any phase opened to traffic shall receive an interim coarse broom finish during placement.

580 The completion of the grooving process shall be within 30 days of completion of the last phase of construction. Any additional maintenance of traffic operations required for the grooving process shall be included in the cost of Maintaining Traffic. The interim broom finish shall not be allowed as a surface texture when opened to traffic over a winter season. If the coarse broom texture is present and the Contractor is not in a position to finish all phases of the project, transverse grooving shall be placed into the hardened concrete in order to establish an acceptable driving surface texture for the winter season.

590 Each groove shall be 1/8 in. \pm 1/64 in. in width, 3/16 in. \pm 1/16 in. in depth. The grooves shall be uniformly spaced at 3/4 in. intervals measured from the center of groove to center of groove or randomly spaced at intervals between 5/8 in. to 1 1/4 in. from center of groove to center of groove with an average spacing of 7/8 in. Grooving shall not be within the area approximately 2 ft adjacent to the curbs. The grooving shall terminate approximately 6 in. from any expansion joints with steel nosing. Stair stepped ends in grooving will be allowed for skewed bridge decks. When a new reinforced concrete approach slab is placed adjacent to the overlay, the grooving shall extend across the reinforced concrete approach slab. Grooving shall terminate approximately 6 in. from the interface with the roadway pavement.

The Contractor shall submit a waste water control and disposal plan for approval seven days prior to commencing grooving activities. The waste water control and disposal plan shall detail how all waste water generated by the grooving activities shall be contained, tested for pH, stored and transported to a disposal facility in accordance with 202.

600 Cleaning of the grooving debris and slurry shall be performed with a vacuum system equipped with fugitive dust control devices and capable of removing wet debris and water in the same pass. The vacuum equipment shall be capable of washing the deck with pressurized water during the vacuum operation to dislodge all debris and slurry from the bridge deck surface. Debris and slurry shall not be allowed to dry prior to vacuuming.

722.12 Curing

When fly ash is used, the requirement for additional wet or dry curing time shall be determined based on the relative initial, and final time of set and a comparison of strength versus age using control concrete strengths at conventional cure period ages as the reference. The additional curing requirements shall be as approved by the
610 Engineer.

For LMC overlays the minimum curing period shall be 48 h of wet cure followed by 48 h of dry cure. An LMC overlaid bridge deck may be opened to traffic during the dry curing duration when the compressive strength of cylinders is 4,000 psi or greater.

For SFMC overlays the minimum curing period shall be seven calendar days consisting of 120 h of wet cure followed by 48 h dry cure. The deck shall remain completely covered during the dry cure period. An SFMC overlaid bridge deck may be opened to traffic after the dry cure period when the compressive strength of
620 cylinders is 4,500 psi or greater.

For LMC-VE concrete overlays the minimum curing period shall be 3 h of wet cure. An LMC-VE overlaid bridge deck may be opened to traffic after the wet curing period when the compressive strength of cylinders is a minimum of 2,500 psi.

The wet cure period for all overlay types is not controlled by strength and shall not be reduced. Membrane forming curing compound shall not be used to cure the bridge deck overlay. All cylinders shall be 6 in. by 12 in. and compressive strength shall be determined from the average of a minimum of two cylinders. For LMC and
630 SFMC, cylinders shall be made and standard cured in accordance with 702.24. For LMC-VE cylinders shall be made and field cured at the jobsite under the same conditions as the LMC-VE overlay.

The plastic film which forms on the surface of the overlay shall be protected from shrinkage cracking with a single layer of well drained wet burlap. This layer of wet burlap shall be placed as soon as the overlay surface will support it without deformation. The entire surface shall be covered with plastic sheeting and maintained in a saturated wet condition during the wet cure period. A network of soaker hoses shall be used under the plastic sheeting during the wet cure period for LMC and silica
640 fume overlays.

When the ambient temperature falls below 50°F during either the wet or dry curing periods, the time that the temperature is below 50°F shall not be considered as part of the total curing period. When there is sufficient rain to wet the surface of the overlay for 1 h or more during the dry cure period, this number of hours shall not be considered as part of the dry cure period.

Immediately upon the start of the dry cure period or opening to traffic, the surface shall be checked for cracks. Upon request, the Contractor shall flood the deck with

650 water to facilitate inspection for cracks and distress. Where cracks exist, a thorough investigation will be conducted prior to sealing cracks. Cores may be required to determine the actual crack depth. Surface cracks not exceeding 3/8 in. in depth shall be sealed with a PCC Sealer/Healer followed by an application of an approved sand. Cracks exceeding 3/8 in. in depth shall not be sealed at this time. Corrective procedures for repairing cracks exceeding 3/8 in. in depth will be determined after further investigation which may include additional cores. The Department's Division of Materials and Tests will be contacted and the Engineer will determine the method of repair including possible removal.

660 Where the area of shallow cracking exceeds 5% of the deck area, then the method of repair shall be the same as for cracks exceeding 3/8 in. The shallow crack area will be calculated by multiplying the total combined linear feet of all cracks less than 3/8 in. deep by a tributary width of 1 ft. The percentage of deck area will be the shallow crack area divided by the total deck area and multiplied by 100.

Where it is determined by sounding or coring that adequate bonding between the overlay and the bridge deck has not been attained, the deficient areas shall be removed and replaced as directed.

670 **722.13 Calibration of Continuous Mixers**

(a) Frequency

A complete calibration shall be performed for each mixer prior to each pour unless the initial calibration was made within the previous 10 calendar days. A mixer that has been calibrated within the previous 10 calendar days may be approved for use providing that the mixer operator is in possession of the completed, signed, certified and dated Department calibration form for that mixer. A complete calibration of a mixer may be required at any time as directed. All mixers which are calibrated within the 10 day limit but are changing aggregate sources shall have an aggregate blend test performed.

680

(b) Equipment

All special equipment required for calibration shall be furnished. It shall include but not be limited to suitable material containers, buckets, stop watches and a scale accurate to within 0.1 lb or 0.3% of the test load, whichever is greater, at any point within the range of use. The minimum capacity of the scale shall be 150 lb. The scale shall be verified annually per ITM 910. The Contractor shall provide paperwork that shows the date the scale was verified by a company with NIST traceable class F weights. Samples shall be obtained and handled by the Contractor. Normal testing equipment such as aggregate sieves and containers shall also be furnished.

690

(c) Pre-calibration

The aggregate bin shall be clean and the bin vibrators shall be in good working order. The mixer shall be equipped with a grounding strap. The cement meter feeder, the fins and all pockets shall be clean and free of any accumulated cement. The

aeration system shall be equipped with a gauge or indicator to verify that the system is operating. The main belts and the latex strainer shall be clean and free of any accumulated material.

700 **(d) Calibration**

1. Cement Meter

The mixer manufacturer's mix setting chart shall determine the specified operating revolutions per minute and the approximate number of counts required on the cement meter to deliver 94 lb of cement. At least 3,760 lb of cement shall be placed in the cement bin.

710 The mixing unit shall rest on a level surface. The engine throttle shall be adjusted to obtain the required revolutions per minute. The unit discharging the cement shall be operated until the belt has made one complete revolution. The unit shall then be stopped and the cement meter shall be reset to zero.

A suitable container shall be positioned to catch the cement and at least 90 lb of cement shall be discharged. The time required to discharge the cement shall be measured with a stop watch, the number of counts on the cement meter shall be recorded, and the weight of the discharged cement shall be determined. This process shall be repeated a total of three times. The cement counter shall be reset to zero before each repetition.

720 The following formulas shall be used to calculate the number of counts per 94 lb of cement and the time required to discharge 94 lb of cement.

$$94 \div \frac{A}{B} = \text{Counts per 94 lb of cement}$$

$$94 \div \frac{A}{C} = \text{Time in seconds per 94 lb of cement}$$

730 where:

A = Total weight of cement in pounds for three trials

B = Total number of counts on the cement meter for three trials

C = Total time in seconds for three trials.

2. Water Flow Meter

740 The accuracy of the water flow meter shall be verified by adjusting the flow to 2 gal. per minute. With the equipment operating at the required revolutions per minute, the water discharged during a one minute interval shall be collected and weighed. The weight in pounds of the discharged water shall be divided by 8.33 to determine the number of gallons. This procedure shall be repeated with the flow meter adjusted to 3 gal. per minute.

3. Aggregate Bin Gates

The aggregate gate openings shall be adjusted to provide the required amount of aggregate to produce a cubic yard of the designated mix. The gate settings for the fine aggregate and coarse aggregate shall be determined separately. Each aggregate shall be verified by stopping the cement discharge and collecting the aggregate discharged in a container. Calculations for all aggregates shall be based on saturated surface dried, SSD, weights taken from the mix design. The calculations shall be adjusted for the tested moisture content. The final gate setting for each aggregate shall dispense material within a tolerance of $\pm 2\%$ of the target weights after adjustment for measured moisture content.

4. Latex Throttling Valve

The latex strainer shall be unobstructed. The latex throttling valve shall be adjusted to deliver the required amount of latex emulsion admixture for each 94 lb of cement. With the unit operating at the required revolutions per minute for the calculated time in seconds per 94 lb of cement, the latex shall be discharged into a container. The weight of the latex shall be determined and, if necessary, the valve shall be adjusted such that the amount of latex discharged is within 1/2 lb of the amount required for each 94 lb of cement. One verification shall be performed to check the accuracy of the valve setting.

5. Admixture Dispensers

This equipment shall be calibrated in accordance with the manufacturer's instructions for the specific materials and quantities involved.

722.14 Patching an Existing Bridge Deck Overlay

770 (a) Materials

Materials shall be in accordance with 722.03.

(b) Storage and Handling of Materials

Storage and handling of materials shall be in accordance with 722.04.

(c) Proportioning

Proportioning shall be in accordance with 722.05.

(d) Preparation of the Bridge Floor

780 Preparation of the bridge floor shall be in accordance with the applicable provisions of 722.06.

(e) Patching

Patching shall be in accordance with 722.07 except as modified herein. Where no new overlay is planned, bridge deck patching concrete used in patching the bridge floor shall be placed to the level of the original deck. The remainder of each cavity shall be patched with the same material as the existing overlay.

(f) Mixing

790 Mixing shall be in accordance with the applicable provisions of 722.09.

(g) Placing and Finishing

Placing and finishing shall be in accordance with the applicable provisions of 722.10. Machine finishing shall be required when directed.

(h) Texturing

The surface texturing shall match the pattern of the adjacent overlay and shall be in accordance with the following:

800 Immediately after the finishing is complete and before the surface film has formed, the surface of the overlay patch shall be textured by grooving in the same direction as the existing overlay. The grooves may be formed by mechanized equipment using a vibrating beam roller, a series of discs or other approved device. Manual tools such as fluted floats, spring steel tined rakes, or finned floats with a single row of fins may be used. The grooves shall be relatively uniform and smooth and shall be formed without tearing the surface or bringing coarse aggregate to the top. The grooves shall be in accordance with 504.03. The grooves shall be terminated the same distance from the vertical faces of railings as the existing grooves in the adjacent existing overlay surface.

810

All areas of hardened grooved overlay patch which do not conform to these requirements due to either a deficiency in the grooving or a rough open textured surface shall be corrected with no additional payment. Corrections shall be made by cutting transverse grooves in the hardened overlay with an approved cutting machine or by sealing with an approved mixture and retexturing to a satisfactory finish as directed.

(i) Curing

Curing shall be in accordance with 722.12.

820

(j) Calibration of Continuous Mixers

Calibration shall be in accordance with 722.13.

722.15 Method of Measurement

Removal of the existing overlay and the additional depth into the existing deck surface will be measured by the square yard of deck area regardless of the number of passes with the milling machine.

830 Removal of the existing concrete deck surface will be measured by the square yard for the initial depth shown on the plans. Additional surface removal required below the initial depth will be measured by the square yard for each required 1/4 in. depth. The areas of the bridge floor which are shown on the plans to be removed, except for undefined full depth patching areas, will not be measured for payment.

Hydrodemolition of the bridge deck will be measured by the square yard. Additional surface preparation will be measured by the linear foot of exposed reinforcing bar. Reinforcing bar repair will not be measured for payment.

840 When hydrodemolition is not shown on the plans, partial depth patching will be measured by the square foot.

The measurement of bridge deck patching concrete for partial depth cavities created by handchipping or hydrodemolition will be based on a theoretical quantity determined by multiplying the area of the appropriate partial depth cavities by an assumed average depth of 2 in. and converting the resulting volume into cubic yards. Overlay material used in a partial depth cavity will be measured by the cubic yard. The quantities of patching material used in a partial depth cavity will be included in the measurement of additional bridge deck overlay.

850 Overlay material used to fill surface irregularities will be measured by the cubic yard and will be included in the measurement of additional bridge deck overlay.

Full depth patching will be measured by the square foot. The patching material used in full depth patching will not be measured for payment.

Bridge deck overlay will be measured by the square yard for the specified thickness. Where there is no specified thickness shown on the plans, the specified thickness shall be 2 in.

860 Overlay dams and patching an existing overlay will be measured by the square foot.

Transverse grooving will be measured by the square yard. No deduction in measurement will be made for areas where grooving is terminated or not required.

Epoxy resin adhesive and bond coat will not be measured for payment. Blasting, cleaning, finishing, texturing other than the transverse grooving, and curing will not be measured for payment.

870 **722.16 Basis of Payment**

Removal of the existing overlay and the additional depth into the existing deck surface will be paid for at the contract unit price per square yard of bridge deck, remove existing concrete overlay.

Milling of the initial depth of surface will be paid for at the contract unit price per square yard of bridge deck, remove existing concrete surface. Additional surface removal below the initial depth will be paid for at the contract unit price per square yard for bridge deck, remove existing concrete surface for each required 1/4 in. depth.

880 Hydrodemolition of the bridge deck will be paid for at the contract unit price per square yard. When hydrodemolition is shown on the plans, additional surface preparation will be paid for at the established price shown per linear foot for bridge deck overlay, additional surface prep.

When hydrodemolition is not shown on the plans, partial depth patching will be paid for at the contract unit price per square foot for bridge deck patching, partial depth.

890 When partial depth cavities are subsequently directed to be made full depth, additional payment will be made at 80% of the contract unit price per square foot for bridge deck patching, full depth.

Full depth patching will be paid for at the contract unit price per square foot for bridge deck patching, full depth.

Patching material used for partial depth cavities will be paid for at the established price shown per cubic yard for bridge deck overlay, additional for the type of overlay material placed.

900 Overlay material used to fill surface irregularities will be paid for at the established price shown per cubic yard for bridge deck overlay, additional for the type of overlay material placed.

Bridge deck overlay will be paid for at the contract unit price per square yard, for the type of overlay material specified.

Patching an existing bridge deck overlay will be paid for at the contract unit price per square foot for bridge deck overlay patching.

910 Overlay dam will be paid for at the contract unit price per square foot, complete in place.

Transverse grooving will be paid for at the contract unit price per square yard.

920 The Department will include the pay item Bridge Deck Overlay Budget, with an established dollar amount in the proposal to pay for additional surface preparation completed after hydrodemolition and bridge deck overlay additional used to fill irregularities and partial depth cavities. This established amount is the Department's estimate of the total cost of the work required to be performed for the contract. The established amount shown in the proposal is included in the total bid amount. The Department will pay for those items installed and listed with established prices for the quantities installed as directed by the Engineer. Where the work exceeds the Department's estimated amount, the additional quantities will be reviewed for acceptance in accordance with 104.03 except that the additional surface preparation and bridge deck overlay additional will be paid at the pre-determined established prices shown.

Payment will be made under:

930	Pay Item	Pay Unit Symbol
	Bridge Deck Overlay Budget	DOL
	Bridge Deck Overlay, Latex Modified	SYS
	Bridge Deck Overlay, LMC-VE.....	SYS
	Bridge Deck Overlay, Patching	SFT
	Bridge Deck Overlay, Silica Fume Modified	SYS
	Bridge Deck, Remove Existing Concrete Overlay	SYS
	Bridge Deck, Remove Existing Concrete Surface.....	SYS
	Bridge Deck Patching, Full Depth.....	SFT
940	Bridge Deck Patching, Partial Depth.....	SFT
	Hydrodemolition	SYS
	Transverse Grooving	SYS
	Overlay Dam	SFT

Items shown with an established price will be paid at the prices shown. Where any of the following items are shown in the schedule of pay items the bid item and price will prevail over the established prices shown.

950	Pay Item	Pay Unit Symbol	Established Price
	Bridge Deck Overlay, Additional LMC	CYS.....	\$550
	Bridge Deck Overlay, Additional LMC-VE.....	CYS.....	\$650
	Bridge Deck Overlay, Additional Silica Fume Modified	CYS.....	\$200
	Bridge Deck Overlay, Additional Surface Prep.....	LFT	\$15

960 The cost of overlay removal by handchipping in areas adjacent to the curb or otherwise inaccessible to the power-operated mechanical milling machine shall be included in the cost of bridge deck overlay, remove existing overlay. The cost of disposing of overlay removal residue, including water, dust, concrete and incidentals shall be included in the cost of bridge deck, remove existing overlay.

970 The cost of deck surface preparation by handchipping in areas adjacent to the curb or otherwise inaccessible to the power-operated mechanical milling machine shall be included in the cost of bridge deck, remove existing concrete surface or bridge deck, remove existing overlay. The removal of surface milling residue, including water, dust, concrete and incidentals shall be included in the cost of bridge deck, remove existing concrete surface or bridge deck, remove existing overlay.

The cost of the waste water control and disposal plan, waste water containment, testing, storing, transporting and disposal, and any incidentals related to the carrying

out of the plan shall be included in the cost of hydrodemolition. If the waste water is found to have a pH of 12.5 or higher and thereby classified as hazardous, the additional costs associated with this classification will be paid for in accordance with 109.05.

980 The initial equipment calibration, any re-calibration, equipment shielding, handchipping curb areas, handchipping unsound concrete, cleaning of debris and slurry, compressed air cleaning, water blasting, and sandblasting shall be included in the cost of hydrodemolition.

When hydrodemolition is shown on the plans, the cost of removal of unsound concrete shall be included in the cost of hydrodemolition. Preparation of cavity surfaces, furnishing and applying bond coat or epoxy resin adhesive as required in handchipped locations, furnishing and placing patching material, and necessary incidentals shall be included in the cost of bridge deck overlay for the type of overlay material specified. Additional concrete removal required around exposed bars shall be included in the cost of additional surface preparation.

990 When hydrodemolition is not shown on the plans, the cost of removal of unsound concrete, preparation of cavity surfaces, furnishing and applying bond coat or epoxy resin adhesive as required, furnishing and placing patching material, and necessary incidentals shall be included in the cost of bridge deck patching, full depth, or bridge deck patching, partial depth.

The cost of patching material used for full depth patching shall be included in the cost of bridge deck patching, full depth. The cost of texturing patched areas will not be paid for separately, but shall be included in the cost of the patch.

1000 The cost of furnishing and placing patching material in partial depth cavities and necessary incidentals shall be included in the cost of bridge deck overlay, additional.

The cost of removing the existing concrete; furnishing, hauling, and placing all materials including the epoxy; preparing the surface; and all necessary incidentals shall be included in the cost of overlay dam.

The cost of deck cleaning shall be included in the cost of other pay items.

1010 The cost of removing and disposing of the slurry created during the transverse grooving shall be included in the cost of transverse grooving.

Coring of the bridge deck, patching core holes, and all corrective measures required in accordance with 722.12 shall be performed at no additional cost to the Department.

SECTION 723 – REINFORCED CONCRETE THREE-SIDED STRUCTURES

723.01 Description

This work shall consist of constructing a reinforced concrete three-sided arch-topped structure or structure extension with headwalls and wingwalls, a reinforced concrete three-sided flat-topped structure or structure extension with headwalls and wingwalls, or a reinforced concrete true arch shape structure or structure extension with spandrel walls and wingwalls in accordance with 105.03. The reinforced concrete three-sided structure, structure extension, headwalls, wingwalls, footings, and spandrel walls may be precast or cast-in-place.

The Contractor may be allowed to substitute a box structure in accordance with 714 which shall be subject to a revision of the waterway permits, and shall be as approved by the Engineer.

MATERIALS

723.02 Materials

Materials shall be in accordance with the following:

20	Chemical Anchor System	901.05
	Coarse Aggregates, Class A or Higher, Size No. 91	904.03
	Concrete	702
	Epoxy Coated Reinforcing Bars	910.01(b)9
	Flowable Backfill	213
	Geotextile	918.02
	Hydrated Lime.....	913.04(a)
	Masonry Cement	901.01(c)
	Mortar Sand.....	904.02(e)
30	Natural Sand.....	904.02(a)
	Non-Epoxy PCC Sealer.....	909.10
	Pipe Joint Sealant	907.11
	Portland Cement.....	901.01(b)
	Precast Reinforced Concrete Headwalls, Wingwalls, Footings, and Spandrel Walls.....	907.06
	Precast Reinforced Concrete Structure Sections	907.05
	Reinforcing Bars.....	910.01
	Riprap	904
	Structure Backfill	904
40	WWR, Smooth and Deformed.....	910.01

Cast-in-place concrete for a reinforced concrete three-sided structure, or splices between an existing culvert structure and a precast reinforced concrete three-sided structure extension shall be class A or higher in accordance with 707.04(c). It shall have a 28-day minimum concrete compressive strength of 5,000 psi. Cast-in-place concrete for headwalls, wingwalls, or spandrel walls shall be class A or higher in

accordance with 707.04(c). It shall have a 28-day minimum concrete compressive strength of 4,000 psi.

- 50 When the Contractor elects to provide a cast-in-place structure, acceptance of the structure will be based on tests for relative yield, air content, slump, water/cementitious ratio, and compressive strength. Relative yield and air content shall be in accordance with 702.05. The slump and concrete temperature shall be in accordance with 707.04(c). The amount of time from the introduction of mixing water to the cement and aggregates to the completion of the discharge of the concrete shall not exceed 90 minutes. The water/cementitious ratio shall be in accordance with 707.04(d). The 28-day compressive strength shall be equal to or greater than the specified concrete compressive strength and otherwise shall be in accordance with 707.04(c)3. The Contractor shall provide the necessary 6 in. diameter by 12 in.
- 60 cylinder molds for the Department's use.

For plastic concrete sampling, acceptance testing procedures and casting cylinders will be in accordance with 505.01. Except for footings, concrete flexural strength or results from beam breaks will not be accepted in lieu of concrete compression cylinder test results.

Cast-in-place concrete used to seal existing culverts shall be class A. Cast-in-place concrete for footings and base slabs shall be class B.

- 70 Unless otherwise specified herein, reinforcement may consist of either reinforcing bars or welded wire reinforcement, WWR. If specified to be coated, WWR shall be coated with either galvanized coating or epoxy coating, and reinforcing bars shall be coated with epoxy coating. For WWR, material with minimum yield strength of 65 ksi shall be used.

- Reinforcement in headwalls and pedestals shall consist of reinforcing bars and shall be epoxy coated. Reinforcement in spandrel walls shall be coated. If the structure is specified as requiring coated reinforcement, reinforcement, including support devices, in that structure shall be coated. In lieu of coating, the support device may be
- 80 manufactured of a non-corrosive material.

Headwalls, wingwalls and spandrel walls shall be connected to the outside structure sections. Wingwalls shall be connected to the spandrel walls if the structure is a true arch shape structure. Precast headwalls, precast wingwalls, and precast spandrel walls shall be connected with bolted steel plates.

CONSTRUCTION REQUIREMENTS

723.03 General Requirements

- 90 Excavation and disposal shall be in accordance with the applicable requirements of 206. The areas designated for waterproofing shall be waterproofed in accordance with 702.23. All underground drains encountered during excavation for the structure shall be perpetuated as dictated by field conditions. Drainage openings through

masonry shall be in accordance with 702.16. Handling of three-sided structures shall be in accordance with 907.05. Handling of wingwalls and spandrel walls shall be in accordance with 907.06.

100 For precast three-sided structures, the manufacturer's representative shall provide technical instruction and on-site technical assistance to the Contractor during the erection of the members.

723.04 Design Requirements

A three-sided structure shall be designed for HL-93 loading in accordance with AASHTO LRFD Bridge Design Specifications.

The three-sided structure, headwalls, wingwalls, footings, and spandrel walls shall be designed in accordance with the soil parameters shown in the contract documents.

110 Headwalls, wingwalls, and spandrel walls shall be designed based on a minimum equivalent fluid pressure of 40 lb/cu ft. If flowable backfill is to be used, the Contractor shall consider the effects of hydrostatic pressure on the structure. Weep holes shall be provided in all wingwalls. Horizontal pressures shall be increased for sloping backfill surfaces and live load surcharge. Headwall connections, wingwall footings, and spandrel walls shall be checked for sliding and for overturning.

A headwall with guardrail mounted on top, the anchorage of the headwall or spandrel wall to the structure section, or a moment slab with bridge railing, shall be designed for the bridge railing test level shown on the plans.

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Continuity shall be established between the structure footing and the wingwall footing.

(a) Placement of Reinforcement

130 For three-sided arch-topped or true arch shape structure sections, the concrete cover over the outside circumferential reinforcement shall be a minimum of 2 in. The cover over the inside circumferential reinforcement shall be a minimum of 1 1/2 in. The clear distance of the end circumferential reinforcement shall not be less than 1 in. and no more than 2 in. from the ends of the structure section. The ends of the longitudinal distribution reinforcement shall be no more than 3 in. from the ends of the structure section.

For flat-topped structure sections, the cover dimension over the top mat of reinforcement shall be a minimum of 2 in. The cover over the lower mat of reinforcement in the structure top shall be a minimum of 1 1/2 in. The cover in the legs shall be a minimum of 2 in. The clear distance of the end circumferential reinforcement shall not be less than 1 in. and no more than 2 in. from the ends of the structure section. The ends of the longitudinal distribution reinforcement shall be no more than 2 in. from the ends of the structure section.

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Cover for headwall, wingwall, spandrel wall, and pedestal reinforcement shall be a minimum of 2 in. Cover for footing and base slab reinforcement shall be 3 in. for the top and sides and 4 in. for the bottom.

(b) Splicing and Spacing of Reinforcement

Reinforcement splicing and spacing shall be in accordance with the AASHTO LRFD Bridge Design Specifications except as indicated herein. Tension splices in circumferential reinforcement shall be made by means of lapping. Where reinforcing bars are used for longitudinal distribution reinforcement, the reinforcing bars shall have a center to center spacing not to exceed 12 in. in flat-topped structure sections or 16 in. in arch-topped or true arch shape structure sections.

Where reinforcing bars are used in wingwalls, the maximum spacing for wingwall reinforcing bars shall be 18 in. for horizontal bars and 12 in. for vertical bars.

Exterior corner reinforcement for flat-topped structure sections shall be fully developed beyond the point where it is no longer required to resist flexure.

(c) Working Drawings

Working drawings shall be submitted in accordance with 105.02 for fabrication of a precast or cast-in-place reinforced concrete three-sided structure, precast or cast-in-place reinforced concrete three-sided structure extension, precast or cast-in-place headwalls, precast or cast-in-place wingwalls, and precast or cast-in-place spandrel walls. The working drawings shall include all details, dimensions, and quantities necessary to construct the structure, headwalls, wingwalls, or spandrel walls and shall include, but not be limited to, the following information.

1. Structure span and rise.
2. Structure section details showing all concrete dimensions and reinforcement requirements. An analysis of the precast segment modeled as a simple span and designed in accordance with AASHTO LRFD Bridge Design Specifications Section 5.7.3. This analysis shall demonstrate that the precast segment is designed to withstand the forces of erection. Details for providing horizontal restraint of the structure legs during installation until after the completion of backfill placement shall be included unless the analysis indicates such details are not needed.
3. Headwall details showing all concrete dimensions, elevations, reinforcing bar sizes, reinforcing bar bending diagrams, lengths, spacings, and anchorage details. Headwall elevation and section views shall be provided.

- 190 4. Wingwall design calculations and details showing all concrete dimensions, elevations, reinforcement sizes, bending diagrams, lengths, spacings, and anchorage details. Wingwall plan, elevation, and section views shall be provided.
5. Spandrel wall details showing all concrete dimensions, elevations, reinforcement sizes, bending diagrams, lengths, spacings, and anchorage details. Spandrel wall elevation and section views shall be provided.
- 200 6. Footing design calculations and details showing all concrete dimensions, elevations, reinforcing bar sizes, reinforcing bar bending diagrams, lengths, and spacings indicated. Footing plan and section views shall be provided. If a pile footing is required, the pile layout shall be shown. The actual soil bearing pressure shall be shown on the footing detail sheets.
7. Design calculations and details for pedestals or closure pours, if required.
- 210 8. Structure backfill type and limits for the structure and wingwalls.
9. Minimum concrete strength for all concrete portions of the structure.
- 220 10. Bridge load rating calculations and load rating summary shall be submitted with the working drawings where the structure span length measured along the roadway centerline is greater than 20 ft, except where the height of cover is greater than 8 ft and exceeds the perpendicular span length. The structure shall load rate greater than 1.0 for the loading described herein or as shown on plans. The load rating methodology shall be in accordance with the AASHTO Manual of Bridge Evaluation using the LRFR methodology.

723.05 Manufacture

The structure sections, headwalls, wingwalls, footings and spandrel walls shall be free of fractures. Headwalls, wingwalls, and spandrel walls shall be given a finish in accordance with 702.21.

230

The structure units shall not be stored in an upright position until the designated

723.06

handling and storage compressive strength, as shown on the working drawings, has been achieved.

723.06 Rejection

Structure sections, wingwalls, footings, or spandrel walls will be rejected due to the following conditions.

- 240 (a) fractures or cracks passing through the section or wall, except for a single end crack which does not exceed one-half the thickness of the section or wall;
- (b) defects which indicate proportioning, mixing, or molding which are not in accordance with this specification;
- (c) honeycombed or open texture; or
- (d) damaged section ends, where such damage prevents making a satisfactory joint.

250

723.07 Repairs

Structure sections, headwalls, wingwalls, footings or spandrel walls shall be repaired, if necessary, due to imperfections in manufacture, handling damage, or construction. Repairs will be acceptable if it is determined that the repairs are sound, properly finished and cured, and if the repaired structure section headwall, wingwall, footing, or spandrel wall is in accordance with the requirements herein.

723.08 Trench Compaction

260 The soils in the bottom of the excavation shall be compacted to 95% of the maximum dry density in accordance with 203.23. If 95% of the maximum dry density cannot be obtained in the bottom of the excavation or in other areas, the Office of Geotechnical Services shall be contacted for additional recommendations. If during construction, soft soils are encountered at depths that make removal impractical, the Office of Geotechnical Services shall be contacted for additional recommendations.

723.09 Footings

270 All footings shall be given a smooth float finish. Footing concrete shall reach a compressive strength of 2,000 psi or flexural strength in accordance with 702.24(c) prior to placement of the structure sections or wingwalls. The surface shall not vary more than 1/4 in. in 10 ft when tested with 10 ft straightedge.

An 8 in. layer of coarse aggregate No. 8 in accordance with 301 shall be placed under the full width of the footing. Precast footings shall be made into a continuous strip footing by the use of closure pours between the precast units. Closure pours shall be as detailed in the working drawings and shall be designed to accommodate the design loads.

723.10 Pedestals

280 Where a reinforced concrete pedestal is required between the base of the structure leg and the top of the footing, the Contractor shall have the option of providing a structure with extended legs or constructing the pedestals.

723.11 Placement of Structure Sections and Wingwalls

290 For three-sided arch-topped structures and three-sided flat-topped structures, the structure sections shall be set on masonite or steel shims. Each wingwall that is not precast as one unit with the footing shall be set on masonite or steel shims. A minimum gap of 1/2 in. shall be provided between the footing and the bottom of each section or wingwall. Once the wingwalls or structure sections are placed, the space underneath the wingwall or structure leg section to the top of the keyway sides shall be filled with prepackaged grout in accordance with ASTM C1107, or conventional or self-consolidating fine grout in accordance with ASTM C476, except as modified herein. If conventional fine grout is used, it shall be troweled into the keyway and mounded on one side of the leg or wingwall. The mound of conventional fine grout shall be vibrated until it passes through to the other side of the leg or wingwall. After completing this process on one side, if the conventional fine grout has not passed through to the other side, the process shall be repeated on the other side. Conventional or self-consolidating fine grout shall be from a prepackaged source or composed of one of the following mixtures:

- 300
- (a) 930 lb/cu yd Type I portland cement with No. 23 natural sand or mortar sand.
 - (b) 930 lb/cu yd Type M masonry cement with No. 23 natural sand or mortar sand.
 - (c) 828 lb/cu yd Type I portland cement and 75 lb/cu yd hydrated lime with No. 23 natural sand or mortar sand.

310 The maximum water/cement ratio shall be 0.446 for both conventional and self-consolidating fine grout. An air entraining agent from the QPL of PCC Admixtures and Admixture Systems may be used. A type F or G chemical admixture from the QPL of PCC Admixtures and Admixture Systems shall be used in self-consolidating fine grout in order to achieve the slump flow and visual stability index requirements. Filling procedure B of ASTM C1611 will be used for measuring slump flow. Appendix X1 of ASTM C1611 will be used for determining the visual stability index value.

320 Acceptance of conventional fine grout will be based on an air content of 12% \pm 4%. Acceptance of self-consolidating fine grout will be based on tests for air content, slump flow, and visual stability index. Air content shall be 12% \pm 4%. Slump flow shall be 27 in. \pm 3 in. Visual stability index value shall not exceed 1.

A type C certification in accordance with 916 shall be provided for prepackaged grout.

330 True arch shape structures may have grout leveling pads poured in the footing keyways to ensure the correct seating of the true arch sections. Leveling pads shall be approximately 2 in. thick and 16 in. long to ensure that each true arch section is resting on approximately 8 in. of pad at each joint. The leveling pads shall be poured within 1/8 in. of the required elevation. No loads shall be placed on the grout leveling pads within 72 h of their placement. Masonite shims may also be used as leveling pads. Concrete blocks of 1 1/2 in. thickness, hardwood wedges, and steel or plastic shims shall be placed to retain the true arch sections in their proper positions until grout can be placed in the keyway. Grout shall be consolidated in the keyway to ensure that the entire area around the true arch section is completely filled. The grout used to construct the leveling pads and to fill the keyways shall be in accordance with this section. Grout shall not be placed if the air temperature is expected to be below 35°F for a period of 72 h following grout placement.

723.12 Extension of Existing Structure

340 All applicable requirements of this specification shall apply to the extension of an existing three-sided arch-topped structure with headwalls and wingwalls, a three-sided flat-topped structure with headwalls and wingwalls, or a true arch shape structure with spandrel walls and wingwalls. Such portions of the existing structure designated for removal shall be removed. All portions of the existing structure which are to remain in place and are damaged shall be repaired or replaced as directed. Those portions left in place which are wholly or partially filled with debris shall be cleaned out. Material removed shall be disposed of in accordance with the applicable requirements of 202.02.

350 Before removing concrete from an existing structure with wingwalls, the Contractor shall saw around the perimeter of the removal area on the interior and exterior of the existing structure a depth of 1 in. All existing reinforcement in the top slab and sidewalls exposed after concrete removal shall be cleaned and straightened in preparation for lapping with reinforcement from adjacent new work. Where existing reinforcement has deteriorated or been damaged during the removal operation, holes shall be drilled into the face of the existing structure to provide embedment for replacement reinforcing bars. The holes shall be of the diameter and depth required by the chemical anchor system manufacturer. The holes shall be cleaned prior to placing the chemical anchor system and the reinforcing bars.

360 No concrete shall be removed from an existing structure that has a headwall but no wingwalls. Reinforcing bars to tie the existing structure to the new structure section shall be installed by drilling holes into the face of the existing structure to provide embedment for reinforcing bars. The diameter and depth of the holes shall be in accordance with the recommendations of the manufacturer of the chemical anchor system. The holes shall be cleaned prior to placing the chemical anchor system and the reinforcing bars.

An existing structure shall be extended by means of one of the following methods.

370

(a) Precast Reinforced Concrete Three-Sided Structure Extension

A cast-in-place concrete splice shall be constructed as a transition between the existing structure and the precast structure extension. The splice reinforcement in the precast structure extension section that will abut the existing structure shall be exposed 18 in. on the tongue end of the precast structure extension section. It shall be lapped 18 in. with either exposed existing structure reinforcement, in the case of an existing structure with wingwalls, or newly installed reinforcing bars in the existing structure, in the case of an existing structure with a headwall only as shown on the plans. Existing exposed structure reinforcement from an existing structure with wingwalls shall be cut off 1 in. from the face of the new precast extension.

380

If the existing tongue or groove joint end is acceptable and matches the mating joint on the new precast reinforced concrete structure extension section, the new extension may be installed using the mating joint of the existing structure. No cutting of the structure or splicing of reinforcement is then required. The joint between the new precast structure extension and the existing structure shall be sealed as directed below.

(b) Cast-In-Place Concrete Three-Sided Structure Extension

The reinforcement for the structure extension shall be lapped with the exposed reinforcement of the existing structure as shown on the plans.

390

723.13 Blank**723.14 Joints**

Joints between structure sections for three-sided arch-topped structures and true arch shape structures, and for flat-topped structures with cover of 3 ft or more, may be either butt joints or keyway joints.

The sections of flat-topped structures with less than 3 ft of cover shall be produced with a minimum 4 in. depth by 1 1/2 in. width keyway joint. Non-shrink grout in accordance with 707.09 shall be placed in the keyway joint.

400

All butt joints between structure sections shall be covered with a joint wrap in accordance with ASTM C877. The surface shall be free of dirt before the joint material is applied. The entire joint shall be continuously covered. Joints between structure sections and wingwalls, between wingwalls and spandrel walls, and between structure sections and headwalls or spandrel walls shall be covered with either the same wrap used between structure sections or with geotextile in accordance with 918.02.

410

The joint wrap shall be kept in its proper location over the joint. It shall not be damaged during the backfilling operation.

Joints in true arch shape structures shall be sealed with 1 1/2 in. diameter preformed pipe joint sealant before placement of the joint wrap.

723.15 Backfilling

Structure backfill shall be placed and compacted in accordance with 211. Structure backfill shall be placed and compacted on each side of the structure to the
 420 fill line shown on the plans. During the backfill operation, the difference in elevations of the fill on each side of the structure shall not exceed 24 in.

Unless otherwise specified by the manufacturer on the working drawings, once the level of structure backfill reaches the top of the structure, two lifts shall be spread and hand compacted over the structure without traversing the structure with heavy equipment. Compaction with heavy equipment will not be allowed until a minimum of two lifts have been placed, hand compacted, and accepted.

The operation of equipment over the structure shall be in accordance with the
 430 structure manufacturer's recommendations.

723.16 Scour Protection

When riprap is specified, geotextile shall first be placed on the in-situ soil in accordance with 616.11. Riprap shall then be placed in accordance with 616.

For concrete base slabs, concrete shall be placed in accordance with 702.

723.17 Method of Measurement

Precast reinforced concrete three-sided flat-topped structures or structure
 440 extensions, precast reinforced concrete three-sided arch-topped structures or structure extensions, precast reinforced concrete true arch structures or structure extensions, cast-in-place reinforced concrete three-sided flat-topped structures or structure extensions, cast-in-place reinforced concrete three-sided arch-topped structures or structure extensions, and cast-in-place reinforced concrete true arch structures or structure extensions will not be measured. The accepted quantities for payment will be the quantities shown on the plans.

Structure backfill will be measured in accordance with 211.09. Flowable backfill will be measured in accordance with 213.08. Geotextile and riprap will be measured
 450 in accordance with 616.12. Field drilled holes will be measured in accordance with 702.27.

Plain or coated reinforcement or WWR used in precast reinforced concrete three-sided flat-topped structures or structure extensions, precast reinforced concrete three-sided arch-topped structures or structure extensions, precast reinforced concrete true arch structures or structure extensions, precast headwalls, precast wingwalls, cast-in-place reinforced concrete three-sided flat-topped structures or structure extensions, cast-in-place reinforced concrete three-sided arch-topped structures or structure extensions, cast-in-place reinforced concrete true arch structures or structure
 460 extensions, cast-in-place headwalls, or cast-in-place wingwalls will not be measured for payment.

If the Contractor elects to provide a box structure in lieu of the three-sided structure shown on the plans, it will be measured in accordance with 714.11.

723.18 Basis of Payment

470 The accepted quantities of precast reinforced concrete three-sided flat-topped structures or structure extensions, precast reinforced concrete three-sided arch-topped structures or structure extensions, precast reinforced concrete true arch structures or structure extensions, cast-in-place reinforced concrete three-sided flat-topped structures or structure extensions, cast-in-place reinforced concrete three-sided arch-topped structures or structure extensions, and cast-in-place reinforced concrete true arch structures or structure extensions, of the size specified will be paid for at the contract unit price per linear foot.

Structure backfill will be paid for in accordance with 211.10. Flowable backfill will be paid for in accordance with 213.09. Geotextile and riprap will be paid for in accordance with 616.13. Field drilled holes will be paid for in accordance with 702.28.

480 If the Contractor elects to provide a box structure in lieu of the three-sided structure shown on the plans, it will be paid for in accordance with 714.12. The Department will not incur additional cost for allowing the Contractor to substitute a box structure for the three-sided structure shown on the plans.

Payment will be made under:

	Pay Item	Pay Unit Symbol
490	Structure Extension, Coated Reinforced Concrete, Three-Sided Sections, _____ in. x _____ in.	LFT
	span rise	
	Structure Extension, Reinforced Concrete, Three-Sided Sections, _____ in. x _____ in.	LFT
	span rise	
	Structure, Coated Reinforced Concrete, Three-Sided Sections, _____ in. x _____ in.	LFT
	span rise	
500	Structure, Reinforced Concrete, Three-Sided Sections, _____ in. x _____ in.	LFT
	span rise	

The cost of all design, coring, testing, pedestals or extended legs, excavation, repairs, plugging core and handling holes, mortar, grout, sealer, cylinder molds, and necessary incidentals shall be included in the cost of the structure or structure extension.

The cost of spandrel walls, concrete base slab, footings, and aggregate base under

724.01

footings shall be included in the cost of the structure or structure extension.

510 The cost of precast concrete headwalls, precast concrete wingwalls, cast-in-place headwalls, or cast-in-place wingwalls shall be included in the cost of the structure or structure extension.

The cost of plain or coated reinforcement or WWR used in precast reinforced concrete three-sided structures, precast reinforced concrete three-sided structure extensions, precast headwalls, precast wingwalls, cast-in-place reinforced concrete three-sided structures, cast-in-place reinforced concrete three-sided structure extensions, cast-in-place headwalls, or cast-in-place wingwalls shall be included in the cost of the structure or structure extension.

520

The cost of concrete used in a cast-in-place splice shall be included in the cost of the structure extension.

The cost of footings for wingwalls and aggregate base under the wingwall footings shall be included in the cost of the structure or structure extension.

The quantities for payment shall remain as shown on the plans whether the Contractor installs the three-sided arch-topped structure or structure extension, the three-sided flat-topped structure or structure extension, or the true arch shape structure or structure extension.

530

No additional payment will be made for carrying an underground drain through a structure or structure extension. However, no deduction will be made for the volume of concrete occupied by the drain pipe in a cast-in-place structure or structure extension.

No additional payment will be made for the repair or replacement of existing concrete damaged by Contractor operations.

540

SECTION 724 – BRIDGE EXPANSION JOINTS

724.01 Description

(a) Bridge Expansion Joint

This work shall consist of furnishing and placing bridge expansion joints of the type specified, in accordance with 105.03.

(b) Replacement of Existing Bridge Expansion Joint

10 This work shall consist of the removal and replacement of an existing bridge expansion joint with a joint of the type specified, in accordance with 105.03.

(c) Replacement of Existing Bridge Expansion Joint Seal

This work shall consist of the replacement of the joint seal in an existing bridge expansion joint of the type specified in accordance with 105.03.

MATERIALS

724.02 Materials

20 Materials shall be in accordance with the following:

Bridge Deck Patching Concrete	722
Concrete, Class C	702
Expansion Joint M.....	906.07(b)
Expansion Joint PCF	906.07(c)
Expansion Joint SS	906.07(a)
Inorganic Zinc Primer.....	909.02(a)1
Rapid Set Patching Materials	901.07
Structural Steel	910.02

30

The joint manufacturer shall prepare and submit working drawings in accordance with 105.02. The working drawings shall include details of the assembly, manufacturer's installation instructions, installation details for where changes in the joint direction are required, manufacturer's specifications, for all joint materials and adhesives, a statement certifying the compatibility of the joint material and the substrate, and joint setting data.

40 For joints constructed in phases, the joint width for the initial phase shall be established in accordance with the joint setting table. The joint width for each subsequent phase shall be equal to the field measurement of the joint constructed in the initial phase taken at the time of the subsequent phase joint construction.

(a) Expansion Joint SS

The joint assembly shall consist of one of the allowable alternates for this type of joint as shown on the plans. The strip seal shall be sized to accommodate a minimum of 4 in. of movement. The strip seal shall be furnished in one continuous length for the entire limits of the installed joint. Field splicing of the strip seal will not be allowed.

(b) Expansion Joint M

50 The joint assembly shall be manufactured in accordance with the details shown on the working drawings as prepared by the manufacturer of the joint assembly. The strip seals shall be furnished in one continuous length for the entire limits of the installed joint. Field splicing of the strip seals will not be allowed.

(c) Expansion Joint PCF

The joint seal shall be sized to accommodate the anticipated thermal movement range shown on the plans. The nominal joint size shall meet or exceed the existing joint mean opening size at 60°F as shown on the plans.

CONSTRUCTION REQUIREMENTS**724.03 General Requirements**

All welding shall be in accordance with 711.32. All splice welds shall develop full strength. All welds which come in contact with the seals shall be ground smooth. All metal surfaces in direct contact with the seal shall be cleaned and properly treated in accordance with the manufacturer's recommendations. Lubricants and adhesives shall be used in accordance with the joint manufacturer's recommendations. All excess lubricant and adhesive shall be removed before it has set.

70 Final adjustment of the assembly shall be made as directed at the time of installation. All movements due to such factors as shrinkage, creep, and mid-slab deflection shall be accounted for prior to this final adjustment.

(a) Replacement of Existing Bridge Expansion Joint

The existing joint and adjacent concrete shall be removed to the limits shown on the plans. Additional removal, as directed, may be required to encounter sound concrete adjacent to the joint area. The replacement joint shall be in accordance with the requirements contained herein for the specified type. Concrete shall be class C in accordance with 702.

80

(b) Replacement of Existing Bridge Expansion Joint Seal

The existing seal shall be removed in its entirety. The new seal shall be installed in accordance with the requirements contained herein for the specified joint type.

(c) Installation of PCF Joint

Where an existing joint is to be replaced, the existing joint and adjacent concrete shall be removed to the limits shown on the plans. Additional concrete removal to ensure sound concrete adjacent to the joint area shall be as directed. Patching of adjacent concrete shall use bridge deck patching concrete or rapid setting patching materials.

90

The Contractor shall measure the existing opening perpendicular to the centerline of the joint to determine the installation opening. Using this information and movement and mean opening size from the plans, the manufacturer shall select a specific joint model for the size.

100 The joint area shall be cleaned as specified herein and in accordance with the manufacturer's guidance. Existing surfaces that will be in contact with the new joint shall be sandblasted and cleaned of all old joint seals, old materials or devices, bituminous material, dirt, grease, and all other deleterious material over the total area of the opening to receive the new joint in accordance with the manufacturer's recommendations. All areas to be in contact with the new joint shall be sound, clean, dry, and frost free. The use of heat will not be allowed to dry the adjacent surfaces. Bridge deck patching concrete shall be cured a minimum of seven days and rapid setting patching materials shall be cured a minimum of three days prior to installing

the joint. Shorter cure durations will be allowed if approved in writing by the joint and sealant manufacturer and shown on the working drawings.

- The joint shall be adhered to the substrate with a field applied epoxy adhesive.
- 110 Adhesives shall be used in accordance with the joint manufacturer's recommendations. All excess adhesive shall be removed before it has set. The epoxy material shall be stored, mixed, and placed in accordance with the manufacturer's recommendations.

- Joints shall be inspected for proper depth, width, alignment and preparation as shown on the plans. The joint shall be installed when the temperature is within the allowable range stated in the manufacturer's instructions, but not less than 40°F. Final adjustment of the seal shall be made as directed at the time of installation. All movement due to such factors as shrinkage, creep and deflection shall be accounted for prior to this final adjustment.
- 120

Prior to the epoxy curing, the Contractor shall force the tip of the silicone sealant between the substrate and the joint, and inject a corner bead of silicone sealant along the entire length of the joint. The Contractor shall tool the silicone sealant to blend with the substrate and silicone coating of the joint.

724.04 Method of Measurement

- Bridge expansion joints will be measured by the linear foot along and parallel to the plane of the finished joint surface. Replacement of existing bridge expansion joints will be measured by the linear foot along and parallel to the plane of the finished joint surface. Concrete removal and class C concrete required for the replacement of existing bridge expansion joints type SS and M will not be measured for payment.
- 130

- Patching of existing concrete adjacent to type PCF joints as shown on the plans, and as required by the Engineer, will be measured by the square foot of actual surface area of patching. Individual areas of less than 1 sq ft in area will be considered as 1 sq ft. Areas greater than 1 sq ft will be recorded as the actual measurement of the repaired area to the nearest 0.1 sq ft. Removal of the existing joint, removal of the concrete adjacent to the joint, epoxy adhesive, silicone sealant, and all other materials used in the installation of the type PCF joint will not be measured for payment.
- 140

Sliding cover plates will not be measured for payment. Replacement of existing bridge expansion joint seals will be measured by the linear foot along and parallel to the plane of the finished seal installation.

724.05 Basis of Payment

- Bridge expansion joint will be paid for at the contract unit price per linear foot of the type specified, complete in place. Replacement of existing bridge expansion joint will be paid for at the contract unit price per linear foot for bridge expansion joint, of the type specified, replace, complete in place. Replacement of existing bridge expansion joint seals will be paid for at the contract unit price per linear foot for bridge
- 150

SECTION 725 – SLIP LINING OF EXISTING PIPE

725.01 Description

This work shall include installing a thermoplastic liner pipe into an existing pipe and filling the space between the liner pipe and the existing pipe with cellular concrete grout all in accordance with 105.03.

MATERIALS

10 725.02 Materials

Materials shall be in accordance with the following:

	Admixture..... *		
	Cellular Concrete Grout	ASTM C796	
	Cement, Type I or Type III.....	901.01(b)	
	Concrete, A.....	702	
	Fine Aggregate**	904	
	Flowable Backfill	213	
	Foaming Agent.....	912.05	
20	Profile Wall HDPE Liner Pipe	907.25(b)	
	Profile Wall PVC Liner Pipe.....	907.25(c)	
	Solid Wall HDPE Liner Pipe.....	907.25(a)	
	Water	913.01	

* An admixture may be used as recommended by and in accordance with the foaming agent manufacturer's specifications.

** The supplier may elect to use gradations in accordance with 904.02(h) or may propose the use of alternate gradations.

30 Where circular liner pipe is shown on the plans, the pipe structure shall be lined with solid wall HDPE liner pipe, profile wall HDPE liner pipe, or profile wall PVC liner pipe. Where deformed liner pipe is shown on the plans, the pipe structure shall be lined with solid wall HDPE liner pipe or profile wall HDPE liner pipe.

40 The maximum number of joints and corresponding maximum length of each section of liner pipe used in each pipe structure to be lined shall be as shown on the plans. If the Contractor has obtained the necessary right-of-entry from all affected property owners and all necessary new permits or amendments to existing permits to enable work in areas accessible via Contractor-obtained right-of-entry, the Department will consider a written request by the Contractor to use liner pipe sections which exceed the maximum length shown on the plans. A corresponding reduction in the maximum allowable number of joints shall be included with the written proposal. The Contractor shall not install longer sections of liner pipe until written approval has been received from the Engineer.

The liner pipe shall either be chosen from those shown on the QPL of Thermoplastic Pipe and Liner Pipe Sources or shall be accompanied by a certification in accordance with 907.25 and 916. If the liner pipe is not on the QPL of Thermoplastic

Pipe and Liner Pipe Sources, then the certification shall be furnished. Liner pipe shall be submitted to the Engineer for review and approval prior to installation.

50

Proper care shall be taken to ensure that no damage is done to the liner pipe during the unloading process. All liner pipes shall be unloaded with straps and lifting equipment.

Liner pipe joints shall be bell and spigot, screw type, grooved press-on, butt fused, extrusion welded, or other joint as recommended by the liner pipe manufacturer and shall be installed according to the manufacturer's recommended methods.

CONSTRUCTION REQUIREMENTS

60

Where a deformed HDPE liner pipe is specified, the liner pipe shall be made deformed by using equipment specifically designed to take a circular liner pipe and deform it without causing damage to the liner pipe. The equipment and method used to deform the liner pipe shall be described in the QCP. Once the liner pipe has been deformed, it shall be structurally reinforced in the horizontal and vertical planes. Structural reinforcement shall be spaced at a maximum distance of 3 ft on centers. Structural reinforcement shall not be removed until the installation of the liner pipe and cellular concrete grout at that structure has been completed.

70 **725.03 Right-of-Entry Areas**

If the Contractor desires more working room than the right-of-way provides, the Contractor may elect to pursue rights-of-entry from all necessary adjacent property owners in accordance with 107.14. A temporary fence shall be installed as required to prevent encroachment of the public or livestock into the work area. Upon completion of the work, disturbed areas on private property shall be restored in accordance with 107.14.

725.04 Quality Control

80 A QCP shall be submitted in accordance with ITM 803. No work on the pipe lining operation shall begin until written notice has been received that the QCP has been accepted by the Engineer. Acceptance of the QCP in no way relieves the Contractor of the responsibility for installation procedures and testing requirements.

A QC representative shall be present at the jobsite for the initial testing of the first welding or fusing at each liner pipe installation location and for the joining, welding, or fusing of the liner pipe at each location.

725.05 Filling of Cavities Outside of the Existing Pipe

90 All obvious cavities outside the existing pipe shall be filled with non-removable flowable backfill in accordance with 213 prior to the liner pipe installation or with cellular concrete grout placed in conjunction with the grouting operation after the liner pipe is installed.

725.06 Joining Liner Pipe

Each liner pipe joint shall be welded, fused, or joined according to the manufacturer's recommended methods. Welded liner pipe joints shall be welded with a continuous weld for the circumference of the liner pipe both inside and outside. Welded liner pipe joints shall have weld beads that are smooth and shall not project further than 3/8 in. into the inside of the liner pipe and shall not reduce the hydraulic capacity of the liner pipe. The ends of liner pipe that are to be welded or butt fused shall be at the same temperature $\pm 5^\circ$ F.

A visual inspection will be conducted for acceptance of all liner pipe joined by methods other than by welding or fusing joints. All joints that do not pass visual inspection shall be removed, shall have a new joint fabricated, and will be re-inspected.

All liner pipe joints shall have sufficient mechanical strength to withstand the liner pipe installation and cellular concrete grouting operations.

110 (a) Welder, Butt Fuser, or Joiner Joint Testing

Welding, butt fusing, or joining shall be performed at all times by an operator trained and certified by either the manufacturer of the liner pipe or the manufacturer of the welding, butt fusing, or joining equipment. A copy of the operator's certification shall be provided to the Engineer prior to the start of work. Prior to fabricating a production joint on a liner pipe, each operator who is performing welding, butt fusing, or joining, shall demonstrate that they can produce a joint that will withstand a destructive test prior to being allowed to join liner pipe. This test shall be repeated as many times as necessary in order to produce a joint that will pass the destructive test. One passing joint test is required per operator per contract. The method of joint testing shall be in accordance with section (b) or (c) below.

(b) Solid Wall HDPE Liner Pipe

Solid Wall HDPE liner pipe joined using butt fusion shall be in accordance with ASTM F2620.

Solid wall HDPE liner pipe that is to have extrusion welded joints shall have destructive testing performed on a test section of liner pipe of the same material as the liner pipe being installed. The Contractor shall propose and describe in the QCP a destructive test, such as but not limited to a bend strap test, to demonstrate that an operator can produce an extrusion welded joint that will not fail. Once an extrusion welded joint is produced on a test section that passes the destructive test, each subsequent joint fabricated that same day by that operator will be visually inspected for acceptance. A destructive test in accordance with the approved QCP shall be conducted on the test section at the beginning of each day that solid wall HDPE liner pipe joining is being done.

(c) Profile Wall HDPE Liner Pipe

Profile Wall HDPE liner pipe joined using extrusion welding shall be in accordance with ASTM F894. The Contractor shall propose and describe in the QCP

- 140 a destructive test, such as but not limited to a bend strap test, to demonstrate that an operator can produce an extrusion welded joint that will not fail. Destructive testing shall be performed on two flat pieces of HDPE sheet stock that has been butt welded together to verify the extrusion gun is working properly and that the operator can produce an extrusion welded joint that will not fail. Once an extrusion welded joint is produced on a test section that passes the destructive test, each subsequent joint fabricated that same day by that operator will be visually inspected for acceptance. A destructive test in accordance with the approved QCP shall be conducted on the test section at the beginning of each day that profile wall HDPE liner pipe joining is being done.

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725.07 Cellular Concrete Grout

The cellular concrete grout shall be designed in accordance with ASTM C796 except as herein modified.

The admixtures, retarders, and plasticizers used in the grout shall be in accordance with the foam concentrate supplier's specifications.

- 160 The grout shall be made using the preformed foam process using foam generating equipment calibrated daily by the foam manufacturer to produce a precise and predictable volume of foam. The foam concentrate shall be certified by the manufacturer to have specific liquid/foam expansion ratio at a constant dilution ratio with water.

The specific job mix shall be submitted to the Engineer by either the foam concentrate supplier or the certified or licensed grouting contractor for approval prior to use on the contract. The mix shall have a minimum 28-day compressive strength of 150 psi. The mix shall be tested by a laboratory qualified by the Department or shall be approved based on prior acceptable performance on Department contracts.

- 170 The cellular concrete grout pump gauges shall be calibrated a minimum of once per month in the presence of the Engineer by the method described in the QCP.

Grout mixed off site shall be delivered to the job site in a truck mixer in accordance with 702.09 filled to half its capacity. The foaming agent shall then be added to the cement mix in the truck and mixed to a uniform consistency.

Grout mixed on site shall be batched in a deck mate or similar device. Small batches of approximately 1 cu yd shall be mixed and pumped in a continuous operation.

180

For each day worked or for each 100 cu yds placed, four test cylinders measuring 3 in. by 6 in. shall be cast at the point of placement of the grout. Sampling, molding, curing, and compressive strength testing of the cylinders shall be in accordance with ASTM C495, except as modified herein.

Initial curing period shall be at a temperature of 70°F ±10°F and shall be from two to five days. After the initial curing, the test specimens shall be placed in a moist closet or moist room or stored in an enclosed curing tank above the water level. All specimens shall be kept in their molds in the moist storage for the remainder of the curing period. The specimens shall be tested at 28 days. At that time, the specimens shall be prepared for testing in accordance with ASTM C495, except the bearing surface may be ground or cut with a dry saw to meet surface tolerance. The specimens shall not be capped. Specimens shall be tested in compression as rapidly as possible to minimize drying. If more than one specimen is removed from the moist storage at the same time, these specimens shall be covered with a damp cloth until time of testing. A type A certification in accordance with 916 shall be provided for cellular concrete grout. The result of the compressive strength test shall be shown on the certification for cellular concrete grout.

200 **725.08 Liner Pipe Installation**

Prior to commencing the liner pipe installation, all jagged existing pipe edges or other deformities shall be repaired. All debris and foreign material shall be removed from the existing pipe and disposed of in accordance with 203.08. A visual walk-through inspection shall be performed after all debris and foreign material has been removed from the existing pipe in order to assess the current condition of the pipe. If visual inspection is not possible, a video inspection of the existing pipe shall be performed. A copy of the video inspection shall be provided to the Engineer. If, upon completion of the inspection of the existing pipe, the Contractor believes that they cannot proceed with the work as shown on the plans, the Engineer shall be notified.

210

The cross-sectional area of the liner pipe shall be as shown on the plans.

Prior to commencing the liner pipe installation operation, steps shall be taken to verify that a liner pipe meeting the required cross-sectional area can be successfully placed inside the existing pipe. If it is discovered prior to installation that a liner pipe with the required opening area cannot fit, the inside and outside diameters of a substitute liner pipe shall be submitted to the Engineer for approval. If this discovery is not made until after the liner pipe installation has begun, the partially installed liner pipe shall be removed. Inside and outside diameters for a substitute liner pipe shall then be submitted to the Engineer for approval.

220

After the liner pipe installation is complete and the liner pipe has cooled to the temperature of the existing pipe, the liner pipe shall be cut so that each end is 8 in. outside the end of the existing pipe.

The cellular concrete grout within the annular space between the existing pipe and the liner pipe shall be contained by bulkheads. The bulkheads shall be constructed at each end of the structure. Each bulkhead shall be constructed to withstand the pressure of the grouting operation. The bulkhead shall be free from leaks and the exterior surface shall be given a smooth trowel finish. The bulkhead shall extend from the end of the existing pipe inward a minimum depth of 18 in.

230

Cellular concrete grout shall be injected into the annular space between the existing pipe and the liner pipe. The injection operation shall provide sufficient cellular concrete grout to fill all voids between the existing pipe and the liner pipe over the entire structure length, but shall also be performed in a manner that does not distort the liner pipe. Injection of the cellular concrete grout in lifts, use of spacers, or other safeguards shall be taken in order to keep the liner pipe in position and prevent the liner pipe from floating. The pressure developed in the annular space between the liner pipe and the existing pipe shall not exceed the liner pipe manufacturer’s recommended maximum value.

All existing culverts, storm drains, underdrain pipes, drain tile, or other pipes that are directly connected to the lined structure shall be perpetuated. Cellular concrete grout shall not leak through the liner pipe at these connections.

725.09 Method of Measurement

All thermoplastic liner pipe will be measured by the linear foot, for the shape and cross-sectional area of the liner pipe, complete in place. Perpetuation of existing pipes through the liner pipe will be measured by the number of existing pipes perpetuated.

No measurement will be made of liner pipe joints or the length of joint welding or fusing, or other incidentals necessary to join sections of liner pipe in accordance with the manufacturer’s recommendations. The liner pipe or flat sheet stock used for destructive testing will not be measured for payment. No measurement will be made of a liner pipe meeting the required opening area that does not fit.

No measurement will be made for debris removal and disposal, filling existing voids, or trimming, cutting, jacking, or other corrective measures performed on jagged edges or other deformities of the existing pipe in order to facilitate installation of the liner pipe. No measurement will be made for visual or video inspection of the existing pipe.

No measurement will be made for the bulkhead.

725.10 Basis of Payment

The accepted quantities of thermoplastic liner pipe will be paid for at the contract unit price per linear foot for the shape and cross-sectional area of the liner pipe, complete in place. Perpetuation of existing pipes through the liner pipe will be paid for by the number of existing pipes perpetuated.

Payment will be made under:

Pay Item	Pay Unit Symbol
Liner Pipe, Thermoplastic, Circular, _____sq ft	LFT
cross-sectional area	

	Liner Pipe, Thermoplastic, Deformed, _____ sq ft	LFT
		cross-sectional area
280	Perpetuation, Existing Pipe	EACH

290 The cost of repairing, trimming, or cutting jagged edges or deformities to existing pipe, filling cavities around the existing pipe with cellular concrete grout, acquisition and restoration of right-of-entry areas, acquiring all necessary new permits or amendments to existing permits to work in areas accessible via Contractor-obtained right-of-entry, erection, maintenance, and removal of temporary fence, removal and disposal of debris and foreign material from the existing pipe, visual or video inspection of the existing pipe, deforming a circular liner pipe, supplying and constructing the bulkheads, grouting the annular space between the existing pipe and the liner pipe, and other incidentals will not be paid separately, but shall be included in the cost of the pay items in this section.

The cost of liner pipe joints other incidentals necessary to join sections of liner pipe in accordance with the manufacturer’s recommendations, and all test sections of liner pipe and test sections of HDPE sheet stock shall be included in the cost of the pay items in this section. All costs associated with having a QC representative on site shall be included in the cost of the pay items in this section.

300 The cost of training and certifying an operator, destructive and non-destructive testing, liner pipe, and incidentals used in destructive testing, and all costs associated with the development of an acceptable QCP shall be included in the cost of the pay items in this section.

Any joint that does not pass the visual inspection and needs to be re-fused, re-welded, or re-joined shall be done at no additional cost to the Department.

310 In situations where the condition of the existing pipe requires that a substitute liner pipe be utilized, there will be no reduction in payment for the installation of the substitute liner pipe. There will be no additional payment for the additional cellular concrete grout required to fill the larger void between the existing pipe and the smaller liner pipe.

There will be no payment for the installation or removal of any liner pipe that cannot be successfully installed due to the condition of the existing pipe. There will be no payment for a liner pipe meeting the required cross-sectional area that does not fit.

320 If the existing pipe or any other object not designated for removal is damaged while performing this work, it shall be considered unauthorized work and repaired or replaced in accordance with 105.11.

SECTION 726 – BEARING ASSEMBLIES

726.01 Description

This work shall consist of furnishing and installing bearing assemblies in accordance with 105.03. Elastomeric bearings shall include plain bearings consisting of elastomer only, and laminated bearings consisting of layers of elastomer restrained at their interfaces by bonded laminates.

MATERIALS

10

726.02 Materials

The materials shall be in accordance with the following:

	Anchor Bolts.....	910.02(g)
	Elastomer.....	915.04
	Grout.....	707.09
	Polytetrafluoroethylene Sliding Surfaces	915.05
	Shim and Fill Plates.....	910.02(a)
	Side Retainers.....	910.02(a)
20	Threaded Studs and Hex Nuts	910.02(c)

CONSTRUCTION REQUIREMENTS

726.03 Construction Requirements

Elastomeric bearings without external load plates may be placed directly on a concrete or steel surface provided the surface is flat to within a tolerance of 0.005 of the nominal dimension for steel reinforced bearings or 0.01 of the nominal dimension for other types. Bearings shall be installed on surfaces that are horizontal and parallel between the top of the bearing and the underside of the girder.

30

The elastomer or the bond shall not be subjected to temperatures higher than 390°F.

Masonry plates for polytetrafluoroethylene, PTFE, bearings shall be perfectly level. The tolerance between the top face of the masonry plate and the bottom face of the top plate shall be a maximum of 1/16 in., measured at the ends of a diameter of the bottom plate of the bearing assembly. Other dimensional tolerances shall be as shown on the plans or in accordance with 915.04(d).

40

Immediately prior to setting bearings, the concrete and metal surfaces that are to be in contact shall be cleaned.

726.04 Method of Measurement

Elastomeric bearing pads will not be measured for payment. PTFE bearing devices will be measured by the number of devices placed.

726.05 Basis of Payment

Elastomeric bearing pads will not be paid for separately.

50 PTFE bearing devices will be paid for at the contract unit price per each device, complete and in place.

Payment will be made under:

Pay Item	Pay Unit Symbol
Bearing Assembly, PTFE	EACH

60 The cost of the pads, side retainers, anchor bolts, shim plates, and other incidentals shall be included in the cost of the structural member, or for PTFE bearing assemblies.

SECTION 727 – STRUCTURAL CONCRETE REPAIR BY EPOXY INJECTION

727.01 Description

This work shall consist of structurally rebonding concrete cracks, fractures, or delaminations by means of an epoxy injection system in accordance with 105.03.

MATERIALS

10 **727.02 Materials**

Materials shall be in accordance with the following:

Epoxy Resin Additives	909.12
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727.03 Approvals

The epoxy injection system proposed for use shall be subject to approval prior to the start of the repair work. One copy of preparation, mixing, and application instructions shall be furnished. Such instructions shall have been developed especially for use with the proposed epoxy injection system.

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CONSTRUCTION REQUIREMENTS

727.04 Construction Requirements

The location and extent of cracks to be repaired by epoxy injection will be determined.

The work shall be performed with two-component automatic metering and mixing equipment.

30 Concrete surfaces adjacent to the cracks shall be cleaned to the extent necessary

to achieve adequate bond of the surface seal material. Entry ports shall be provided along the crack at intervals determined in the field to ensure full depth penetration of the injection resin. Surface seal shall be applied between entry ports and on both faces of through cracks, when possible.

Epoxy injection shall begin at the lower entry port and continue until there is an appearance of epoxy at the adjacent entry port. Injection shall continue until all cracks are filled. If port to port travel is not apparent, the work shall be stopped immediately. The Engineer shall be notified.

40

Upon completion of the injection, the adhesive shall cure for sufficient time to enable removal of surface seal without draining or runback of material from the cracks. Surface seal material and injection adhesive runs or spills shall be removed from concrete surfaces. The face of the crack shall be finished flush to the adjacent concrete. The face of the concrete shall show no indentations or protrusions caused by the placement of entry ports.

727.05 Method of Measurement

Furnishing equipment for epoxy injection will not be measured for payment.
 50 Crack preparation for epoxy injection will be measured by the linear foot of prepared crack. Epoxy material will be measured by the gallon placed.

727.06 Basis of Payment

This work will be paid for at the contract lump sum price for epoxy injection, furnishing equipment. Crack preparation will be paid for at the contract unit price per linear foot for epoxy injection, crack preparation. Epoxy resin adhesive will be paid for at the contract unit price per gallon for epoxy injection, epoxy material.

Payment will be made under:

60

Pay Item	Pay Unit Symbol
Epoxy Injection, Crack Preparation.....	LFT
Epoxy Injection, Epoxy Material.....	GAL.
Epoxy Injection, Furnishing Equipment.....	LS

SECTION 728 – BLANK

SECTION 729 – HEAT STRAIGHTENING OF STEEL MEMBERS IN THE FIELD

729.01 Description

This work shall consist of field-repairing damaged steel members by the planned and supervised application of limited amounts of localized heat and jacking forces,

grinding, and drilling crack-arrest holes in accordance with 105.03.

729.02 Prequalification Requirement

- 10 The Contractor performing the heat straightening work shall hold a current prequalification certification from the Department with a work type of 0050, steel bridge beam heat-straightening, regardless of whether the value of the total work under contract from all sources is less than \$300,000.

MATERIALS

729.03 Materials

Materials shall be in accordance with the following:

- | | | |
|----|---------------------------|------------|
| 20 | Organic Zinc Primer | 909.02(a)2 |
| | Partial Paint System..... | 619.09(b) |
| | Structural Steel | 910.02 |

CONSTRUCTION REQUIREMENTS

729.04 Pre-Heat Straightening Inspection

- Steel members shall be inspected by the Engineer and Contractor for impact damage such as but not limited to gouges, sharp dents, cracks, or other damage prior to any other work related to heat straightening commencing. All areas identified as having impact damage shall have the paint removed by abrasive blasting, hand tool cleaning, power tool cleaning, or water blasting. The existing coating shall not be removed by flame or heat. The steel members in the areas identified as having damage resulting from an impact shall be checked for fine cracks using liquid penetrant testing in accordance with ASTM E165 or magnetic particle testing in accordance with ASTM E709.
- 30

(a) NDT Testing and Reporting Requirements

- The testing shall be performed on surfaces that are clean, dry, and free of contaminants such as oil, grease, rust, weld flux, spatter, paint, and any other contaminant detrimental to NDT testing. A minimum visible light having an intensity of 200 ft-candles and 2,150 lux shall be provided.
- 40

The following requirements apply to magnetic particle testing. The yoke method shall be used. Half-wave rectified DC yokes shall demonstrate the ability to lift a 30 lb steel block at 2 in. \leq yoke pole spacing \leq 4 in. and 50 lb at 4 in. \leq yoke pole spacing \leq 6 in. AC yokes shall demonstrate the ability to lift a 10 lb steel block at 2 in. \leq yoke pole spacing \leq 4 in. and 50 lb at 4 in. \leq yoke pole spacing \leq 6 in. Dry, non-fluorescent medium meeting the requirements of AMS 3040, SE-709 shall be used. The Contractor shall provide a test medium in contrasting color to the test part.

50

(b) NDT Personnel Qualifications

Personnel performing either the liquid penetrant testing or magnetic particle

testing shall be qualified and certified in accordance with the American Society of Nondestructive Testing, ASNT, recommended practice SNT-TC-1A, or ANSI/ASNT Standard CP-189, and shall be a Level II Inspector.

(c) Results and Reporting

At the conclusion of the testing, the NDT testing technician shall provide a report of each impact location tested; one report per location. The following information shall
60 be included in the report:

1. location of the test on the structure, using nomenclature matching the contract plans,
2. date of examination and testing,
3. technician's name, certification, and signature,
- 70 4. examination results and findings. If no cracks are found, this shall be stated in the report,
5. the medium used, manufacturer, and color, and
6. a high quality photo with a scale reference and location label. The photo shall be taken immediately after the testing and the reports shall be submitted on a daily basis to the Engineer.

The Contractor shall notify the Engineer no later than the end of each work day
80 of any base metal or weld metal defects that require additional treatment.

729.05 Contractor's Work Plan

Upon completion of the pre-heat straightening inspection, the Contractor shall submit a written work plan for the following:

- (a) cleaning of, and existing coating removal from the work area and any other areas of concern discovered during the pre- heat straightening inspection;
- 90 (b) types of heat patterns at each location and sequences;
- (c) jacking or other means used to augment the heat straightening process. Detailed information on the method used and the proposed force measurement system shall be included. The force measurement system shall have been calibrated within the past 12 months;

- 100 (d) disconnecting, supporting, and adjusting steel members, as required;
- (e) cleaning method and painting system to be used following the heat straightening.

The Contractor shall receive written approval of the work plan from the Engineer prior to beginning any work described in the work plan.

729.06 Grinding

- 110 After the damaged areas have been checked for cracks or other damage as outlined above, all gouges, tears, and sharp dents shall be ground smooth. An area 3 in. larger than the impact area on each side of the location of the impact shall be ground to a smooth, bright metal surface to remove the cold-worked region of the steel resulting from the impact. Any weld toes within, or immediately adjacent to, the impact area shall be ground smooth with a die grinder. Cracks discovered in the pre-heat straightening inspection shall be ground out by excavating the crack into a dish-like shape, the sides of which shall approximate a 3:1 taper. If the crack is not removed after grinding approximately a 1/8 in. depth of steel or if prior to grinding, the crack appears to be excessively long, deep or wide, the Engineer shall be notified prior to any grinding. Under no circumstances shall the cracks be v-grooved, filled with
- 120 welding material, and then ground smooth.

729.07 Surface Preparation of Area to be Heated

Before cutting or heating any steel member, paint shall be removed from inside the limits of the heat straightening area. Surface preparation shall be in accordance with 619.08(a) and either 619.08(d) or 619.08(h).

729.08 Equipment

- 130 All gas fueled heating equipment, force application devices, and accessories shall be supplied by the Contractor. Fuel for heating shall be an oxygen-fuel mixture. The fuel shall be acetylene, natural gas, or propane.

Heat application shall be by a torch designed for heating, not cutting, with single-orifice tips only, unless otherwise specified herein. The size of the tip shall be proportional to the thickness of the heated material. As a guide, the tip size is shown in the following table:

Steel Member Thickness, t (in.)	Orifice Size
$t \leq 1/4$	3
$1/4 < t \leq 3/8$	4
$3/8 < t \leq 1/2$	5
$1/2 < t \leq 5/8$	7
$5/8 < t \leq 7/8$	8
$t > 7/8$	*
* multiple torches, rosebud, or multiple orifice tips may be used.	

729.09 Suspension of Work

140 If adverse weather conditions such as rain, snow, or hail arise, or anything else causing unexpected or sudden cooling of the heated members, the Engineer may order the suspension of work. If a suspension of work is ordered, the Contractor shall immediately cease applying heat to the steel members. The suspension of work will only apply while adverse weather conditions exist at the project location. The Contractor shall not recommence work until directed by the Engineer.

729.10 Heat Application and Heat Patterns

150 The Contractor shall identify, by measurements, all yield zones and yield lines prior to starting heat straightening. The temperature of the steel member within a heat pattern during any heat straightening cycle shall be between the minimum and maximum temperature values for the respective type of steel shown in the table below.

Temperature, °F		Type of Steel Shown on the Plans (ASTM Classification Shown)
Minimum	Maximum	
850	950	A709, grade HPS 100W
900	1,000	A709, grade 70W; A709, grade HPS 50W; A709, grade HPS 70W; A852; A913
950	1,050	A514
1,100	1,200	A7; A36; A242; A373; A440; A441; A529; A572; A588; A709, grades 36, 50, 50S, and 50W; A992

Temperatures outside the limits specified above will be cause for rejection and replacement of the steel member.

The Contractor shall provide and use one or more of the following devices to verify temperatures during heat straightening:

- 160 (a) Contact pyrometer
(b) Infrared non-contact thermometer.

The contact pyrometer shall be calibrated daily with temperature crayons prior to use. The infrared non-contact thermometer shall be calibrated every 12 months. Documentation showing the last date of calibration for the infrared non-contact thermometer shall be provided to the Engineer before use. Heat application shall not be performed unless at least one of the devices listed above is being used to verify the temperature of the steel member. Heat patterns and sequences shall be selected to match the type of damage and cross section shape.

170 Heat shall be applied within an included angle of 15 to 55°, but limited to a base width of 12 in. Sufficient number of heat patterns shall be used to eliminate chording

effects, where chording effects are defined as straightening small portions of the damaged steel member. Each heat pattern shall be heated in a single pass. The entire heat pattern shall not be reheated until the steel member has cooled below 250°F. Only cooling with clean, dry air will be allowed. Cooling with compressed air will only be allowed after the steel member has cooled naturally to 600°F. When the steel member thickness exceeds 1 in., two torches shall be used simultaneously to heat both sides of the heat pattern. The torches shall be located one above the other throughout the heating process.

180

The number, location, and sequence of the areas to be heated shall be marked on the steel members. The following heat patterns shall be used:

- (a) edge heats
- (b) line heats
- (c) spot heats
- (d) strip heats
- (e) vee heats.

190 Heat pattern boundaries shall be marked with soapstone. In no case shall heat be applied to undamaged portions of the steel member.

When using vee heats, the heat pattern shall be located on the convex side of the steel member; heat pattern edges shall not overlap and shall be greater than the width of the bottom flange element apart. The apex of the vee should be truncated to an approximate 1 in. width at the junction of the web and flange with the boundaries extending to the edge of the flange. Once the desired temperature of the steel member has been obtained, heating shall progress in a serpentine motion from the apex of the vee toward the base of the vee in a single pass.

200

729.11 Application of Restraining Forces

Restraining forces shall not be applied without acceptable force measurement systems in place. Force measurement devices shall be calibrated every 12 months. Jacks or come-alongs, not exceeding 25 t capacity, may be used to put steel members into limited compression as a means of mechanically augmenting the heat straightening process. The load shall be applied prior to the application of heat. The load shall not be increased during the heat cycle. After a number of heat cycles and the steel member has cooled below 250°F, the load may be adjusted to compensate for the effects of the heat cycles.

210

Any section of the steel member that becomes distorted, cracked, or permanently deformed due to methods of handling, supporting, and loading or by any other means shall be replaced or repaired as determined by the Engineer.

729.12 Tolerances

The steel member shall be straightened to within the following tolerances:

Criteria	Tolerance
Horizontal Sweep	3/8 in. per every 20 ft of length
Horizontal Sweep at the point of impact	3/8 in. per every 5 ft of length, or 1/2 in. per every 8 ft of length
Vertical Deflection	1/4 in. maximum
Deflection of Web (out of plane of web)	1/4 in. maximum in both the vertical and horizontal direction

220 Tolerances shall be achieved before cross frames, diaphragms, or any other lateral restraint devices are attached. In no case shall the steel member be forced into position and then welded or bolted to the cross frames or diaphragms to hold the steel member in position.

729.13 Post-Heat Straightening Inspection

Following the completion of steel member straightening, the straightened steel member shall be inspected by the Engineer and the Contractor. The inspection shall be performed using the same methods and procedures used in the pre-heat straightening inspection, including performing NDT.

230 729.14 Epoxy Injection

If the top flange of the steel member has pulled away from and is no longer in contact with the concrete bridge deck, the resultant void shall be completely filled by epoxy injection in accordance with 727 after completion of all of the steel member straightening and repairs.

729.15 Painting

240 Upon completion and acceptance of the heat straightened steel members, the Contractor shall clean, prime, and paint the steel members. Surface preparation shall be in accordance with 729.07. The paint system shall be in accordance with 619.09(b). Painting shall be in accordance with 619.10. All exposed surfaces on heat-straightened steel members shall be fully painted from the edge of the nearest splice plate or steel member end outside the heat straightened area to the nearest splice plate or steel member end on the other side of the heat straightened area. The color of the top coat shall be a similar color to match the color of the existing bridge.

729.16 Method of Measurement

Heat straightening, grinding, drilling crack-arrest holes, NDT testing, and other incidentals will not be measured for payment.

250 New structural steel and drilled holes for installation of bolts will be measured in accordance with 711.72.

729.17 Basis of Payment

New structural steel and drilled holes for installation of bolts will be paid for in accordance with 711.73.

The accepted heat straightened steel members will be paid for at the contract lump sum price for straighten steel member.

260 Payment will be made under:

Pay Item	Pay Unit Symbol
Straighten Steel Member	LS

The cost for all material, labor, equipment, and incidentals for the inspection of the steel members, the temperature verification devices, calibration of the temperature verification devices, grinding, and drilling crack-arrest holes if shown on the plans or directed by the Engineer, shall be included in the cost of straighten steel member.

270

The cost for all NDT activities, including but not limited to all material, equipment, and labor necessary to clean the test areas, perform and interpret NDT, and preparation of all NDT reports shall be included in the cost of straighten steel member.

The cost for all materials, labor, equipment, and incidentals necessary for disconnecting, supporting, or adjusting the steel members or secondary steel members, jacks or other augmenting devices, the force measurement system, and calibration of the force measurement system shall be included in the cost of straighten steel member.

280 The cost for all materials, labor, equipment, and incidentals required for existing coating removal, preparing, priming, and painting of the steel members shall be included in the cost of straighten steel member.

If the Engineer deems it necessary for the Contractor to perform epoxy injection as outlined above, this extra work will be paid for in accordance with 109.05.

If, as a result of the Contractor’s methods used in the prosecution of the work, the integrity of the steel member has been compromised as determined by the Engineer, all costs to remedy the situation up to and including replacing of the steel members and all costs associated with replacing the steel members shall be at no additional cost to the Department.

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SECTION 730 – BLANK

SECTION 731 – MECHANICALLY STABILIZED EARTH RETAINING WALLS

731.01 Description

This work shall consist of the design, furnishing materials, and placement of MSE retaining walls in accordance with 105.03.

731.02 General Design Requirements

10 An MSE retaining wall shall consist of a non-structural concrete leveling pad, concrete face panels, precast or cast-in-place concrete coping, ground reinforcement elements mechanically connected to each panel, and accommodations for appurtenances behind, in front of, under, mounted upon, or passing through the wall. Ground reinforcement shall have sufficient strength, frictional resistance, and quantity as required by design. If a drainage system is shown on the plans, the wall design shall accommodate the drainage system.

20 The MSE retaining wall system shall be selected from the QPL of Retaining Wall Systems. A retaining wall system manufacturer will be considered for inclusion on the QPL by following ITM 806, Procedure J. The quantities shown in the Schedule of Pay Items will be the same for each MSE retaining wall system. The MSE retaining wall panels shall be constructed as shown on the panels' working drawings, based on the requirements herein.

If the wall manufacturer needs additional information to complete the design, the Contractor shall be responsible for obtaining such information.

30 All appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, or other appurtenances shown on the plans, shall be accounted for in the design of the wall.

40 The Contractor shall determine the final leveling-pad layout and step elevations that provide the wall envelope shown on the plans. The Contractor shall use this information to provide a final horizontal plan and vertical elevation profile along the front face of the wall to account for the wall envelope shown on the plans. The final coping or top-of-wall elevations shall be at or above those shown on control line 1 on the plans. The final top-of-leveling-pad elevations shall be at or below those shown on control line 3 on the plans. Leveling-pad steps shall be in 2.5 ft increments. The top of the leveling pad elevation shall be a minimum of 1.0 ft above the ordinary high water mark, OHWM, or the groundwater table elevation, whichever is higher. The leveling pad dimensions shall typically be 12 in. wide and 6 in. thick and as shown on the working drawings.

Where a coping or barrier is utilized, the wall face panel shall extend up into the coping or barrier a minimum of 2 in. The top of the face panels may be level or sloped to meet the top of the face panel line shown. Cast-in-place concrete will not be an acceptable replacement for panel areas indicated by the wall envelope.

50 Where walls or wall sections intersect with an included angle of 130° or less, a vertical corner element separate from the standard panel face shall abut and interact with the opposing panels. The corner element shall have ground reinforcement connected specifically to that panel. All turn-point locations where the wall forms an angle that are shown on the working drawings shall correspond to those shown on the

plans unless otherwise approved in writing by the Engineer.

Face panels shall be designed to accommodate a differential settlement of 1 linear unit in 100. Face panels of an area greater than 32 sq ft through 64 sq ft shall be designed to accommodate differential settlement of 1 linear unit in 200. Where shown on the plans, slip joints to accommodate excessive or differential settlement shall be included.

60

Only one typical face panel shape and architectural finish shall be used per contract.

731.03 Design Criteria

The internal, external, and compound stability shall be the responsibility of the Contractor. The global stability of the wall mass will be the responsibility of the Engineer.

70 The Contractor shall use the information supplied in the contract documents including but not limited to the plans and the geotechnical report when designing the wall. The design of the wall including the internal, external, and compound stability shall be in accordance with the AASHTO LRFD Bridge Design Specifications and the requirements specified herein.

The splay angle of soil reinforcement measured from a line perpendicular to the wall face, in order to avoid an obstruction, shall not be more than 15°. The tensile capacity of the splayed reinforcement shall be reduced by the cosine of the splay angle.

80 The design for internal stability shall include connection strength design. Each design case shall present maximum tension capacity, soil overburden pressure, and horizontal pressure at each reinforcement level, pullout capacity at each reinforcement level, the length of embedment in the resisting zone, and the total length of reinforcement at each level.

The design for the external stability shall include applied bearing pressure, overturning, sliding, and stability of temporary construction slopes.

The design for the compound stability shall include the slope present on top of and at the toe of the MSE wall.

90

The value of the pullout resistance factor, F^* , used in design calculations shall be obtained from AASHTO LRFD Bridge Design Specifications figure 11.10.6.3.2-2.

The minimum embedment at the front face of the wall shall be in accordance with the AASHTO LRFD Bridge Design Specifications, section 11.10.2.2. However, the minimum embedment depth to the top of the leveling pad shall never be less than 3 ft unless founded on rock. A 4 ft horizontal bench in front of the wall shall be provided for slopes steeper than 4.0H:1.0V.

100 The embedment and bench material, at the front face of the wall, shall match the structural backfill material used for the wall and shall be encased in accordance with 203.09. It shall be 6 in. minimum depth measured perpendicular to the face of the slope. Geotextiles, Type IB, in accordance with 918.02(a), shall be installed over the bench material in accordance with 616.11. The embedment and bench shall be daylighted at the bottom of the slope with uniform riprap placed at a minimum 12 in. depth for erosion control.

An MSE wall shall be designed for a service life of 75 years.

110 **(a) Geotechnical Considerations**

The theoretical failure plane within the soil mass shall be analyzed so that the soil-stabilizing component extends sufficiently beyond the failure plane to stabilize the material. External loads which affect the internal stability, such as those applied through piling, bridge footings, traffic, crashwall, or slope surcharge, shall be accounted for in the design. The sizes of all structural elements shall be determined such that the design load stresses do not exceed the factored stresses shown in the AASHTO LRFD Bridge Design Specifications.

120 The material used as backfill in the reinforced backfill zone shall be assumed to have a unit weight of at least 120 lb/cu ft unless lightweight fill has been specified. The ϕ angle for the internal design of the reinforced backfill shall be 34° . The ϕ angle of the retained backfill zone shall be 30° for design. For the external design parameters, such as but not limited to, bearing capacity, sliding, overturning, eccentricity, and global stability, the actual soil strength parameters and the expected settlement of the existing soil under the reinforced backfill zone shall be obtained from the geotechnical report.

(b) Height of Wall

130 The wall limits shall be defined by the wall envelope shown on the plans. For internal stability design purposes, the design height of wall shall be as follows:

1. For a wall with a level surcharge, the design height of the wall, H, shall be measured from the theoretical top of the leveling pad to the top of the coping or to the gutter line of the traffic barrier. The top of the wall shall be the theoretical top of the face panels only where a coping or barrier is not used.
- 140 2. For a wall with a sloping surcharge, the design height of the wall, Z, shall be measured from the theoretical top of the leveling pad to a point above the top of the wall as calculated from the formula as follows:

$$Z = H + \frac{0.3H \tan \beta}{1 - 0.3 \tan \beta}$$

where:

β = surcharge slope angle as measured from the top of the coping, and

150 H = height of the wall from the theoretical top of the leveling pad to the top of the coping.

3. For an abutment face, the design height of the wall, H, shall be measured from the theoretical top of the leveling pad to the top of the roadway surface.

(c) Ground Reinforcement

The ground reinforcement length shall be the controlling length resulting from the internal or external design.

160

The ground reinforcement shall be the same length from the bottom to the top of each wall section regardless of the type of ground reinforcement used. Differing ground reinforcement elements shall be marked for ease of construction. This element may be used individually or in a prefabricated grouping.

The ground reinforcement for the MSE volume shall be sized using the lesser of the factored loads for each specific connection and each specific reinforcing element. The connection's applied factored load and effective pullout length shall be determined in accordance with the AASHTO LRFD Bridge Design Specifications.

170

For mats, grids, or strip steel, the minimum zinc coating thickness shall be 2 oz/sq ft. Such thickness shall be assumed to be 4 mils for purpose of calculation of reduced structural section.

The factored applied bearing pressures under the stabilized mass for each reinforcement unit's length shall be shown on the working drawings. It shall not exceed the maximum factored soil bearing resistance shown on the plans. Passive pressure in front of the wall mass shall be assumed to be zero for design purposes.

180

(d) Other Criteria

1. Traffic Load Considerations

Traffic load shall be considered as live load surcharge. The load factor of traffic load shall be 1.75 in accordance with AASHTO LRFD Bridge Design Specifications table 3.4.1-1.

2. Traffic Impact Considerations

Where traffic barriers are constructed above an MSE wall or reinforced backfill

zone, the MSE wall supporting traffic shall include computations showing that the
 190 Extreme Event II limit state due to traffic impact has been met.

Loadings for MSE wall design for the Extreme Event II limit state shall be in
 accordance with the following table:

Maximum Nominal Tension Rupture and Pullout Impact Loads		
Layer	Tension Impact Load	Pullout Impact Load
First Top Layer	2,300 lb/ft	1,300 lb/ft
Second Top Layer	600 lb/ft	600 lb/ft

The Extreme Event II design for the top two layers shall be separately prepared
 and compared with the routine internal stability design.

3. Tributary Area – Design Basis

200 For internal stability analysis of MSE walls, each layer of reinforcement is
 assigned a tributary area, A_{trib} in accordance with FHWA publication No. FHWA-
 NHI-10-025, Design and Construction of Mechanically Stabilized Earth Walls and
 Reinforced Soil Slopes Volume II and as follows:

$$A_{trib} = (w_p) (S_{vt})$$

where:

w_p = the wall system concrete panel width of the precast facing
 element, and

S_{vt} = the vertical tributary spacing of the reinforcement based on
 the location of the reinforcement above and below the level
 of the reinforcement under consideration.

210 For a wall system with steel reinforcement, within each tributary area, the factored
 reinforcement tensile resistance, T_r , and the factored pullout resistance, P_{rr} , shall be no
 less than the maximum factored tension load, T_{max} . If the calculated minimum number
 of strips is a decimal number, the minimum number required shall be rounded up to
 the next whole number.

731.04 Submittals

220 The Contractor shall submit working drawings in accordance with 105.02. The
 Contractor shall submit design calculations in accordance with 105.02 and the
 following additional requirements. In case of discrepancy, the requirements listed
 below supersede those listed in 105.02. Design calculations shall include each design
 case of the MSE wall analyzed. Calculations may be in either longhand or computer-
 printout format and shall follow a systematic and logical methodology. A summary
 sheet that shows design assumptions and their source, controlling parameters and load
 cases, and other pertinent input and output information shall be included with the

calculations package. Wall construction operations shall not begin until the Contractor receives written notice that the working drawings are approved.

- 230 (a) The working drawings shall include all details, dimensions, quantities and cross-sections necessary to construct the wall. They shall include, but shall not be limited to, the following:
1. Plan and elevation views along the front face of wall alignment, which shall include the following:
 - a. A final profile along the front face of the wall.
 - b. A plan layout of the front face of the wall showing all alignment points with stations and offsets.
 - 240 2. A plan view of the wall that indicates the offsets from the construction centerline to the face of the wall at all changes in horizontal alignment. A plan view and elevation view which detail the placing position and connection of all ground reinforcement units in areas where piling, utility, or other structures are near the wall.
 - 250 3. An elevation view along the front face of the wall with respect to the wall alignment, which shall include the following:
 - a. The elevation at the top of the wall at all horizontal and vertical break points at least every 50 ft along the face of the wall.
 - b. All steps in the leveling pad.
 - c. The designation as to the type of wall unit.
 - d. The length of ground reinforcement units.
 - e. A wall-elevation envelope that encompasses such envelope shown on the plans.
 - 260 4. All general notes required for constructing the wall.
- (b) Panel details shall show all dimensions necessary to construct the element, all reinforcement in the element, and the location of ground reinforcement connection devices embedded in the panels.
- (c) Details for construction of the wall around drainage facilities including outletting of internal drainage from the MSE volume.
- 270 (d) Details of the architectural treatment.

- (e) Details for diverting ground reinforcement around obstructions such as piles, catch basins, or utilities.
- (f) Details for the connections between the concrete panel and the ground reinforcement.
- (g) Determination of ϕ angle for reinforced materials and retained materials.
- (h) Detailed differential settlement calculations.
- (i) Detail standard summary sheet of the input values in the following format:

280

	Wall Detail	Design Value
Design	Life	
Reinforcement	Type	
	Configuration(Strip or grid)	
	Width, in.	
	E_c (Corroded Thickness), in.	
	Reinforcement Strength (F_y), ksi	
	Coverage Ratio (R_c)	
Reinforced Fill	Type	
	Unit Weight, pcf	
	Friction Angle, degrees	
Reinforcement Pullout Resistance	F^*	
	α	
Retained Fill	Type	
	Unit Weight, pcf	
	Friction Angle, degrees	
Foundation Soil	Type	
	Unit Weight, pcf	
	Friction Angle or cohesion ^A , degrees or lb/sq ft	
^A Use only one value, whichever is applicable.		

MATERIALS

731.05 Materials

290

Materials shall be in accordance with the following:

- Admixtures for Concrete 912.03
- Air Cooled Blast Furnace Slag 901.09

	Alignment Pins	910.07(d)
	B Borrow	211.02
	Coarse Aggregate, Class A or Higher, Size No. 8 or 91.....	904.03
	Components of MSE Retaining Walls.....	901.10
	Concrete, Class A or Class C.....	702
	Deformed and Smooth Steel WWR.....	910.01(b)5
300	Fine Aggregate, Size No. 23.....	904
	Fly Ash	901.02
	Geotextile for Use Under Riprap.....	918.02
	Joint Spacers and Joint Covering.....	901.10(b)
	Portland Cement	901.01(b)
	Rapid Setting Patch Materials	901.07
	Reinforcing Bars.....	910.01
	Steel Components.....	910.07
	Structure Backfill	211.03.1, 904.05
	Underdrains	718
310	Underdrains for MSE Walls	718.03
	Water	913.01

MSE wall backfill, and the horizontal bench in front of the wall, shall consist of structure backfill type 3 in the reinforced backfill zone in accordance with 211, except that nominal size aggregate No. 30 shall not be used. Structure backfill in the retained backfill zone shall be type 3 or B borrow as shown on the plans.

320 If coarse aggregate No. 5, No. 8, No. 9, or No. 11 is used in the reinforced backfill zone and the Contractor elects to use a different material in the retained backfill zone, geotextiles shall be installed at the interface between the reinforced and retained backfill zones. If the Contractor elects to use coarse aggregate No. 5, No. 8, No. 9, or No. 11 in both the reinforced and retained backfill zones, geotextiles shall be installed along the interface between the retained backfill zone and the adjacent soil. In addition, geotextiles shall be installed over the top of the No. 5, No. 8, No. 9, or No. 11 aggregate used in the reinforced or retained backfill zones.

330 Concrete for the leveling pad and coping shall be class A. Concrete used in openings to accommodate appurtenances behind, in front of, under, mounted upon, or passing through the wall shall be class C.

340 The Contractor shall supply the MSE retaining wall components listed above, including tie strips, fasteners, bearing pads, and all necessary incidentals, through a manufacturer listed on the QPL of Retaining Wall Systems.

CONSTRUCTION REQUIREMENTS

731.06 General Requirements

340 The wall manufacturer's representative shall provide technical instruction, guidance in preconstruction activities including the preconstruction conference, and on-site technical assistance to the Contractor during construction.

731.07 Foundation Preparation

Prior to wall construction, the foundation for the structure shall be graded for a width equal to or exceeding the length of the ground reinforcement or as shown on the plans. The foundation, if not in rock, shall then be compacted in accordance with 203. After the foundation has been compacted, the resulting grade of the foundation shall be 1 in. per foot sloped from the back of the foundation downward toward the leveling pad. The portion of the foundation beneath the leveling pad shall not be sloped. The foundation shall be proofrolled in accordance with 203.26. If unsuitable foundation material is encountered, it shall be removed and replaced with B borrow in accordance with 211.02 and compacted in accordance with 211.04.

After proofrolling has been completed and all unsuitable foundation material has been removed and replaced, compaction of the portion of the foundation beneath the reinforced backfill zone will be verified by dynamic cone penetrometer, DCP, testing in accordance with ITM 509.

One DCP measurement for every 500 sq ft within the reinforced backfill zone and five DCP measurements per end bent will be performed.

A DCP measurement is defined as the number of blows per 6 in. increment for a total penetration of 30 in., based on five sets of DCP readings at each location. A minimum of five blows of the DCP for each 6 in. increment is considered acceptable.

Unsuitable areas shall be removed, replaced, and compacted in accordance with 203 and 211. DCP verification of compaction beneath the reinforced backfill zone will not be required if the foundation is in an embankment section that is constructed in accordance with 203.

An unreinforced concrete leveling pad shall be provided at each foundation level as shown on the plans. The leveling pad shall be cured in accordance with 702.22 for a minimum of 12 h before placement of concrete face panels.

731.08 Retaining Wall Excavation

The Contractor shall notify the Engineer a minimum of 7 calendar days or other time as mutually agreed upon before beginning the excavation so that measurements can be taken of the undisturbed ground.

Prior to starting excavation operations at the wall site, clearing and grubbing shall be in accordance with 201.03. The area shall be cleared and grubbed to the excavation in accordance with the limits shown on the plans. All timber, stumps, or debris shall be disposed of in accordance with 201.03. Excavation shall include the construction and subsequent removal of all necessary bracing, shoring, sheeting, and cribbing. Excavation shall also include all pumping, bailing, and draining.

The excavation shall be shored or braced in accordance with State and local safety

requirements. Excavation and related work shall be performed such that no portion of the wall is endangered by subsequent operations.

- 390 Where excavation for the wall requires shoring, sheeting, or bracing, the method shall be shown on the working drawings. Excavation operations shall not begin until the Contractor receives notice that the working drawings are approved.

After the excavation for the wall has been performed, the Contractor shall notify the Engineer. The material beneath the leveling pad shall be compacted in accordance with 203. Concrete for the leveling pad shall not be placed until the Engineer has approved the depth of the excavation and the foundation material. The leveling pad shall be in accordance with 731.07.

- 400 When an internal drainage system is shown on the plans, the drain pipe shall be 6 in. underdrain pipe in accordance with 715.02(d). The remainder of the internal drainage system shall be in accordance with 718, longitudinal underdrains. Video inspection will not be required.

731.09 Wall Erection

- 410 Concrete face panels shall be handled by means of a lifting device set into the upper edge of each panel. Panels shall be placed in successive horizontal lifts in the sequence shown on the plans as backfill placement proceeds. As backfill material is placed behind the panels, the panels shall be maintained in vertical position by means of temporary wooden wedges placed in the joint at the junction of the two adjacent panels on the external side of the wall. External bracing will be required for the initial lift.

Panels shall be stored on blocking to minimize contact with the ground or being covered by standing water. Panels placed in contact with the ground or covered by standing water shall have face discoloration removed by means of a chemical wash.

- 420 Plumb, vertical tolerances, and horizontal alignment tolerances shall not exceed 3/4 in. as measured with a 10 ft straightedge. The maximum allowable offset in panel joints shall be 3/4 in. For a wall of over 10 ft height, the overall plumb from top to bottom of the wall shall not exceed 0.05 in./ft of wall height.

For aesthetic considerations and to make differential settlement unnoticeable, the panels shall be erected such that the horizontal site line is discontinuous at every other panel. This shall be accomplished by starting erection with the lower panel level of each wall by alternating full-height and half-height panels. Panels above the lowest level shall be of a uniform size, except as required to top out the wall, to be in accordance with the plan elevations.

- 430 The Contractor shall perform the necessary work to verify that the foundation is at the correct elevation, that the wall is constructed to the correct alignment, and that the work is in accordance with the specified tolerances. The checking of alignments

and tolerances shall include verifying that the plumb of the face panels is in accordance with 731.10 over the entire height of the wall. Alignment shall be checked at each layer of panels after the backfill behind the panels has been compacted, and the results shall be recorded.

440 The connections of the ground reinforcement to the panels shall be in two elevations for full height panels. The connections shall not be more than 30 in. vertically apart. To prevent out-of-plane rotation, full height face panels shall be connected to the ground reinforcement on at least three different points in two different planes. However, a preapproved system utilizing a horizontal stabilizing leg to prevent rotation shall require only ground reinforcement attachments in one plane. Partial size panels shall have three different connection points, but only one plane shall be attached to the ground reinforcement. Panels located at the top of the wall shall not be attached to the coping or traffic barrier.

450 Ground reinforcement shall be placed normal to the face of the wall, unless otherwise shown on the plans or as directed. Prior to placement of the ground reinforcement, backfill shall be compacted in accordance with 731.11.

731.10 Joint Spacers and Joint Covering for Wall Panels

Horizontal and vertical joint spacers shall be provided between adjacent face panels to prevent concrete-to-concrete contact and chipping if differential settlement occurs. Panels without an uninterrupted vertical joint shall have a minimum joint thickness of 3/4 in. Joint covering shall be provided and attached to the rear face of the panels. Geotextiles used to cover the joint behind the MSE wall facing panels shall be in accordance with 918.02(a), Type IB.

460 731.11 Backfill Placement

Backfill placement shall follow erection of each course of panels and ground reinforcement. All sheeting and bracing shall be removed as the backfilling progresses. Backfill shall be placed so as to avoid damage or disturbance to the wall materials or misalignment of the concrete face panels. All material for backfill shall be subject to approval and shall be free from lumps, wood, or other undesirable material. Wall materials that become damaged or disturbed during backfill placement shall be removed and replaced or corrected as directed. All misalignment or distortion of the concrete face panels due to placement of backfill outside the limits described herein shall be corrected as directed.

470

B borrow and structure backfill type 3 shall be compacted in accordance with 203.23 or 203.24. Compaction equipment shall be in accordance with 409.03(d). For all other structure backfill material used, compaction shall consist of four passes with a vibratory roller and one pass with the same roller in static mode. The vibratory roller shall be equipped with a variable amplitude system and a speed control device. It shall have a minimum vibration frequency of 1,000 vibrations per minute. A roller in accordance with 409.03(d)4 may be used. All displacement or rutting of the aggregate shall be repaired prior to placing subsequent material.

480 The maximum loose lift thickness shall not exceed 8 in. However, lifts within 3 ft of the wall shall not exceed 5 in. in loose thickness. This lift thickness shall be decreased if necessary, to obtain the specified density.

Compaction within 3 ft of the back face of the concrete face panels shall be achieved by means of a minimum of five passes with a lightweight mechanical tamper, roller, or an alternative vibratory system.

490 At the end of each day's operation, the last level of backfill shall be sloped away from the wall units. Surface runoff from adjacent areas shall not enter the wall construction site.

Subsurface drainage for the pavement section shall be underdrains for MSE walls and shall be as shown on the plans.

500 Cutting or altering of the basic structural section of ground reinforcement at the site will be prohibited, unless the cutting is preplanned and detailed on the approved working drawings. Cutting shall be considered only if adequate additional ground reinforcement is provided to produce the required strength shown in the approved calculations. If the ground reinforcement is shortened in the field, the cut ends shall be covered with a galvanized paint or coal tar to prevent corrosion of the metal.

731.12 Method of Measurement

The measurement of concrete face panels and wall erection will be based on the square foot of area contained within the neat line limits of the wall envelope shown on the plans and not that of the wall system supplier.

510 Concrete leveling pad will be measured by the linear foot. Common excavation will be measured by the cubic yard in accordance with 203.27(a) to the neat lines shown on the plans. Structure backfill and B borrow will be measured in accordance with 211.09. Unsuitable foundation materials, if found, will be measured in accordance with 211.09. Geotextile used in conjunction with MSE wall construction will not be measured for payment. Underdrains for MSE walls and components of the internal drainage system will be measured in accordance with 718.09. If unsuitable foundation material is encountered in the portion of the foundation beneath the leveling pad in a section constructed on original ground or in a cut section, the removal, replacement, and compaction of the new material will be measured in accordance with 203 and 211.

520 Precast or cast-in-place concrete coping will not be measured.

731.13 Basis of Payment

The accepted quantities of concrete face panels will be paid for at the contract unit price per square foot. Wall erection will be paid for at the contract unit price per square foot. Concrete leveling pad, complete and in place, will be paid for at the contract unit

price per linear foot for leveling pad. Common excavation will be paid for in accordance with 203.28. Structure backfill and B borrow will be paid for in accordance with 211.10, except that structure backfill used in the retained backfill zone will be paid for as B borrow. Unsuitable foundation materials, if found, will be paid for in accordance with 211.10. Underdrains for MSE walls and components of an internal drainage system will be paid for in accordance with 718.10.

Payment will be made under:

Pay Item	Pay Unit Symbol
Face Panels, Concrete.....	SFT
Leveling Pad, Concrete	LFT
Wall Erection.....	SFT

540 The cost of designing the wall system, services including the testing laboratory, certified testing personnel, and the testing and inspection of the concrete panels shall be included in the cost of face panels, concrete.

The cost of all wall materials including concrete face panels, ground reinforcement, tie strips, fasteners, joint materials, joint covering, precast or cast-in-place concrete coping, repair or replacement of face panels damaged or removed due to backfill placement, and incidentals shall be included in the cost of face panels, concrete.

550 The cost of all labor and materials required to prepare the wall foundation, place the ground reinforcement, and erect the concrete face panels shall be included in the cost of wall erection.

If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone in a section constructed on original ground or in a cut section, the cost of removal, replacement, and compaction of new material will be paid for in accordance with 203 and 211.

560 If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone that is constructed on an embankment section that is constructed under the same contract, the cost of removal, replacement, and compaction of new material will not be considered for payment.

The cost for geotextile used in MSE wall construction shall be included in the cost of the pay items in this section.

The cost of refilling and refinishing of the core holes from verification coring shall be included in the cost of face panels, concrete.

570 The cost of performing the laboratory tests by a qualified geotechnical consultant

for structure backfill or ACBF slag shall be included in the cost of the pay items in this section.

The cost of cutting, altering, or recoating the ground reinforcement at the site shall be included in the cost of wall erection.

SECTION 732 – MODULAR CONCRETE BLOCK RETAINING WALL

732.01 Description

This work shall consist of design as required, furnishing materials, and placement of modular block wall units in accordance with 105.03. The modular block wall unit shall have ground reinforcement if shown on the plans or required by the manufacturer.

732.02 General Design Requirements

10 The modular block wall shall consist of an aggregate leveling pad, concrete modular block wall units, and if specified, ground reinforcement elements. Ground reinforcement shall have sufficient strength, frictional resistance, and quantity as required by design, and shall be frictionally or mechanically connected to the facing units.

Modular block wall units shall be constructed as shown on the approved working drawings based on the requirements herein. The recommendations of the wall system supplier shall not override the minimum performance requirements shown herein.

20 The top of the modular block wall shall be designed to prevent the removal of the top course of blocks.

If the wall system provider needs additional information to complete the design, the Contractor shall be responsible for obtaining such information.

All appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, or other appurtenances shown on the plans shall be accounted for in the stability design of the wall.

30 The modular block wall design shall follow the general dimensions of the wall envelope shown on the plans. The working drawings shall show the location of the leveling pad at or below the theoretical leveling pad elevation shown on the plans. The top of the modular block wall unit shall be at or above the top of the wall elevation shown on the plans.

Cast-in-place concrete will not be an acceptable replacement for modular block wall unit areas indicated by the wall envelope.

Modular block wall units shall be designed to accommodate a differential settlement of 1 linear unit in 100. Where shown on the plans, slip joints to

- 40 accommodate excessive or differential settlement shall be included.

Only one typical modular block face finish shall be used per contract.

732.03 Design Criteria

The maximum modular block wall unit face area shall be 1 sq ft. The minimum depth of modular block wall units shall be 9 in.

- Modular block wall units shall be dry stacked in a running bond configuration. Vertically adjacent units shall be connected with an approved shear connection.
- 50 Approved shear connections consist of steel pins, concrete lips on the blocks, or other connections as approved by the Engineer.

The internal stability shall be the responsibility of the Contractor. The design for internal stability shall be in accordance with the AASHTO LRFD Bridge Design Specifications. The design by the Engineer will consider the external stability of the modular block wall mass including the applied bearing pressure, overturning, sliding, and stability of temporary construction slopes.

(a) Geotechnical Considerations

- 60 The theoretical failure plane within the soil mass shall be analyzed so that the soil-stabilizing component extends sufficiently beyond the failure plane to stabilize the material. External loads which affect the internal stability such as those applied through piling, bridge footings, traffic, crashwall, or slope surcharge, shall be accounted for in the design. The sizes of all structural elements shall be determined such that the design load stresses do not exceed the factored stresses shown in the AASHTO LRFD Bridge Design Specifications.

- 70 The internal friction angle, ϕ , for the internal design of the modular block wall backfill volume shall be assumed to be 34°. The ϕ of the backfill behind the modular block wall backfill volume shall be assumed to be 30°. The ϕ for the internal design of the foundation soils shall be assumed to be 30°. For the external design parameters, such as but not limited to, bearing capacity, sliding, overturning, eccentricity, and global stability, the actual soil strength parameters used shall be obtained from the geotechnical report.

- 80 The minimum embedment at the front face of the wall shall be in accordance with the AASHTO LRFD Bridge Design Specifications, section 11.10.2.2, and the minimum embedment depth to the top of the leveling pad shall be at least 3 ft unless founded on rock. A 4 ft horizontal bench in front of the wall shall be provided for slopes steeper than 4.0H:1.0V.

The factored applied bearing pressures under the stabilized mass for each reinforcement unit's length shall be indicated on the working drawings. It shall not exceed the maximum factored soil bearing resistance shown on the plans. Passive pressure in front of the wall mass shall be assumed to be zero for design purposes.

(b) Height of Wall for Internal Stability

The wall limits shall be defined by the wall envelope shown on the plans.

- 90
1. For a wall with a level surcharge, the design height of the wall, H, shall be measured from the theoretical top of the leveling pad to the top of the coping or to the gutter line of the traffic barrier. The top of the wall shall be the theoretical top of the face panels only where a coping or barrier is not used.
 2. For a wall with a sloping surcharge, the design height of the wall, Z, shall be measured from the theoretical top of the leveling pad to a point above the top of the wall as calculated from the formula as follows:
- 100

$$Z = H + \frac{0.3H \tan \beta}{1 - 0.3 \tan \beta}$$

where:

β = surcharge slope angle as measured from the top of the coping, and

H = height of the wall from the theoretical top of the leveling pad to the top of the coping.

3. For an abutment face, the design height of the wall, H, shall be measured from the theoretical top of the leveling pad to the top of the roadway surface.

(c) Ground Reinforcement

- 110 The ground reinforcement length shall be the controlling length resulting from the internal or external design or as shown on the plans. All of the ground reinforcement shall extend to and shall be connected to the modular block wall units.

The ground reinforcement shall be the same length from the bottom to the top of each wall section regardless of the type of ground reinforcement used. Differing ground reinforcement elements shall be marked for ease of construction. This element may be used individually or in a prefabricated grouping.

- 120 The ground reinforcement for modular block wall sections shall be sized using the lesser of the factored loads for each specific connection and each specific reinforcing element. The connection's applied factored load and effective pullout length shall be determined in accordance with the AASHTO LRFD Bridge Design Specifications.

For mats, grids, or strip steel, the minimum zinc coating thickness shall be 2 oz/sq ft. Such thickness shall be assumed to be 4 mils for purpose of calculation of reduced structural section.

130 Where the presence of opposing walls limits the length of ground reinforcing, the design shall account for the reduced length and internal and external stability calculations shall be made to check for adequate factor of safety.

732.04 Submittals

The Contractor shall submit working drawings and design calculations in accordance with 105.02. Wall construction operations shall not begin until the Contractor receives written notice that the working drawings are approved.

140 (a) The working drawings shall include all details, dimensions, quantities, cross-sections, and general notes necessary to construct the wall and shall include, but shall not be limited to the following:

- 150 1. Plan and elevation sheets showing views which detail the placing position and connection of all ground reinforcing elements in areas where piling, utility, or other structures are near the wall.
2. Plan sheets of the wall that indicate the offsets from the construction centerline to the face of the wall at all changes in horizontal alignment.
- 160 3. Elevation views of the wall which shall include the following:
 - a. elevations at the top of the wall at all horizontal and vertical break points at least every 50 ft along the face of the wall;
 - b. all steps in the aggregate leveling pad;
 - c. the designation as to the type of modular block wall unit;
 - d. the length of ground reinforcement units;
 - e. the distance along the face of the wall to where changes in length of the ground reinforcement occur;
 - 170 f. an indication of the original and final ground lines and maximum bearing pressures.

(b) All modular block wall units shall show all dimensions

necessary to construct the element and the location of soil reinforcing system devices embedded in the units.

- 180 (c) The details for construction of walls around drainage facilities and the outletting of internal drainage from the modular block wall volume.
- (d) All details of the architectural treatment.
- (e) The details for diverting ground reinforcement around obstructions such as piles, catch basins, landscape plantings where the bottom of the root ball extends below the top level of ground reinforcement, and other obstructions.
- 190 (f) The details for mechanical connection between the modular block wall unit and the ground reinforcement.

MATERIALS

732.05 Materials

Materials shall be in accordance with the following:

	Admixtures for Concrete*	912.03
	Air Cooled Blast Furnace Slag	901.09
	B Borrow	211.02
	Coarse Aggregate, Class A or Higher, Size No. 91	904.03
200	Coarse Aggregate, Class D or Higher, Size No. 8	904.03
	Concrete	702
	Fine Aggregate, Size No. 23	904.02
	Fly Ash	901.02
	Geogrid, Type III	918.05
	Geotextile	918.02
	Portland Cement	901.01(b)
	Structure Backfill	211.03.1
	Water	913.01
210	* Admixtures in accordance with ASTM C1372 may be used for the modular block if approved by the Engineer.	

Aggregate for the leveling pad shall be compacted aggregate No. 53 and shall be in accordance with applicable requirements of 303. Drainage fill used immediately behind the modular block wall, as shown on the plans, shall be coarse aggregate No. 8 crushed stone in accordance with 904.03.

220 Backfill material used in the modular block wall volume shall be structure backfill type 3, in accordance with 211. Where ground reinforcement is required, nominal size aggregate No. 30 shall not be used. The size of the structure backfill selected for use in the reinforced area of the modular block volume shall remain the same for that

wall's volume. If coarse aggregate No. 8 is used, and soil, B borrow, structural backfill, or coarse aggregate No. 53 are to be placed above the coarse aggregate No. 8, a single layer of geotextile shall be placed on top of the coarse aggregate No. 8 in accordance with 616.11.

230 If ground reinforcement is required, it shall be either steel in accordance with 910.07 or geogrid. The ground reinforcement supplied shall be the same type as that used with the pullout test and shall be consistent throughout the contract work. If the ground reinforcement is steel, structure backfill shall be in accordance with the backfill requirements for retaining wall systems contained in 211.03.1.

(a) Concrete Modular Block Wall Units

240 Concrete modular block retaining wall units shall be in accordance with ASTM C1372, except for the modifications below, and shall have a minimum compressive strength of 4,000 psi at 28 days. Modular block wall units utilizing type I or II cement will be considered acceptable for placement in the wall when 7-day strengths exceed 3,500 psi. The modular block wall unit's compressive strength shall be considered acceptable regardless of curing age when compressive test results indicate that the compressive strength is in accordance with the requirements stated above.

Retarding agents, accelerating agents, coloring pigments, or additives containing chloride shall not be used without approval.

1. Testing and Inspection

- a. Material properties shall be in accordance with the requirements of 732.05 in lieu of Section 4.
- 250 b. Table 1, "Strength and Absorption Requirements", shall be modified to require that the average compressive strength, when sampled and tested in accordance with ASTM C140, of a three CMU compressive strength sample shall be 4,000 psi with no individual unit less than 3,500 psi. Maximum absorption shall be 6%.
- 260 c. Freeze-thaw durability testing shall be completed in accordance with Section 8.3 by a laboratory qualified by the Department. Test results on all mix designs used in the manufacture of modular blocks shall have been completed in accordance with ASTM C1372. If a change to the mix design, such as proportioning or material source, is desired, the modified mix design shall be retested for freeze-thaw. A type A certification in accordance with 916 shall be provided for the blocks. The result of the freeze-thaw durability test shall be shown on the certification for the blocks.

- 270 d. Sampling and testing of the manufacturer's production
lots will be conducted by the Engineer in accordance
with ASTM C140. If the compressive strength test
result does not meet the requirements of 732.05(a), the
production lot units may not be used. The manufacturer
may resample the same production lot in the presence
of the Engineer for retesting. The Engineer will test the
additional samples in accordance with ASTM C140. If
the retested samples meet the requirements of
732.05(a), the production lot may be used. If the
280 retested samples do not meet the requirements of
732.05(a), all the units from the production lot may not
be used.

2. Rejection

Units shall be subject to rejection due to failure to be in accordance with the requirements specified above. In addition, the following defects may be sufficient cause for rejection.

- a. Defects which indicate imperfect molding.
- 290 b. Defects which indicate honeycombed or open texture
concrete.
- c. Defects in the physical characteristics of the concrete,
such as broken or chipped concrete, or color variations,
or dunnage marks on the front face due to excessive
form oil or other reasons.

300 The Engineer will determine whether spalled, honeycombed, chipped, or
otherwise defective concrete shall be repaired or be cause for rejection. Repair of
concrete, if allowed, shall be completed in a satisfactory manner. Repair to concrete
surfaces, which are to be exposed to view after completion of construction shall be
subject to approval.

3. Marking

The date of manufacture, the production lot number, and the place mark shall be clearly scribed on the rear face of each unit or on each shipping pallet.

4. Handling, Storage, and Shipping

310 All modular block wall units shall be handled, stored, and shipped so as to
eliminate the danger of chipping, cracks, fractures, and excessive bending stresses.

(b) Blank

CONSTRUCTION REQUIREMENTS

732.06 General Requirements

The wall supplier representative shall provide technical instruction, guidance in preconstruction activities including the preconstruction conference, and on-site technical assistance to the Contractor during construction.

320

732.07 Foundation Preparation

The foundation for the modular block wall shall be graded level for the width shown on the plans. Foundation preparation shall otherwise be in accordance with 731.07.

At each foundation level, an aggregate leveling pad shall be provided as shown on the plans.

732.08 Retaining Wall Excavation

330

Excavation shall be in accordance with 731.08.

732.09 Wall Erection

Modular block wall units shall be stored to minimize contact with the ground or being covered by standing water. Modular block wall units having face discoloration shall not be used.

The Contractor shall perform the necessary work to verify that the foundation is at the correct elevation, that the wall is constructed to the correct alignment, and that the work is in accordance with the specified tolerances.

340

Modular block wall units shall be placed in successive horizontal lifts in the sequence shown on the plans as backfill placement proceeds. As backfill material is placed behind the units, the units shall be maintained in vertical position. Horizontal alignment tolerances shall not exceed 3/4 in. when measured with a 10 ft straightedge. Alignment shall be checked at each layer of modular block wall units after the backfill behind the modular block wall units has been compacted, and the results shall be recorded. Checking of alignments and tolerances shall include verifying that the modular block wall units are plumb over the entire height of the wall.

350

Ground reinforcement shall be placed normal to the face of the wall, unless otherwise shown on the plans and shall be constructed in accordance with 214.04.

732.10 Backfill Placement

Backfill placement shall follow erection of each course of modular block wall units. All sheeting and bracing shall be removed as the backfilling progresses. Backfill shall be placed so as to avoid damage or disturbance to the wall materials or misalignment of the modular block wall units. All material for backfill shall be subject to approval and shall be free from large or frozen lumps, wood, or other undesirable material. Wall materials that become damaged or disturbed during backfill placement

360 shall be removed and replaced or corrected as directed. All misalignment or distortion of the modular block wall units due to placement of backfill outside the limits described herein shall be corrected as directed.

The work shall also include backfilling beyond the theoretical length of the ground reinforcement in accordance with the details shown on the plans, and the disposal of surplus of unsuitable excavated materials, as allowed.

Backfill placement and compaction shall otherwise be in accordance with 731.11.

370 **732.11 Method of Measurement**

The measurement of concrete modular block wall units with or without ground reinforcement and wall erection will be based on the square foot area contained within the neat line limits of the wall envelope shown on the plans and not that of the wall system supplier.

380 Common excavation will be measured by the cubic yard in accordance with 203.27(a) to the neat lines shown on the plans. Structure backfill and B borrow will be measured in accordance with 211.09. Unsuitable foundation materials, if found, will be measured in accordance with 211.09. Coarse aggregate No. 8 used as drainage fill will be measured by the cubic yard based on the theoretical volume to the neat lines as shown on the plans. Compacted aggregate No. 53, and ground reinforcement will not be measured. Geotextile materials will not be measured. Drainage of the backfill including piping and geotextile materials used in the drainage system will not be measured.

732.12 Stockpiled Modular Block Units

390 Partial payment may be made for block wall units stockpiled on the project site or at the Contractor's approved storage location. Partial payment will include the delivered cost of the units, as verified by invoices that include freight charges. The Contractor shall furnish the invoices. The partial payment will not exceed 75% of the contract unit price for modular block wall with or without ground reinforcement. Prior to authorizing partial payment, the Engineer will verify that the units are in accordance with 732.05(a).

732.13 Basis of Payment

400 The accepted quantities of modular block wall units with or without ground reinforcement will be paid for at the contract unit price per square foot. Erection of modular block wall units will be paid for by the square foot. Common excavation will be paid for in accordance with 203.28. Structure backfill and B borrow will be paid for in accordance with 211.10. Unsuitable foundation materials will be paid for in accordance with 211.10. The accepted quantities of coarse aggregate No. 8 used as drainage fill will be paid for as aggregate for drainage fill at the contract unit price per cubic yard, complete in place.

Payment will be made under:

733.01

	Pay Item	Pay Unit Symbol
	Aggregate for Drainage Fill.....	CYS
410	Modular Block Wall Erection.....	SFT
	Modular Block Wall with Ground Reinforcement	SFT
	Modular Block Wall.....	SFT

The cost of designing the wall system, services including the testing laboratory, certified testing personnel, and the testing and inspection of modular block wall units shall be included in the cost of the pay items of this section.

420 The cost of materials, ground reinforcement if required, fasteners, cutting or altering the ground reinforcement at the site, repair or replacement of units damaged or removed due to backfill placement, compressive-strength retesting if required, retesting or replacing failed block units, and incidentals shall be included in the cost of the pay items of this section.

The cost of all labor and materials required for preparing the wall foundation, compacted aggregate No. 53, coarse aggregate No. 8 placed outside the neat lines as shown on the plans, replacement materials damaged during backfill placement if required, and erecting the modular block units shall be included in the cost of wall erection.

430 The cost of all labor and materials for geotextiles shall be included in the cost of the pay items of this section.

SECTION 733 – STEEL BIN-TYPE RETAINING WALL

733.01 Description

This work shall consist of furnishing materials and placement of steel bin-type retaining walls in accordance with 105.03.

MATERIALS

733.02 Materials

10 Materials shall be in accordance with the following:

Fasteners.....	910.02(g)1
Steel Bin-Type Retaining Wall Units.....	910.08
Structure Backfill	211.03.1, 904.05

Backfill material used in the bin-wall sections shall be type 3 structure backfill in accordance with 211.

CONSTRUCTION REQUIREMENTS

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733.03 General

All units shall be fabricated such that units of the same nominal size shall be fully interchangeable. Drilling, punching, or drifting to correct defects in manufacture will not be allowed. Each unit with unauthorized holes shall be replaced. The ends of all stringers and spacers shall be bolted to corner columns by means of connecting channels.

30

The proper curvature for the face of a wall constructed on a curve shall be obtained through the use of shorter stringers in the front or rear panels of retaining walls as shown on the plans or as otherwise directed.

The wall height and depth may be varied. Two or more retaining wall designs may be incorporated in the same wall by the use of standard split columns to make the connection on the step back.

733.04 Foundation Preparation

40

The foundation for the structure shall be graded level or as shown on the plans. Prior to wall construction, the foundation, if not in rock, shall be compacted in accordance with 203. The base of the wall excavation shall be proofrolled with a vibratory roller weighing not less than 10 t, or with other approved compacting equipment. If unsuitable foundation material is encountered, it shall be removed and replaced with B borrow in accordance with 211.02 and compacted in accordance with 211.04.

733.05 Retaining Wall Excavation

Retaining wall excavation shall be in accordance with 731.08.

733.06 Backfill Placement

50

The fill material for the interior of the bin and behind the wall shall be structure backfill placed in layers not to exceed 6 in. in thickness. Backfilling behind the wall shall progress with the filling of the bins and shall not be carried ahead of the interior bins. Existing slopes, which are shaped so as to cause a wedge action in the backfill, shall be benched before backfilling.

60

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill material shall have placement moisture content between optimum and -3 percentage points of the optimum moisture content. Backfill material with placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable through the entire lift.

Compaction within 3 ft of the back face of the bins shall be achieved by means of a minimum of three passes with a lightweight mechanical tamper, roller, or an alternative vibratory system.

Backfill placement shall otherwise be in accordance with 731.11.

733.07 Method of Measurement

70 The measurement of steel bin walls will be based on the square foot of area contained within the neat line limits of the wall envelope shown on the plans and not that of the wall system supplier. Common excavation will be measured in accordance with 203.27. Structure backfill will be measured in accordance with 211.09. Unsuitable foundation materials, if found, will be measured in accordance with 211.09.

733.08 Basis of Payment

80 This work will be paid for at the contract unit price per square foot for binwall, steel. Common excavation will be paid for in accordance with 203.28. Structure backfill will be paid for in accordance with 211.10. Unsuitable foundation materials will be paid for in accordance with 211.10.

Payment will be made under:

Pay Item	Pay Unit Symbol
Binwall, Steel	SFT

90 The cost of furnishing, handling, and installing the steel units, including all materials, bolts, and appurtenances; necessary excavation and structure backfill testing; and all labor, equipment, all necessary incidentals, or replacement of steel units with unauthorized holes, or those damaged and replaced during construction shall be included in the cost of the pay item.

SECTION 734 – PERMANENT EARTH RETENTION SYSTEM FOR CUT-WALL APPLICATION

734.01 Description

10 This work shall consist of designing and constructing a permanent earth retention system utilizing a cut-wall application in accordance with 105.03. Cut-wall applications refer to a class of earth retention systems in which construction of the system is performed from the top of the wall to the base utilizing either externally or internally stabilized elements or a combination of both. Geotechnical Engineering Circular No. 2 – Earth Retaining Systems, Report No. FHWA-SA-96-038 provides further discussion of cut-wall applications.

734.02 Contractor Design Requirements

The permanent earth retention system utilizing a cut-wall application shall be designed by a professional engineer having experience in the design of at least three completed permanent earth retention systems involving cut-wall applications. The

permanent earth retention system shall be designed using the procedure described in the AASHTO LRFD Bridge Design Specifications, or in the FHWA-IF-03-017, Soil Nail Walls. The required partial safety factors or allowable strength factors for Service Load Design, SLD, and load and resistance factors for LRFD, shall be in accordance with the above-referenced publications. The minimum factor of safety for SLD global stability or minimum required LRFD global stability shall be in accordance with the above-referenced publications, unless specified otherwise. Structural design of an individual wall element not addressed in the FHWA report shall be designed in accordance with the AASHTO specifications. Geometric data and design criteria including shear strength parameters and unit weights for soil and rock, corrosion protection, internal and external drainage requirements, horizontal and vertical alignment of the wall, and all known site and construction constraints, wall facing, and facing architectural requirements shall be as shown on the plans.

30

(a) Design Calculations

Design calculations shall include, but not be limited to, the following:

1. A written summary report which describes the overall design.
2. Applicable code requirements and design references.
3. Design cross section geometry including soil and rock strata and location, magnitude and direction of design slope, external surcharge loads, and piezometric levels with the most critical slip surface shown along with the minimum calculated SLD factor of safety for global stability or minimum required LRFD global stability soil resistance to load ratio.
4. Design criteria including the undrained and drained shear strength parameters and unit weights for soil and rock.
5. Unit bond resistances for externally and internally stabilized elements.
6. Partial safety factors and strength factors for SLD or load and resistance factors for LRFD used in the design on the pullout resistance, surcharges, unit weights of soil and rock, and all materials proposed for the system including, but not limited to shotcrete, steel and concrete.
7. Seismic design acceleration coefficient.
8. Design calculation sheets with the contract number, designation number, wall location and designation, date of

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preparation, initials of designer and checker, page number shown on each page, and an index page.

9. Design notes including an explanation of all symbols and computer programs used in the design.

70

10. Structural design calculations for all temporary and permanent facing and facing connections, including consideration of flexural and shear strength of the facing and all externally stabilized elements, tensile strength of all headed studs, upper cantilever, minimum reinforcement ratio, mechanical splices, welds, built-up sections, and cover and splice requirements.

(b) Working Drawings

The limits of the wall and ground survey data shall be verified before preparing the drawings. Working drawings shall include all details, dimensions, quantities, ground profiles, cross sections necessary to construct the wall, and the following:

80

1. A plan view of the wall identifying the following:

a. A reference centerline and elevation datum.

b. The offset from the construction centerline to the finished face of the wall at its base and at all changes in horizontal alignment.

90

c. Beginning and ending stations of the wall.

d. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures, or other potential interferences.

e. The centerline of each drainage structure or drainage pipe behind, passing through, or passing under the wall.

100

f. Limit of externally and internally stabilized elements.

g. Subsurface exploratory locations with appropriate reference base lines to fix the locations of the explorations relative to the wall.

2. An elevation view of the wall identifying the following:

a. The elevations at the top of the wall, at all horizontal

- 110 and vertical break points, and at least every 30 ft along the wall.
- b. Elevations at the base and top of the wall for casting the facing.
 - c. Beginning and ending stations of the wall.
 - d. The distance along the face of the wall to all steps in the base of the wall.
- 120
- e. All externally and internally stabilized elements as well as vertical and horizontal spacing.
 - f. The location of drainage elements and permanent facing expansion and contraction joints along the wall length.
 - g. Existing and finished grade profiles, both behind and in front of the wall.
- 130
- 3. Design parameters and applicable codes.
 - 4. General notes for constructing the wall including sequencing and all special construction requirements, such as dewatering, if required.
 - 5. Horizontal and vertical curve data affecting the wall and control points.
- 140
- 6. Match lines or other details to relate the wall stationing to centerline stationing.
 - 7. A listing of the summary of quantities on the elevation drawing of each wall showing estimated square feet of exposed wall face areas and other pay items.
 - 8. Typical sections including staged excavation elevations, wall elements, and corrosion protection details.
- 150
- 9. Typical details of production and test anchors or nails defining the orientation and dimensional relationships of the unbonded and bonded lengths.
 - 10. Details, dimensions, and schedules for all externally and internally stabilized elements, reinforcing bars, steel

welded wire reinforcement, bearing plates, headed studs, and attachment devices for pneumatically placed mortar, cast-in-place, or prefabricated facings.

- 160 11. Details and dimensions for appurtenances such as barriers, coping, drainage gutters, and fences.
- 12. Details for constructing the wall around drainage facilities.
- 13. Details for terminating the wall and adjacent slope construction.
- 14. Facing finishes, color and architectural treatment requirements for permanent facing elements.

170 **(c) Submittals**

The Contractor shall submit working drawings and design calculations in accordance with 105.02.

At least 30 calendar days before the start of the wall construction, the Contractor shall submit a quality control plan, QCP, which will be subject to approval. The QCP shall include, but not be limited to, personnel qualifications, wall construction procedures and sequencing, a verification testing program, and a performance monitoring program. Work shall not begin until written notice has been received from the Engineer that the QCP has been accepted.

180

1. Personnel Qualifications

The field superintendent or field foreman shall have supervised the construction of a minimum of three completed walls of the same type as that submitted by the Contractor.

2. Verification Testing Program

The program shall include a verification testing program of all production and test anchors and nails. The program shall identify the test locations and the type of test, such as proof, performance, or pullout, testing procedures, acceptance criteria, and load and measuring devices to be used.

190

MATERIALS

734.03 Materials

Materials shall be in accordance with the following:

	Geotextile Under Riprap.....	918.02
	Pneumatically Placed Mortar.....	708
	Reinforcing Bars.....	703
200	Steel H Piles	915.02

Steel Pipe Piles	915.01
Steel Sheet Piling.....	910.21
Structural Concrete.....	702
Structural Steel	910.02
Structure Backfill	904.05
Uncoated Seven-Wire Strand	910.01(b)7
WWR, Smooth and Deformed.....	910.01

Drainage pipe shall be underdrain pipe in accordance with 715.02(d).

210

CONSTRUCTION REQUIREMENTS

734.04 General Requirements

Excavation and embankment shall be in accordance with 203.

Welding shall be in accordance with 711.32.

734.05 Performance Monitoring During Construction

220 The program shall identify points of monitoring interest, in accordance with Geotechnical Engineering Circular No. 2 – Earth Retaining Systems, Report No. FHWA-SA-96-038, and the frequency of monitoring during and following construction of the wall. The program shall also include a baseline survey for points of monitoring interest.

230 The Contractor shall notify the Engineer if indications of ground movement in the vicinity of the wall, increased size of old cracks, or separation of joints in structures, foundations, streets, or paved or unpaved surfaces are observed. The Contractor shall monitor the performance of the wall and movements of buildings, roads, or other facilities within a distance of three times the excavation depth for the wall. If the Engineer determines that the movements exceed those anticipated for construction, the Contractor shall take corrective actions necessary to arrest the movement, or make repairs.

Within 30 days after completion of the work, as-built drawings shall be submitted to the Engineer. Revised design calculations, signed by the professional engineer, shall be provided for all design changes made during the construction of the permanent earth retention system.

734.06 Performance Monitoring After Construction

240 Performance monitoring by the Contractor shall be done during construction and for a period of one year from the date the Contractor has been relieved of further maintenance, as set out in the final acceptance letter from the Department. The Contractor shall post a warranty bond for the performance monitoring that occurs after the Contractor has been relieved of further maintenance. The Contractor shall make evaluations of the test and monitoring data and performance of the wall at the frequency defined in the approved performance monitoring program. The Contractor,

734.07

if necessary during the monitoring period or as directed, shall correct deficiencies in the capacities of individual elements or take other corrective measures which may be required to prevent damage or excessive movement of the wall and adjacent facilities.

250 The Contractor shall submit all test and monitoring data to the Engineer on a weekly basis or as otherwise directed.

734.07 Method of Measurement

Cut wall will be measured by the square foot of exposed face area of wall above finished grade as shown on the plans.

734.08 Basis of Payment

The accepted quantities of cut wall will be paid for at the contract unit price per square foot for cut wall.

260

Payment will be made under:

Pay Item	Pay Unit Symbol
Cut-Wall, No. ____	SFT

270 The costs of all professional services, labor, excavation, structure backfill, equipment, materials, tests, QCP, and incidentals necessary to design, construct, and monitor the wall including all drainage required by the wall design and all temporary construction facing or permanent facing, if applicable, and correction required by the wall design of deficiencies which may be required to prevent damage or excessive movement of the wall shall be included in the cost of this work. No additional payment will be made for the costs of providing and taking corrective actions.

SECTION 735 – TEMPORARY WIRE-FACED MECHANICALLY STABILIZED EARTH RETAINING WALLS

735.01 Description

This work shall consist of the design, furnishing materials, and placement of temporary wire-faced mechanically stabilized earth retaining walls in accordance with 105.03.

735.02 General Design Requirements

10 A temporary wire-faced MSE wall shall consist of wire-facing elements, ground reinforcement elements mechanically connected to the wire-facing elements, and a drainage system if required. Concrete face panels will be required for the lower course of the wall if shown on the plans. Ground reinforcement shall have sufficient strength, frictional resistance, and quantity as required by the design.

A temporary wire-faced MSE wall shall be constructed in accordance with the approved plans and panels working drawings based on the requirements herein. The

recommendations of the wall system supplier shall meet or exceed the minimum performance requirements included herein.

20

If appurtenances interfere with connecting ground reinforcement to face panels, back up panels shall be provided.

The top of the wire-facing elements shall be at or above the top of the wall envelope shown on the plans.

The maximum dimensions for wire-face panels shall be limited to 2 ft vertical and 8 ft horizontal.

30 **735.03 Design Criteria**

The design life of the wall shall be 36 months. The minimum allowable yield stress for reinforcement shall be 65 ksi. The maximum allowable stress in the reduced section after sacrificial steel has been removed at the end of the design life shall be $0.55F_y$ for WWR. The maximum allowable stress may be increased to $0.77F_y$ if the design life does not exceed 36 months. The reduced section of ground reinforcement shall be limited to the allowable stress shown above at the end of the 36-month design life.

40 The connections of the ground-reinforcing steel to the wire-facing shall not be more than 24 in. apart vertically.

The design shall otherwise be in accordance with 731.02 and 731.03.

735.04 Submittals

50 The Contractor shall submit working drawings in accordance with 105.02. The Contractor shall submit design calculations in accordance with 105.02 and the following additional requirements. In case of discrepancy, the requirements listed below supersede those listed in 105.02. Design calculations shall show the complete design of the temporary wire-faced wall. Calculations may be in either longhand or computer-printout format and shall follow a systematic and logical methodology. A summary sheet that shows design assumptions and their source, controlling parameters and load cases, and other pertinent input and output information shall be attached to the calculations package. Wall construction operations shall not begin until the Contractor receives written notice that the working drawings are approved.

60

- (a) The working drawings shall include all details, dimensions, quantities and cross sections necessary to construct the wall. They shall include, but shall not be limited to, that listed in 731.04(a) and (b).
- (b) Wire-facing details shall show all dimensions necessary to construct the element, all wire in the element, and the location of ground-reinforcing-system devices attached to the wire-facing.

MATERIALS

735.05 Materials

Materials shall be in accordance with the following:

70	Admixtures for Use in Concrete	912.03
	Air-Cooled Blast-Furnace Slag	901.09
	Alignment Pins	910.07(d)
	B Borrow	211.02
	Coarse Aggregate, Class A or Higher, Size No. 8 or 91.....	904.03
	Components of MSE Retaining Walls.....	901.10
	Concrete, Class A	702
	Fine Aggregate, Size No. 23.....	904.02
	Fly Ash	901.02
80	Geotextile for Underdrains	918.02
	Joint Spacers and Joint Covering.....	901.10(b)
	PCC Components	901.10
	Portland Cement	901.01(b)
	Rapid Setting Patch Materials	901.07
	Reinforcing Bars.....	910.01
	Steel Components.....	910.07
	Steel WWR, Smooth	910.01(b)5
	Water	913.01
90	Backfill material used in the temporary wire-faced MSE wall volume shall be type 3 structure backfill in accordance with 211 with the exception that nominal size aggregate No. 30 shall not be used.	

All retention fabric or filter cloth shall be geotextile for use with underdrains.

The Contractor shall supply the MSE retaining wall components described above, including wire-facing, concrete face panels, retaining strips or mesh, tie strips, fasteners, earth-retention materials, drainage system components, and all necessary incidentals, through a manufacturer shown on the QPL of Retaining Wall Systems.

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CONSTRUCTION REQUIREMENTS

735.06 General Requirements

Foundation preparation shall be in accordance with 731.07. Retaining-wall excavation shall be in accordance with 731.08.

735.07 Wall Erection

The wall system components shall be constructed in accordance with the wall system supplier's recommendations and construction manual.

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The Contractor shall perform the necessary work to verify that the foundation is at the correct elevation, that the wall is constructed to the correct alignment, and that the work is in accordance with the specified tolerances.

Ground reinforcement shall be placed normal to the face of the wall, unless otherwise shown on the plans or as directed. Prior to placement of the ground reinforcement, backfill shall be placed and compacted in accordance with 731.11.

120 Where shown on the plans, backing mats shall be placed behind the wire-facing.

Where shown on the plans, galvanized screens with openings not exceeding 1/2 in. shall be placed behind the wire-facing to retain the earth.

735.08 Method of Measurement

The measurement of temporary wire-facing and temporary wall erection will be based on the square foot of area contained within the neat line limits of the wall envelope shown on the plans and not that of the wall system supplier.

130 Common excavation will be measured in accordance with 203.27. Structure backfill and B borrow will be measured in accordance with 211.09.

Unsuitable foundation materials, if found, will be measured in accordance with 211.09. If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone in a section constructed on original ground or in a cut section, the removal, replacement, and compaction of the new material will be measured in accordance with 203.27 and 211.09.

140 Geotextile materials will not be measured. Drainage of the backfill including piping, aggregates, and incidentals will not be measured.

735.09 Basis of Payment

The accepted quantities of temporary wire-facing and temporary wall erection will be paid for at the contract unit price per square foot.

Common excavation will be paid for in accordance with 203.28. Structure backfill and B borrow will be paid for in accordance with 211.10. Unsuitable foundation materials will be paid for in accordance with 211.10.

Payment will be made under:

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Pay Item	Pay Unit Symbol
Temporary Wall Erection.....	SFT
Temporary Wire-Facing.....	SFT

The cost of all MSE retaining wall components including wire-facing elements,

737.01

concrete face panels, ground reinforcing, tie strips, fasteners, soil retention materials, repair or replacement of wire-facing elements damaged or removed due to backfill placement, and incidentals shall be included in the cost of temporary wire-facing.

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If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone in a section constructed on original ground or in a cut section, the cost of removal, replacement, and compaction of new material will be paid for in accordance with 203.28 and 211.10.

If unsuitable foundation material is encountered in the portion of the foundation beneath the reinforced backfill zone that is constructed on an embankment section that is constructed under the same contract, the cost of removal, replacement, and compaction of new material will not be considered for payment.

170

The cost of geotextiles shall be included in the cost of the pay items in this section.

The cost of all labor and materials required to prepare the wall foundation, to place the ground reinforcement, and to erect the concrete face panels shall be included in the cost of temporary wall erection.

The cost of labor and materials required to provide for the drainage of the backfill including piping, aggregates, or geotextile materials shall be included in the cost of temporary wire-facing.

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The cost of performing the laboratory tests by a qualified geotechnical consultant for structure backfill or ACBF slag shall be included in the cost of the pay items in this section.

The cost of all labor and materials for geotextile materials used shall be included in the cost of the pay items in this section.

The cost of cutting, altering, and recoating of the ground reinforcement at the site shall be included in the cost of temporary wall erection.

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SECTION 736 – BLANK

SECTION 737 – WELDED WIRE REINFORCEMENT, WWR

737.01 Description

This work shall consist of furnishing and placing WWR as an alternative to furnishing and placing reinforcing bars in concrete superstructures, reinforced concrete bridge approaches, crashwalls, and cast-in-place retaining walls in accordance with 105.03.

MATERIALS

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737.02 Materials

Materials shall be in accordance with the following:

Deformed and Smooth Steel WWR..... 910.01(b)5

CONSTRUCTION REQUIREMENTS

737.03 Design Requirements

20 The nominal yield strength shall be the minimum as specified for the grade of steel selected, except that the maximum nominal yield strength used for design purposes shall not exceed 75 ksi. The nominal yield strength shall not be less than 65 ksi for smooth WWR and 70 ksi for deformed WWR. The area of steel in the longitudinal and transverse directions may be reduced in proportion to the nominal yield strength specified for the grade of steel up to the maximum allowable. For purposes of crack control, spacing of reinforcement in the WWR sheet shall not be greater than 8 in. in either direction.

30 If the plans show uncoated reinforcing bars, the Contractor shall use uncoated WWR. If the plans show epoxy coated reinforcing bars, the Contractor may elect to supply either epoxy coated or galvanized WWR.

737.04 Working Drawings

Working drawings shall be submitted for approval in accordance with 105.02. Fabrication shall not begin until the working drawings are approved.

737.05 Fabrication

40 WWR shall be cut and bent to the shapes shown on the working drawings. All WWR shall be cold bent, unless otherwise approved by the Engineer. Hook dimensions and diameters of bends shall be as shown on the working drawings. WWR partially embedded in concrete shall not be field bent, except as shown on the approved working drawings or allowed by the Engineer. Coated WWR shall not be field cut, unless allowed by the Engineer. If allowed, field cutting of coated WWR shall be performed using hydraulic-powered or friction cutting tools to minimize coating damage and field touch-up. Field cut coated WWR shall be repaired with compatible patching material that is deemed suitable for repairs in the field. Flame cutting of coated WWR will not be allowed.

737.06 Handling and Storage

50 All WWR shall be handled and stored by methods that will not damage the coating or WWR, and in accordance with the applicable requirements of 703.04. Bundles shall not be dropped or dragged. WWR shall be transported and stored so as to not damage the applied coating. The coated WWR shall not be exposed to fire or flame.

Prior to placement of concrete, all WWR shall be free from dirt, loose rust or

scale, mortar, paint, grease, oil, or other materials that can reduce bond. Coated WWR shall be free from cracks or laminations. For uncoated WWR, bonded rust, surface irregularities, or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area, and tensile properties of the WWR specimen satisfy the physical requirements for the size and grade of WWR specified.

60

737.07 Placing and Securing

WWR shall be placed as shown on the approved working drawings and held in position during the placing and finishing of concrete. WWR shall be lapped and tied around the perimeter of each sheet in order to maintain proper positioning of the WWR. Lap splices shall have a minimum of two ties per spliced length. Unless otherwise shown on the approved working drawings, WWR sheets shall overlap a minimum of 8 in. in each direction to make a splice. Plastic or wire bar supports, such as chairs and bolsters, shall be in accordance with the requirements herein and industry practice as described in the Wire Reinforcing Institute, WRI, WWR-500, Manual of Standard Practice. All metal bolsters or chairs which bear against the forms for exposed surfaces shall be equipped with snug fitting, high density, polyethylene tips which provide 1/2 in. minimum clearance between the metal and an exposed surface. The spacing of slab bolster rows and high chair rows for deck slabs shall be as described in the WRI WWR-500, Manual of Standard Practice unless otherwise directed. For epoxy-coated WWR, tie wires, chair and bar supports, and metal clips shall be epoxy, plastic, or nylon coated. For galvanized WWR, tie wires, chair and bar supports, and metal clips shall be plastic coated or hot dipped galvanized after fabrication in accordance with ASTM A1060. Tie-down bars shall be placed as shown on the approved working drawings. With the exception of tie-down bars, tack welding will not be allowed, unless shown on the approved working drawings.

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WWR shall be supported in its specified position by use of plastic or wire bar supports, supplementary tie-down bars, side-form spacers, or other approved devices. Such devices shall be placed at intervals so as to maintain the WWR cover as shown on the approved working drawings. Platforms for the support of workers and equipment during concrete placement shall be supported directly by the forms and shall not alter the positioning of the WWR.

737.08 Repair of Coated WWR

All damaged, cut, or otherwise compromised areas of the coating shall be repaired.

90

(a) Epoxy-Coated

In addition to the requirements of ASTM A884, all visible damage, including but not limited to scratches, nicks and cracks to the epoxy coating caused during shipment, storage, or placement shall be repaired on the project site with approved patching material. Ends of WWR that have been sheared, sawed, or cut by other means shall be coated with approved patching material. Areas on the WWR sheets and tie-down bars damaged due to welding shall be repaired with approved patching material. Patching of damaged areas shall be performed in accordance with the patching material

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manufacturer's recommendations. If the damaged surface area exceeds 10% of the total WWR sheet surface area, the sheet shall be removed and replaced with an acceptable sheet. All patching material shall be fully cured prior to placing concrete. Patching material shall be compatible with the epoxy coating, deemed inert in concrete, and deemed suitable for repairs in the field. Patching material shall be identified on the container as satisfying ASTM A775, Annex A2, or a type C certification in accordance with 916 shall be provided for the patching materials, certifying that the material satisfies or exceeds the requirements of Annex A2.

110 **(b) Galvanized**

All visible damage, including but not limited to scratches, nicks and cracks to the galvanized coating caused during shipment, storage, or placement shall be repaired on the project site in accordance with ASTM A1060. Ends of WWR that have been sheared, sawed, or cut by other means shall be coated. Areas on the WWR sheets and tie-down bars damaged due to welding shall be repaired and recoated. Field coating of damaged areas shall be performed in accordance with the coating manufacturer's recommendations.

120 Galvanized coating shall be in accordance with ASTM A1060. It shall be applied to achieve a dry film equal to or exceeding that designated in ASTM A1060. All touchup coating material shall be fully cured prior to placing concrete.

737.09 Final Inspection

After being placed, WWR shall be subject to approval of the Engineer before beginning concrete placement. Concrete placed prior to approval of the WWR will be subject to rejection and removal.

737.10 Method of Measurement

This work will not be measured for payment.

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737.11 Basis of Payment

The accepted quantity for payment will be the quantity for reinforcing bars or epoxy-coated reinforcing bars shown on the plans. This work will be paid for as reinforcing bars or epoxy-coated reinforcing bars in accordance with 703.08, regardless of whether the WWR design results in a reinforcement weight that is different from that shown on the plans.

If galvanized WWR is supplied, it will be paid for as epoxy-coated reinforcing bars.

140

The cost of tie wires, chair and bar supports, metal clips, spacers, or other mechanical means used for fastening or holding WWR in place, and laps shall be included in the cost of WWR.

The cost of epoxy-coating materials or galvanizing materials and repair of damaged or removed coating materials on WWR and on tie wires, chair and bar

737.11

supports, metal clips, spacers, or other mechanical means used for fastening or holding WWR in place, and laps shall be included in the cost of WWR.

- 150 If reinforcing bars or epoxy-coated reinforcing bars are not paid for separately, but instead included in the cost of a pay item, and WWR is substituted for reinforcing bars or epoxy-coated reinforcing bars, the WWR will not be paid separately, but shall be included in the cost of the pay item.

DIVISION 800 – TRAFFIC CONTROL DEVICES AND LIGHTING

SECTION 801 – TRAFFIC CONTROLS FOR CONSTRUCTION AND MAINTENANCE OPERATIONS

801.01 Description

This work shall consist of furnishing, placing, and maintaining signs, barricades, temporary pavement markings, and other traffic control devices at construction and maintenance operations in accordance with 105.03.

MATERIALS

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801.02 Materials

Materials shall be in accordance with the following:

	Automated Flagger Assistance Devices	923.08
	Coarse Aggregate, Class D or Higher, Size No. 73	904.03
	Construction Warning Lights	923.03
	Delineator Posts.....	910.15
	Delineators.....	926.02
	Field Paint.....	909.04
20	Flashing Arrow Sign.....	923.04
	Flexible Delineator Posts.....	926.01
	Pavement Marking Materials.....	921
	Portable Changeable Message Sign.....	923.05
	Steel Posts	910.14
	Temporary Barrier Delineator	926.02(d)
	Temporary Highway Illumination Materials	807
	Temporary Panel Signs.....	919.01
	Temporary Pavement Marking Tape	923.01
	Temporary Raised Pavement Markers.....	923.02
30	Traffic Signal Materials and Equipment.....	922
	Traffic Signs	802
	Tubular Marker.....	923.07
	Wood Sign Posts	911.02(e)
	Worksite Speed Limit Sign Assembly.....	923.06

Non-ground mounted temporary traffic sign backing material and supports shall both be certified to meet NCHRP 350 crash test standards and approved for use by the FHWA. A copy of the FHWA acceptance letter shall be provided to the Engineer upon request. Roll-up materials will not be allowed except as specified in 801.16.

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The reflective sheeting type used for construction signs, channelizing and delineation devices such as drums, tubular markers, vertical panels, and 42 in. cones, shall be the same for the entire project and shall be in accordance with 919.01(b)1.

The background for all construction signs shall be fluorescent orange reflective sheeting.

Steel sign posts need not be galvanized.

50 Wood posts for temporary panel signs shall be dense southern yellow pine or design calculations shall be provided to the Engineer identifying the type of wood and verifying the location and size of the holes to be drilled through the posts to provide break-away capability.

All temporary traffic control devices which will become the property of the Department shall be a new product at the time of final acceptance.

60 The basis for use for traffic paint; durable pavement marking materials; temporary marking tape type II; glass beads; barrels; barricades; construction warning lights; steel posts; temporary panel signs; traffic signs, except non-ground mounted signs; tubular markers; and wood sign post used for temporary traffic control will be visual inspection.

The connecting bolt or threaded rod used to connect adjoining sections of temporary barrier wall shall have a tensile strength of 120,000 psi. The spacers used between adjoining sections of temporary barrier wall shall be in accordance with ASTM A36 with a tensile strength of 58,000 psi.

CONSTRUCTION REQUIREMENTS

70 **801.03 General Requirements**

The applicable requirements of the MUTCD shall apply to the installation and materials for traffic control devices subject to the requirements of 107.08 and 107.12. When the plans do not include a maintenance of traffic plan, the Engineer will provide such a plan to the Contractor. The Contractor shall be responsible for the field layout, placement, operation, maintenance, and removal of temporary traffic control devices. A worksite traffic supervisor certified by the American Traffic Safety Service Association, ATSSA, or approved equal certifying organization, shall direct all field layout, placement, operation, inspection, maintenance, and removal of temporary traffic control devices. The certified worksite traffic supervisor, CWTS, shall ensure 80 that all traffic control devices, except temporary concrete barrier, meet acceptable standards as outlined in the plans, specifications, and ATSSA's "Quality Standards for Work Zone Traffic Control Devices" prior to installation. The CWTS shall also, prior to installation, ensure that all traffic control devices can be installed in accordance with the plans, specifications, and the MUTCD. All problems shall be reported to the Engineer so a resolution can be worked out prior to installation. The field layout will be reviewed and is subject to approval by the Engineer prior to placement of any temporary traffic control devices. The CWTS shall be present for the initial setup and all phase changes during the life of the project. The CWTS may designate responsible Contractor personnel to perform day to day operation, inspection, and maintenance of

- 90 the temporary traffic control devices. These responsible personnel shall work under the direction of the CWTS and their names shall be given to the Engineer on the project. A copy of the CWTS's certification shall be provided to the Engineer prior to the start of construction or placement of temporary traffic control devices or if the worksite traffic supervisor changes.

Regulatory control devices shall be erected only as directed.

Advisory speeds to be posted will be determined by the Department.

- 100 The names and telephone numbers of the superintendent and one other responsible employee shall be furnished. Such employees shall be on call or available at night, on weekends, or during other non-working periods to repair or replace all traffic control devices which may become damaged or inoperative.

- When traffic lanes are restricted and when specified as a pay item, a patroller shall inspect and maintain traffic control devices. The patroller shall patrol the construction zone and shall immediately correct, maintain, and repair traffic control devices or notify the Contractor designated persons for immediate repair to such traffic control devices. A full time patroller shall be on duty during periods when work is not in progress.
- 110

- Temporary traffic control devices shall be maintained to ensure visibility and to protect the public. All reflective sheeting backgrounds and lights shall be kept clean of foreign matter. The Contractor shall complete and submit a "Traffic Control Device Report" when a temporary traffic control device has been installed, removed, relocated, repaired, or at a minimum of once per week based on field observations. This report is supplied in the Proposal Book for the contract and shall be used to ensure that the traffic control devices are inspected daily. The report shall be completed or reviewed by the CWTS. Each report shall be signed by the person who performed the inspection and shall be initialed by the CWTS that it was reviewed. The Engineer will sign and date the report when received. The Engineer will not be responsible for the report's completeness and accuracy.
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The location by reference post and the date and time of operation of Temporary Worksite Speed Limit sign assemblies shall be recorded daily on a form provided by the Department. The completed report shall be submitted weekly to the Engineer. The report shall be completed and signed by the CWTS or their designee and shall be reviewed by the CWTS for completeness and accuracy.

- 130 Except for construction warning lights and temporary signals, the ATSSA brochure titled "Quality Guidelines for Work Zone Traffic Control Devices and Features" will be used as a guide to determine if temporary traffic control devices and markings are Acceptable, Marginal, or Unacceptable. Upon initial setup and phase changes of temporary traffic control devices, all individual devices shall be of the Acceptable classification. A device not completely covered or removed when the message does not apply or when directed, will be considered unacceptable.

140 A temporary traffic control device will be deemed to be in non-compliance when considered Unacceptable. A type of temporary traffic control device will be deemed to be in non-compliance when 25% or more of the individual devices are considered Marginal. Damages may be assessed in accordance with 105.14 for non-compliance.

Within 10 work days on HMA open to traffic, the edge lines shall be placed and shall be maintained until the next lift of HMA is placed or the permanent lines are placed, as appropriate. On PCCP open to traffic, the edge lines shall be placed, within 10 work days, and shall be maintained until the permanent lines are placed, as appropriate.

150 A quality assurance unit for placed longitudinal temporary pavement markings shall be 500 lft on marked pavement in any combination or pattern, or portion thereof. A quality assurance unit for transverse marking, message, or symbol shall be each.

When longitudinal durable markings are specified, a quality assurance unit for longitudinal temporary markings shall be 5,000 lft for markings that have not been placed.

160 Damages may be assessed in accordance with 105.14 for non-compliance. Damages for temporary pavement markings will not be assessed for patches less than 200 ft in length.

Non-compliance of construction warning lights will be in accordance with 801.14.

All barricades, signs, or flashing arrow signs shall be moved from one location and re-erected at another location as shown on the plans or as directed.

170 Traffic shall be maintained for maintenance activities or for HMA resurface work. The Contractor shall have an extra set of construction signs and an extra flashing arrow sign on the project site so that the taper may be moved forward without suspending the operations and clearing the work area. Additional traffic control devices shall be furnished for situations determined to be more complex, for protection in hazardous areas, and when traffic conditions warrant.

All non-fixed signs shall be removed at the completion of each day's operations. All fixed signs shall remain in place until all temporary pavement markings have been removed. All lanes shall be open to normal traffic during non-daylight hours. If a traffic lane is directed to remain closed during non-daylight hours, traffic shall be maintained on the remaining lanes as shown on the plans.

180 Where two-way traffic is to be maintained on a one-way pavement, and where the existing shoulders on such roadway are earth, aggregate No. 73 shoulders shall be compacted in accordance with 303.06 as shown on the plans. Compacted aggregate shoulders shall remain in place unless subsequent construction activities on the contract require its removal.

Temporary drainage structures, temporary concrete median barrier units, and other temporary devices required and used for traffic maintenance shall remain the property of the Contractor.

801.04 Construction Signs

190 Construction signs shall include the typical sign standards or posts which support the sign, all necessary hardware, and specified construction warning lights.

A route or lane closure notice sign shall consist of a construction sign type A, in accordance with 801.04(a), which indicates route or lane closure. The sign shall be mounted for a maximum of 14 calendar days and a minimum of seven calendar days before the closure date shown on the sign. The sign shall be removed when the route or lane is closed.

200 Trailers in accordance with 910.14(f) may be used as supports for portable construction signs. The trailer shall be located to hold the sign in a proper position. The position of the tongue shall be so as to cause no hazard to traffic. Wheel chocks other than sandbags shall not be used. The tongue may be pinned to reduce wind-induced rolling if designed to pull up or break from vehicle impact. During non-working hours, trailers with signs that do not apply to existing conditions shall be stored in accordance with 107.08(c).

210 Sign posts and their foundations shall be located and constructed to hold signs in a proper position; to resist swaying, turning, or displacement; and minimize the hazard to motorists. No rigidly fixed sign supports will be allowed in exposed areas where it would be practicable to utilize a breakaway or yielding type design. Signs shall be completely covered or removed when the message does not apply.

If the work on a project, or a portion thereof, is not active, and the roadway is open to unrestricted traffic, construction signs may be removed until work resumes. Removal of such signs shall not relieve the Contractor of responsibilities or liabilities described elsewhere herein.

(a) Type A

220 A type A sign shall consist of a construction sign as detailed in the MUTCD or on the standard drawings which is 9 sq ft or more in area.

(b) Type B

A type B sign shall consist of a construction sign as detailed in the MUTCD or on the standard drawings which is less than 9 sq ft in area.

(c) Type C

A type C sign shall consist of a construction sign which is not detailed in the MUTCD or on the standard drawings and which is 9 sq ft or more but less than 33 sq ft in area.

801.05

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(d) Type D

A type D sign shall consist of a construction sign which is not detailed in the MUTCD or on the standard drawings and which is less than 9 sq ft.

(e) Temporary Panel Sign

A temporary panel sign shall consist of a sign fabricated and constructed in accordance with 919.01 and which is greater than 33 sq ft. Temporary panel signs shall be mounted on wood posts as shown on the plans or as approved by the Department. External bracing shall not be used.

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801.05 Detour Route Marker Assembly

Detour route marker assemblies shall be on a single post for a single route or may be on multiple posts for multiple routes. When two routes are being detoured across a common roadway, each route shall be shown by a separate detour route marker assembly. A detour route marker assembly-multiple route shall be used for three or more routes across a common roadway.

801.06 Road Closure Sign Assembly

250 Road closure sign assemblies shall be used at each road closure location where type III-A barricades or type III-B barricades are used. Road closure sign assemblies shall not be used within lane closures where adjacent lanes remain open to traffic, unless otherwise directed. Road closure sign assemblies may be required at other locations as directed.

Permanent road closure sign assemblies shall be left in place after the contract is completed and shall become the property of the Department. They shall be installed just prior to final acceptance of the contract. Supports shall be painted with white field paint for wood.

260

801.07 Barricades

Barricades shall include rails, posts, and all incidentals necessary to complete this part of the work.

High intensity reflective sheeting shall be placed on specified rails of all barricades. The colors for temporary barricades shall be orange and white, and for permanent barricades red and white.

270 All type III barricades shall be skid mounted within pavement, shoulder, or sidewalk areas, and on ground mounted posts in all other areas. Type III barricades shall be used on all slopes which are 3:1 or flatter for roadway closures.

(a) Type III-A Barricade

The type III-A barricade shall have rails which are reflectorized on one side and shall be used for roadway closures and lane closures where traffic can approach from only one side.

(b) Type III-B Barricade

280 Type III-B barricades shall have rails which are reflectorized on both sides and shall be used for roadway closures and lane closures where traffic can approach the barricade from both sides.

(c) Permanent Type III Barricade

Permanent type III barricades shall be 10 ft sections and shall be left in place after the contract is completed, and shall become the property of the Department. Permanent type III barricades shall be installed just prior to final acceptance of the contract. All non-reflectorized wood and non-galvanized steel shall be painted with white field paint. Such barricades shall otherwise be in accordance with 801.07(a).

801.08 Cones and Tubular Markers

290 Cones shall be made of a material to withstand impact without damage to striking vehicles. They shall have a substantial base to restrict overturning. Cones and tubular markers shall be as shown on the plans.

Cones shall be used only during temporary activities where portability is advantageous and they remain in place and do not create a hazard to traffic. The use of cones in lieu of drums will be allowed as shown on the plans except cones shall not be used for interstate lane restrictions.

300 Tubular markers shall be used for separating two-lane two-way traffic as shown on the plans or as directed.

Cones and tubular markers shall be secured in place either by weighting or adhesives. The use of metal bases will not be allowed.

801.09 Drums

Drums shall be molded orange polyethylene.

310 The shape of the drum shall appear basically cylindrical to the motorist from any direction in any given application. The top outside diameter shall not exceed the bottom outside diameter. Drums shall be multisided, elliptical or have a flattened side to inhibit rolling.

The top section of the drum shall have at least one construction warning light mounting bracket. The minimum drum height is exclusive of lifting handles or construction warning light mounting brackets.

320 The drums shall stand on end, be stable against overturning, and shall be internally or externally ballasted to resist wind speeds of up to 50 mph and gusts created by traffic. The weight of the ballast shall be 45 to 55 lb. The top of the drum shall be free from openings. Internally ballasted and externally collar ballasted drums shall not be mixed in each continuous set-up.

Internal ballast shall be sandbags, a molded plastic base filled with sand and closed with a locking cover, or a solid rubber base. The internal ballast shall be placed in the lower 1/4 of the drum. The ballast device shall be self-draining.

330 The external ballast shall be two rubber tire base collars. The tire base collars shall have a circumferential contact with the road surface. The maximum diameter of the tire base collar shall not exceed 36 in. The height of two tire base collars at the outside edge shall not exceed 5 in. The rubber ballasting collars shall be clean cut, proper in size, black in color, and not curved up at the edges. The interior and exterior circumference of the collar shall not be slit or cut. Drums which are external collar ballasted shall not be used in situations where the width of the collar interferes with proper placement of the drum. The Department's Guidelines for External Ballast will be used for determining acceptability of rubber tire base collars.

340 Upon impact by a vehicle traveling at a speed of 55 mph, the drum and ballast device shall be of a type that enables the body of the drum to separate from the base, thus allowing vehicles to easily pass over the base.

Construction warning lights shall be used in accordance with 801.14 and as shown on the plans and shall be securely fastened to the mounting brackets. Signs shall not be mounted on drums.

Permanent drums shall be left in place after the contract is complete, and shall become the property of the Department. They shall be installed just prior to final acceptance of the contract.

801.10 Temporary Traffic Barriers

350 Temporary traffic barrier shall be one of the following four types as shown on the plans.

Type 1

360 Type 1 temporary traffic barriers shall be used to separate two-way traffic and shall be precast concrete in accordance with applicable requirements of 707 and 602 and as shown on the plans. Type 1 barriers may also be used to separate traffic from the work zone. The surfaces of individual precast units shall vary no more than 1/4 in. in 10 ft from the specified cross section, as measured from a longitudinal straightedge. The maximum variation in the vertical and horizontal alignment of adjacent units shall be 1/4 in. across the joint, as measured from a 10 ft longitudinal straightedge. Sections that have obvious defects or visual cracks shall not be used. Sections that develop any of these conditions during the contract shall be repaired with concrete or replaced within a reasonable amount of time.

Type 1 barrier units precast prior to 2003 shall not be used after January 1, 2012. Units precast after March 1, 2003 shall be clearly marked with the name or trademark of the manufacturer, the year of manufacture, and "INDOT". The markings shall be indented on an end or on the top of each barrier section. Units precast after January 1, 2007 shall be from the QPL of Certified Precast Concrete Producers.

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Type 2

Type 2 barriers may be used to separate traffic from the work zone. Type 2 temporary traffic barriers shall meet the appropriate test level 2 or 3 MASH or NCHRP 350 crash test standards and shall be approved for use by the FHWA. A copy of the MASH or NCHRP 350 crash test FHWA eligibility letter shall be provided to the Engineer prior to placing the unit. The unit selected shall be appropriate for the location considering the maximum posted speed limit on the project and the allowable area for deflection. The unit shall be installed according to the manufacturer's recommendations.

380

If concrete barriers are used as type 2 barriers, they shall be in accordance with the requirements for type 1 barriers.

Type 3

Type 3 temporary traffic barriers shall be those type 1 temporary traffic barriers that are to be left in place at the completion of the contract and shall become the property of the Department. They shall be in like-new condition at the completion of the contract. All necessary delineation and required anchor systems shall be left in place.

390

Type 4

Type 4 temporary traffic barriers shall be those types that are intended to be readily moveable to accommodate the shifting of traffic lanes on a daily basis to better facilitate the changing volumes of traffic during the peak hours of a day. Type 4 temporary traffic barriers shall meet the appropriate test level 3 MASH or NCHRP 350 crash test standards and shall be approved for use by the FHWA. A copy of the MASH or NCHRP 350 crash test FHWA eligibility letter shall be provided to the Engineer prior to placing the unit.

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(a) Placement

Temporary traffic barriers shall be located as shown on the plans or as directed. Temporary traffic barriers used to close a lane of traffic shall be flared at the rates as shown on the plans for the applicable regulatory speed within the construction zone. If field conditions are such that the required flare rate cannot be utilized, the tapered alignment may be altered, with approval, to a 10:1 flare rate with a 20 ft minimum offset from the edge of the through traffic lane to the approaching end of the flared temporary traffic barrier. If field conditions are such that that the 10:1 flare rate cannot be utilized, the tapered alignment may be further altered, with approval, to a 6:1 flare rate with the 20 ft minimum offset. Flare rates for ends of temporary traffic barriers at locations where a lane of traffic is not being closed to traffic or where the lane has already been closed shall be the same as above, however the minimum offset from the edge of the through traffic lane may be 10 ft. The use of flare rates sharper than those shown on the plans may require additional traffic control devices as directed.

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Type 2 barriers shall not be intermixed with type 1 or type 3 barriers in any run. Type 2 barriers from different manufacturers shall not be intermixed in any run.

(b) Connection

Type 1 and type 3 barrier sections shall be connected as follows:

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1. The adjacent barrier sections shall be placed end to end, with sufficient overlapping of the smooth bar hooks to allow placement of the connecting bolt or threaded rod and the top spacer.
2. The adjacent barrier sections shall then be moved in opposite directions for a sufficient distance to develop the maximum contact between the smooth bar hooks and the connecting bolt or threaded rod.

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3. The bottom spacer and nut shall then be placed as shown on the plans. The nut shall be sufficiently tightened to eliminate all gaps between the adjacent bolt heads, spacers, nuts, and washers which form the connection.

Type 1 and type 3 precast units which have previously been cast meeting earlier Department standards may be used. The Contractor will be allowed to mix type 1 and type 3 units in a run as long as the units are in good condition and the connecting devices are compatible. If units meeting earlier Department standards are used, a 1 in. bolt will be allowed to link the units together. The spacer detail shall, however, be in accordance with the current standard. Units cast after March 1, 2003 shall be linked with the 1 1/4 in. bolt.

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Type 2 temporary traffic barriers shall be connected as recommended by the barrier manufacturer.

(c) Anchorage

Type 1 and type 3 temporary traffic barriers shall be anchored in accordance with the methods shown on the plans, at the locations described herein. Type 2 barriers shall be anchored as recommended by the barrier manufacturer and at locations described herein. Temporary concrete traffic barriers shall be anchored when located on or within 60 ft of a bridge, and along tapered alignments. Anchoring at locations in addition to those described herein will be required when directed.

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Chemical anchor systems with removable bolts, or mechanical anchors may be used to anchor type 1 barriers to bridge decks, concrete pavement, and concrete shoulders. Mechanical anchors may be ferrous or non-ferrous material. All anchors shall have a shear strength of 10,000 lb and an ultimate pullout strength of 6,500 lb.

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Non-ferrous mechanical anchors shall be installed such that the top end of the sleeve is a minimum of 2 1/2 in. below the final finished concrete surface.

Ferrous mechanical anchors shall be completely removed when no longer required. All damage to the pavement shall be repaired as directed.

Non-ferrous anchor sleeves and the chemical adhesive component of chemical anchor systems may remain in place when no longer required. The holes remaining in the pavement shall be filled with appropriate material as directed.

470 **(d) Delineation**

Type 1 barriers used to separate two-way traffic shall be delineated with top mounted temporary barrier delineators and with side mounted delineators. The top mounted delineators shall be two-sided, shall be yellow, and shall be placed on every other section of barrier wall. The top mounted delineators shall be mounted perpendicular to the direction of traffic flow. The side mounted delineators shall be yellow and shall be mounted in accordance with 602.03(f).

480 Temporary traffic barriers in locations other than separating two-way traffic shall be delineated with either type C construction warning lights or top mounted temporary barrier delineators and with side mounted barrier delineators. The type C lights or the top mounted barrier delineators shall be spaced at the number of feet equal to the number of miles per hour in the posted speed limit with a minimum spacing of 20 ft. Bi-directional lenses will be required on the warning lights when the barrier is adjacent to a lane that is carrying alternating one-way traffic. The color of the barrier delineators shall be white when located on the right side of the traffic lane, and yellow when located on the left side of the traffic lane. The color of the barrier delineators shall be white when located adjacent to a lane that is carrying alternating one-way traffic.

490 Where the temporary traffic barrier is located along a tapered alignment and is located behind drums or other reflective delineation devices, the type C construction warning lights and barrier delineators shall not be used.

(e) End Treatment

Where possible, the ends of temporary traffic barriers shall be flared in accordance with 801.10(a). Where conditions do not allow the temporary traffic barrier to be flared in accordance with 801.10(a), appropriate end treatments shall be incorporated to protect vehicles from the ends of the barriers. The end treatments shall have re-direct capability and shall meet the appropriate test level 2 or 3 NCHRP 350 crash test standards and be approved for use by the FHWA.

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(f) Storage

No barrier segments shall be stored on the right-of-way unless written permission is given by the Department. Requests for permission to store traffic barrier segments on the right-of-way will not be accepted until after the contract has been awarded.

801.10.1 Construction Zone Energy Absorbing Terminal, CZ

The construction zone energy absorbing terminal, CZ, shall have passed NCHRP 350 level 3 crash test for all Interstate and other construction sites having a

801.11

510 construction zone speed limit in excess of 45 mph and level 2 for non-Interstate construction sites having a construction zone speed limit of 45 mph or less. All energy absorbing terminal, CZ, shall have redirect capabilities and shall be approved by the FHWA.

A copy of the crash test report confirming the product is NCHRP 350 or MASH compliant for the test level specified, or a copy of the FHWA eligibility letter, shall be furnished to the Engineer prior to the installation of the unit.

The unit's nose cover shall be reflectorized to provide improved visibility.

520 Assembly and installation of the unit shall be supervised or performed at all times by an installer trained and certified by the unit's manufacturer. The size, assembly, and installation shall be in accordance with the manufacturer's recommendations at the locations shown on the plans. When required for bi-directional traffic protection, transition panels and all other necessary hardware shall be included in the installation. A copy of the installer's certificate shall be provided to the Engineer prior to the start of work.

The Contractor shall provide the Department with all necessary manufacturer's installation manuals and working drawings in accordance with 105.02.

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Sufficient spare parts or complete units shall be stored in a safe, convenient, nearby location. Such standby materials are not shown in the Schedule of Pay Items. The standby materials shall be utilized to repair or replace damaged units in the shortest time possible. Standby materials used in the repair of damaged units shall be replaced within 24 h of their use.

801.11 Temporary Crossovers

540 Temporary crossovers shall be either type A or type B as shown on the plans and shall be constructed in accordance with the applicable sections of 207, 402 or 502. If applicable, a CMDS shall be submitted to the Engineer for approval. Utilization of the Department provided spreadsheet is not required. When required to maintain median drainage, a 15 in. diameter pipe shall be placed at the centerline of the median under the crossover. If the crossover is to remain in place for future construction, the pipe shall have appropriate grated box ends in accordance with 715.

The pavement structure for the temporary crossover shall be as shown on the plans.

550 Traffic control devices, including temporary pavement markings, shall be as shown on the plans. Separation of opposing vehicular traffic between two crossovers shall be as shown on the plans.

Refurbishing of a temporary crossover shall consist of the removal of drums or earth cover from an existing temporary crossover. The temporary crossover shall be

patched and resurfaced as directed. Excavated soil resulting from the refurbishing operation, if not used as a part of the contract work, shall become the property of the Contractor. Removed drums will remain the property of the Department.

560 After construction is complete, and prior to the opening of all lanes to traffic, the temporary crossover shall be removed or closed.

Where guardrail is required to be removed for construction or refurbishing of crossovers, such removal and subsequent re-erection shall be done as shown on the plans or as directed.

Acceptance of HMA for temporary crossovers will be in accordance with 402.09.

801.12 Temporary Pavement Marking

570 Temporary pavement markings shall be new materials placed in accordance with 808.04 and 808.05. However, when temporary markings are to be in place for 10 work days or less the dashed line pattern used on center line and lane lines may be 4 ft line segments on 40 ft centers and gore areas shall be marked by outline only and may be 5 in. wide lines. No-passing zones on all undivided two-way roadways shall be identified with signs and centerline markings. Markings shall remain clearly visible during the day and night for a minimum of 200 ft ahead of a vehicle. All temporary markings shall be maintained and replaced until they are no longer applicable.

580 Where possible, when non-removable temporary markings are used on a final surface, such markings shall be placed at the same location where permanent markings will later be affixed or parallel to and within 12 in. of the permanent marking pattern.

Where temporary pavement markings are to be placed on a pavement which has existing markings, the existing markings which conflict with the temporary markings shall be removed in accordance with 808.10. On asphalt pavement, black temporary tape Type I, may be used to cover conflicting markings. The black temporary tape shall extend at least 1/2 in. beyond the edges of the marking to be covered. Overlapping of temporary tape will not be allowed.

590 When working under traffic, the temporary pavement markings shall be placed before opening the lane to traffic. This shall include, but not be limited to, the marking patterns of gore areas, outside edge line of deceleration and acceleration lanes, narrow bridge markings, lane reduction transitions, lane lines, centerlines, and transverse markings as appropriate.

600 Temporary pavement markings which are to be in service from December 1 through the following March 31 shall be painted markings. Such markings shall be placed in the standard pavement marking pattern and applied prior to the suspension of the work, or within seven work days after the Contractor is directed to place the markings. Adjustments to these dates to accommodate actual seasonal suspension and continuance of work are subject to approval by the Engineer upon written request.

The prismatic reflectors shall be removed from snowplowable raised pavement markers which conflict with the temporary traffic marking pattern. Snowplowable raised pavement marker castings damaged by the removal of the reflector shall be replaced in accordance with 808.11. New prismatic reflectors shall be mounted on existing castings in accordance with 808.11 when the final traffic pattern is established.

Removal of temporary pavement markings shall be in accordance with 808.10.

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(a) Temporary Pavement Marking Methods

Pavement markings shall be installed in accordance with 808.07 except that measurement of retro-reflectivity is not required by the Contractor and quality adjustments in accordance with 808.07 will not apply. All other performance measures shall apply.

1. Paint

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Temporary edge lines shall be painted markings. When traffic is in the final pattern, the temporary edge lines shall be placed at the same location as the permanent markings.

2. Temporary Pavement Marking Tape

Temporary pavement marking tape shall be applied in accordance with the manufacturer's recommendations. Temporary marking tape shall be new type I or type II material.

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All temporary pavement marking tape shall be removed prior to placing the next pavement course, prior to placing an overlay, prior to recycling the pavement, or prior to placing the final pavement markings, except as otherwise described herein.

a. Type I

Type I tape is a removable material. It may be used for longitudinal and transverse markings.

Type I tape shall be removed without the use of solvents, grinding, abrasive blasting, or other methods which may damage the pavement. All visible adhesive residue shall be removed without use of solvents or grinding.

b. Type II

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Type II tape is a non-removable material. It may be used on PCCP to be removed or on PCCP to be overlaid with an HMA course greater than 165 lb/sq yd. Type II tape placed on HMA pavement shall be removed prior to placing the next pavement course.

If it is necessary to remove type II tape, it shall be removed without the use of solvents. All damage to the pavement shall be repaired.

3. Temporary Raised Pavement Marker

The temporary raised pavement marker shall be grade 1 or grade 2. When used, it

650 shall be a supplement to other temporary pavement markings. The color of the reflector shall be in accordance with the other temporary pavement marking. The color of the shell of the grade 1 marker shall be in accordance with the color of the other temporary pavement marking.

Temporary raised pavement markers shall be removed before the next layer of pavement is placed and before the final pavement markings are applied. All damage to the pavement shall be repaired.

4. Temporary Buzz Strips

660 Temporary buzz strips shall be a set of transverse markings constructed of removable or durable marking material. Durable marking material shall be used in accordance with 808.07(b).

(b) Blank

801.13 Temporary Illumination

The temporary highway illumination shall be in accordance with applicable requirements of 807 except as modified herein.

670 The electric energy necessary to power the luminaires on a continuous basis is the responsibility of the Contractor.

At completion of the contract work, the temporary illumination shall be removed and shall remain the property of the Contractor. After removal of the temporary illumination equipment, all holes and trenches shall be backfilled with B borrow.

801.14 Construction Warning Lights

680 Construction warning lights shall be portable, lens directed, enclosed lights that emit an amber color. All warning lights shall be mounted a minimum of 36 in. above the traveled way to the bottom of the lens, unless otherwise directed. Lights not working shall be repaired or replaced immediately. For each day that more than 5% of the required warning lights are not operating, a sum equal to \$4.00 per non-working light will be deducted from the monies due the Contractor.

(a) Type A

690 Type A lights shall be low intensity flashing warning lights. These lights shall be visible on a clear night from a minimum distance of 3,000 ft when there is no external illumination directly on or in the immediate vicinity of the light. They shall operate from dusk to dawn or when conditions exist which tend to obscure vision. Traffic control devices used for maintaining traffic will not require Type A warning lights during unobscured daylight hours.

(b) Type B

Type B lights shall be high intensity, flashing, warning lights. These lights shall be visible on a sunny day from a minimum distance of 1,000 ft when viewed without the sun directly on or behind the light.

(c) Type C

700 Type C lights shall be steady burning warning lights. These lights shall be visible on a clear night from a minimum distance of 3,000 ft when there is no external illumination directly on or in the immediate vicinity of the light. They shall operate from dusk to dawn or when conditions exist which tend to obscure vision.

(d) Vehicle Warning Lights

Vehicle warning lights shall be amber and shall be a strobe light or a flashing, oscillating, or rotating directed beam light. They shall be visible to all approaching traffic for a distance of 1,000 ft.

801.15 Electronic Devices**710 (a) Flashing Arrow Sign**

Where specified, a flashing arrow sign shall be furnished, installed, and maintained. It shall be operated continuously, when necessary, to divert traffic.

The flashing arrow sign may be of the solar power assisted type only in stationary operations when the horizontal or vertical curvature in the road is such that motorists do not drive into and out of the beam width of the lighted arrow while within sight of the sign.

(b) Portable Changeable Message Signs, PCMS

720 This shall consist of furnishing, installing, and maintaining a trailer-mounted, portable sign upon which varying electronically generated messages will be displayed to traffic. The message being relayed to traffic shall be legible and easily understood for a minimum distance of 650 ft.

The messages shall be as shown on the plans or as approved or directed by the Engineer. Messages shall be formatted in accordance with the Department's Guidelines for Portable Changeable Message Signs. Only upper case letters shall be used. Each message phase shall be displayed for at least 2 s. Display time for an entire message shall not exceed 8 s.

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Placement of PCMSs shall be as shown on the plans or as directed by the Engineer. A minimum clearance of 7 ft from pavement to the bottom of the PCMS shall be provided. Units shall be level and PCMSs shall be turned away from traffic, placed in stand-by mode, or left blank until there is a valid message to be displayed. When in use PCMSs shall be turned approximately 3° from perpendicular towards oncoming traffic to minimize glare. A drum shall be placed immediately in front of the PCMS trailer at both corners for delineation.

(c) Temporary Worksite Speed Limit Sign Assembly

740 This shall consist of furnishing and placing portable speed limit signs as shown on the plans or as directed in areas of work activity. When used, the worksite speed

limit flashing strobe lights shall be activated when the worksite speed limit is in effect. This shall be only where and while work is actually in progress and workers are present. Each strobe light shall be visible through a range of 120° when viewed facing the sign and shall be visible from a distance of 750 ft.

750 Wherever a permanent speed limit sign exists within the limits controlled by the worksite speed limit sign assemblies, additional worksite speed limit sign assemblies shall be placed at the permanent signs. The permanent signs shall be covered or removed during continuous worksite speed limit use.

A worksite speed limit authorized for intermittent use shall only be activated when workers are present at the site. The intermittent worksite speed limit shall only be used in the area of work. A worksite speed limit authorized for continuous use shall not include the flashing strobe lights or the S4-4 "WHEN FLASHING" plaque.

760 The worksite speed zone signage shall be placed and maintained by the Contractor. The worksite speed limit will be as shown on the plans or as directed by the Engineer and at least 10 mph below the posted speed limit for the roadway under construction.

A worksite reduced speed advance warning sign assembly shall be placed in advance of the first worksite speed limit sign assembly when the reduction in speed limit is greater than 10 mph.

(d) Temporary Traffic Signals

This work shall consist of furnishing, installing, and maintaining temporary traffic signals in accordance with 805 except as modified herein.

770 Except as shown on the plans, all materials not furnished by the Department shall remain the property of the Contractor after work is completed and the equipment is removed.

The traffic signal equipment shall be as specified, but may be either new or used. Used equipment shall be in satisfactory working condition and will be approved prior to use.

780 Two signal heads shall be displayed for each approach. Signal cable may be extended across bridges through conduit which shall be attached to the underside of the coping. Type and spacing of clamps shall be approved prior to installation.

Conduit shall be steel or plastic. Flexible conduit will be an acceptable alternate for use as ground rod entry, magnetometer, or microloop installations.

1. Fixed Temporary Signals

Fixed temporary signals shall be displayed overhead on a span, catenary, and tether utilizing an aircraft cable, unless otherwise directed.

790 Electric energy necessary to power the fixed temporary signal is the responsibility of the Contractor. Prior to the start of construction, the schedule of activities shall be coordinated with the power company.

The Contractor shall obtain permits from local officials, companies, or individuals for the use of poles, right-of-way, or other property incidental to the installation of fixed temporary signals. Although entering into the contract implies permission and authority to install conduit under pavement, sidewalks, and alleys, all damage to underground utilities or interruption of such service shall be the responsibility of the Contractor.

800 The location, spacing, and timing of fixed temporary signals will be determined by the Engineer.

An IMSA certified level II Traffic Signal Construction Technician or a level II Traffic Signal Field Technician shall be available 24 h a day to respond within 2 h for the maintenance of the traffic signal equipment.

The controller shall be traffic actuated solid state digital. For used controllers, the model selected shall be from a manufacturer with a controller on the QPL of Traffic Signal and ITS Devices.

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Vehicle detection shall be provided and shall be either inductive loop or wireless unless otherwise noted on the plans.

2. Portable Signals

Portable signals shall be selected from the QPL of Portable Traffic Signals. Prior to the activation, the Contractor shall provide a completed inspection checklist to the Engineer certifying that the portable signal is functioning properly.

820 The portable signal shall be equipped with remote monitoring. Unless otherwise shown on the plans, Microwave or Doppler vehicle detection as shown on the QPL of Portable Traffic Signals shall be provided. A minimum of three drums shall be placed immediately in front of the portable signal trailer for delineation.

830 A technician certified by the manufacturer shall be available 24 h a day to respond within 2 h for the maintenance of the traffic signal equipment. Copy of the certification shall be provided to the Engineer prior to the placement of the portable signals. Maintenance of the portable signal includes adjustments to the phasing or timing as indicated on the plans or directed by the Engineer. The Contractor shall replace portable signals that cannot be returned to normal operation or that fail two times during the contract.

The Contractor shall provide a record of any modifications to the signal timing plan, failures, and all maintenance issues, to the Engineer prior to final acceptance and

when otherwise requested. The report shall indicate the date, time, and nature of each event.

(e) Automated Flagger Assistance Devices

An Automated Flagger Assistance Device, AFAD, may be used to control a single lane of approaching traffic on a two-lane highway for flagging operations.

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Only qualified flaggers who have been trained on the operation of the AFAD shall operate the AFAD. AFAD operators shall provide written proof that they have been trained by the AFAD manufacturer. Two trained flaggers shall be available on-site to provide flagging in case of an AFAD malfunction. The flagger operating the AFAD shall be positioned to have an unobstructed line of sight to approaching traffic and the AFAD. A single flagger may be used to control both approaches to the work site if adequate unobstructed sight distance exists between the AFAD operator and both approaching directions of traffic and both AFADs.

850

The flagger operating the AFAD shall not leave the device unattended at any time while the AFAD is in use. The operating flagger shall be positioned at such point to be in full view of oncoming traffic and the AFAD at all times the AFAD is in use. The flagger operator shall keep a backup handheld remote readily available at all times when the device is being operated.

The AFAD shall be positioned so that the end of the gate arm, if used, shall extend at least to the center of the lane being controlled but shy of the roadway centerline.

860 A drum shall be placed immediately in front of the AFAD trailer at both corners for delineation.

801.16 Temporary Traffic Control Zone

A temporary traffic control zone is a work zone with frequently changing operation, a maximum duration of seven calendar days; mobile operation; or a temporary traffic stoppage.

Daytime lane closures on two-lane two-way roads shall be limited in length to a maximum of 1 mi or the length of a half day's operation, whichever is less, or as shown on an approved alternate traffic control plan.

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(a) Temporary Mounted Construction Signs

When the vertical mounting height for TTCS is between 12 in. and 18 in. to the bottom of the sign, tripod supports may be used. Temporary mounted construction signs, which are mounted on portable supports such as sign stands and tripods may be used for the construction signs in a temporary traffic control zone. The bottom of a temporary mounted construction sign shall be at least 12 in. above the traveled way. Signs on tripod supports shall be installed so that the angle from vertical does not exceed 30°.

- 880 Roll-up materials will only be allowed for mobile, short duration, or short-term stationary work which will not exceed one daytime period. Roll-up materials shall be selected from the QPL of Reflective Sheeting. Roll-up sign supports shall be ballasted in accordance with the manufacturer's recommendations.

(b) Maintenance of Traffic for Flagging and Mobile Operations

Signs, flagging, flashing arrow signs, and other required traffic control devices shall be furnished in accordance with the details shown on the plans or as directed. The Engineer reserves the right to stop work at any time to relieve traffic congestion.

- 890 Flagging operations shall be conducted under the supervision of either the designated CWTS or a flagger certified by ATSSA or approved equal certifying organization. The person supervising the flagging operation shall ensure that the flaggers are trained in proper flagging procedures and that the flagging operation is in accordance with 107.12, the standard drawings, and the applicable sections of the MUTCD.

(c) Traffic Control for Temporary Traffic Stoppage

- 900 Traffic shall not be allowed to pass directly beneath personnel or equipment working on an overhead structure. Traffic stoppage during an overhead operation shall not exceed 20 minutes at one time. There shall be enough time between consecutive stoppages to allow traffic to return to normal flow.

Three working days prior to commencing work which necessitates temporary stoppage of traffic, written notice shall be given to the Department and the Indiana State Police that highway traffic shall be stopped temporarily at a specific location, time, and date to accomplish specified work. Traffic shall be safely controlled during the stoppage. The following minimum requirements shall be met.

1. On Multi-Lane Divided Highways

- 910 Advance warning signs shall be located as specified or as otherwise directed. For each direction of road closure two flaggers shall be located at the site of the work and a minimum of two additional flaggers shall be used to warn approaching traffic.

2. On Non-Divided Highways

Advance warning signs shall be located as specified or as otherwise directed. For each direction of road closure, one flagger shall be located at the site of the work and a minimum of one additional flagger shall be used to warn approaching traffic.

801.17 Method of Measurement

- 920 Construction signs, detour route marker assemblies, detour route marker assemblies-multiple routes, temporary worksite speed limit sign assemblies, road closure sign assemblies, portable changeable message signs, Aries Field Processor for PCMS, and temporary raised pavement markers will be measured by the number of units installed, maintained, and removed.

Temporary panel signs will be measured by the square foot. Temporary panel sign supports, when required, will be measured by the linear foot, complete and in place.

930 Type III-A, type III-B, and permanent type III barricades will be measured by the linear foot of the width of closure.

Temporary traffic barrier will be measured by the linear foot per the type specified. Anchored traffic barrier will be measured by the linear foot, separately from unanchored temporary concrete barrier per the type specified. End treatments used on a type 2 or type 4 temporary traffic barrier will be measured by the linear foot as part of the barrier.

940 Construction zone energy absorbing terminals, CZ, used on type 1 and type 3 temporary traffic barriers will be measured by the number of terminals placed.

950 Temporary crossovers type A and type B will be measured per each crossover. The refurbishing of temporary crossovers will be measured per each type of crossover refurbished. HMA mixtures for temporary crossovers will be measured by the ton in accordance with 109.01(b). Initial resurfacing and initial patching of refurbished crossovers will be measured in accordance with 402.19. Temporary drainage pipe for temporary crossovers will be measured by the linear foot. Seeding and sodding placed due to the construction and removal or refurbishing and closing of temporary crossovers, will be measured in accordance with 621.13. Removal and subsequent replacement of permanent pavement markings and snowplowable raised pavement markers for temporary crossovers will be measured in accordance with 808.12. Removal and resetting of guardrail, if required for temporary crossovers, will be measured in accordance with 601.13.

Flashing arrow signs will be measured by the number of calendar days each unit is operated.

960 Patroller will be measured by the number of calendar days during the phase or phases of traffic control, as shown on the plans or as otherwise directed, that require the patroller's presence. Each portion of a day will be measured as a whole day.

Temporary pavement message markings will be measured by the number of each type placed. Longitudinal and transverse temporary pavement markings will be measured by the linear foot of material actually placed. Temporary buzz strips will be measured by the linear foot for each 8 in. strip placed, without regard to the number of passes required to attain the specified height.

970 Removal, when necessary, of any type of non-removable temporary pavement markings will be measured in accordance with 808.12. Removal of removable temporary pavement markings will not be measured for payment.

Where temporary pavement markings are to be placed on a pavement which has existing markings, removal of existing markings which conflict with the temporary

801.18

markings will be measured in accordance with 808.12. Where conflicting markings are covered with black temporary tape Type I, the black temporary tape will be measured by the linear foot of markings covered.

The removal and replacement of prismatic reflectors on existing snowplowable raised pavement markers will be measured in accordance with 808.12.

980 Compacted aggregate No. 73 used for shoulder material will be measured in accordance with 303.09. Excavation of the existing earth shoulder will not be measured for payment.

Cones and tubular markers will not be measured for payment. Permanent tubular markers will be measured per each.

Temporary illumination, fixed temporary signals, portable signals, and maintaining traffic will not be measured for payment.

990 **801.18 Basis of Payment**

The accepted quantities of construction signs, detour route marker assemblies, detour route marker assemblies-multiple routes, temporary worksite speed limit sign assemblies, road closure sign assemblies, permanent road closure sign assemblies and temporary raised pavement markers will be paid for at the contract unit price per each. Payment for temporary worksite speed limit assemblies, PCMS, and Aries Field Processors will be made for the maximum number of such assemblies in place at any one time during the life of the contract. Type III-A, type III-B, and permanent type III barricades will be paid for at the contract unit price per linear foot.

1000 Temporary traffic barrier and anchored temporary traffic barrier will be paid for at the contract unit price per linear foot per the type specified. Payment will be made only once, regardless of the number of times the barrier is moved to accommodate different phases of traffic maintenance or construction operations as shown in the contract. End treatments used on a type 2 or type 4 temporary traffic barrier will be paid for on a linear basis as part of the barrier.

1010 Construction zone energy absorbing terminal, CZ, when used with type 1 or type 3 temporary traffic barriers will be paid for at the contract unit price per each for energy absorbing terminal, CZ, of the test level placed. Each unit will be paid for only once regardless of how many times it is moved. Construction zone energy absorbing terminal, CZ, when used with type 2 or type 4 temporary traffic barriers will be paid for at the contract unit price per linear foot of type 2 or type 4 temporary traffic barrier. Back-up units will be paid for as energy absorbing terminal, CZ, of the test level placed, if they are placed in service due to non-repairable damage to the units already in service.

The accepted quantities of temporary crossovers will be paid for at the contract unit price per each for the type specified. The accepted quantities of refurbishing

1020 existing temporary crossovers will be paid for at the contract unit price per each for the type specified. The accepted quantities of HMA for temporary crossovers will be paid for as HMA for temporary pavement at the contract unit price per ton in accordance with 402.20. Temporary drainage pipe for temporary crossovers will be paid for at the contract unit price per linear foot. Sodding and seeding for temporary crossovers will be paid for in accordance with 621.14. Removal and subsequent replacement of permanent pavement markings and snowplowable raised pavement markers for temporary crossovers will be paid for in accordance with 808.13. Removal and resetting of guardrail, if required for temporary crossovers, will be paid for in accordance with 601.14.

1030 If more than one construction sign is mounted on a common support with the messages facing opposite directions, the largest sign will be paid for at the contract unit price of the sign, and each additional sign will be paid for at half the unit price of the sign if it had been erected independently.

Temporary panel signs will be paid for at the contract unit price per square foot as shown on the plans. Temporary panel sign supports will be paid for at the contract unit price per linear foot, complete and in place.

1040 A temporary worksite speed limit sign assembly for continuous use includes two signs; each will be paid for at the contract unit price for construction sign.

Flashing arrow signs and patrollers will be paid for at the contract unit price per day per each.

Temporary pavement message markings placed will be paid for at the contract unit price per each, for the message specified. Longitudinal and transverse temporary pavement markings and temporary buzz strips, will be paid for at the contract unit price per linear foot of material, complete in place.

1050 Removal, when necessary, of non-removable temporary pavement lines and message markings will be paid for in accordance with 808.13. The cost of removal of removable temporary pavement markings shall be included in the cost of the pay item for placement of the markings.

1060 Where temporary pavement markings are to be placed on a pavement which has existing markings, removal of the existing markings which conflict with the temporary markings will be paid for in accordance with 808.13. Where conflicting markings are covered with black temporary tape Type I, the specified width of black temporary tape will be paid for at the contract unit price per linear foot of temporary pavement marking, removable.

Permanent tubular markers and permanent drums will be paid for at the contract unit price per each.

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Compacted aggregate used for shoulder material will be paid for as compacted aggregate No. 73 in accordance with 303.10.

The removal and replacement of reflectors on existing snowplowable raised pavement markers will be paid for in accordance with 808.13.

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Temporary illumination will be paid for at the contract lump sum price.

All temporary traffic control devices which are specified as separate pay items and used for maintenance of traffic will be paid for as set out in the Schedule of Pay Items. The furnishing, placing, moving, removal, and maintenance of all other temporary traffic control devices will be paid for at the contract lump sum price for maintaining traffic.

1080 The accepted fixed temporary and portable signals, complete in place and later removed as specified, will be paid for at the contract lump sum price.

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Aries Field Processor for PCMS	EACH
	Barricade, _____	LFT
	type	
	Barricade, III, Permanent	LFT
1090	Barrier, Direction Indicator	EACH
	Construction Sign, _____	EACH
	type	
	Detour Route Marker Assembly.....	EACH
	Detour Route Marker Assembly, Multiple Routes	EACH
	Drum, Permanent.....	EACH
	Energy Absorbing Terminal, CZ, TL - _____	EACH
	test level	
	Fixed Temporary Signal.....	LS
	Flashing Arrow Sign.....	DAY
1100	Maintaining Traffic	LS
	Patroller	DAY
	Portable Changeable Message Sign.....	EACH
	Portable Signal	LS
	Road Closure Sign Assembly.....	EACH
	Road Closure Sign Assembly, Permanent.....	EACH
	Temporary Buzz Strips.....	LFT
	Temporary Crossover Drainage Pipe.....	LFT
	Temporary Crossover, _____	EACH
	type	
1110	Temporary Crossover, _____, Refurbish.....	EACH
	type	

	Temporary Illumination.....	LS
	Temporary Panel Sign Supports.....	LFT
	Temporary Panel Signs.....	SFT
	Temporary Pavement Marking, _____ in.....	LFT
	width	
	Temporary Pavement Marking, Removable, _____ in.....	LFT
	width	
1120	Temporary Pavement Message Marking, _____	EACH
	description	
	Temporary Pavement Message Marking, Removable, _____	EACH
	description	
	Temporary Raised Pavement Marker, _____	EACH
	grade	
	Temporary Traffic Barrier, _____	LFT
	type	
	Temporary Traffic Barrier, Anchored, _____	LFT
	type	
1130	Temporary Transverse Pavement Marking, _____ in.....	LFT
	width	
	Temporary Transverse Pavement Marking, Removable, _____ in.....	LFT
	width	
	Temporary Worksite Speed Limit Sign Assembly	EACH
	Tubular Marker, Permanent.....	EACH

1140 Each construction sign, barricade, temporary worksite speed limit sign assembly, road closure sign assembly, or flashing arrow sign will be paid for only once regardless of how many times each is moved, replaced, or how many times each is altered to change the sign message within a Project Work Zone. Payment will be made for signs placed in, or relocated to, a separate Project Work Zone. A Project Work Zone is defined as a segment of highway from the “Road Construction Ahead” sign to the “End Construction” sign. Payment will not be made for signs or barricades used for the convenience of the Contractor.

1150 If a temporary worksite speed limit sign assembly, for intermittent use is not flashing when required beginning 2 h after work begins, or if such assembly is flashing when no work has been taking place for 2 h or longer, \$200.00 will be deducted from payment for such work for each 4 h period or part thereof, beginning after the 2 h grace period.

Temporary mounted construction signs will not be paid for.

Replacement of snowplowable raised pavement marker castings damaged due to removing reflectors will not be paid for.

801.18

Electric energy necessary to power luminaires and fixed temporary signals will not be paid for.

1160

The cost of furnishing all materials, erection, maintenance, removal, and necessary incidentals shall be included in the cost of barricades.

The cost of furnishing, installing, maintaining, and subsequent removal of the detour marker, route marker, or street or road name sign, cardinal directional marker, directional arrow marker, posts which support the assembly, and all necessary hardware shall be included in the cost of detour route marker assembly or detour route marker assembly, multiple routes.

1170

The cost of all materials, equipment, labor, and incidentals necessary to install, maintain, repair, and to remove the unit shall be included in the cost of energy absorbing terminal, CZ. The cost of stockpiling standby terminals and terminal materials, whether incorporated into the work or not, shall be included in the cost of energy absorbing terminal, CZ. All units shall remain the property of the Contractor upon completion of the contract.

The cost of the excavation required for placement of compacted aggregate shoulders No. 73 will be included in the pay item maintaining traffic.

1180

If the compacted aggregate No. 73 required for shoulders is removed, the cost of such removal shall be included in the cost of the compacted aggregate.

If the Contractor elects to use more than two simultaneous operations during the installation of snowplowable pavement markers or reflectors, the cost of required traffic protection devices for additional operations shall be included in the cost of maintaining traffic.

1190

The cost of necessary flaggers; automated flagger assistance devices; protection of traffic at structure foundations; and furnishing, erecting, placing, maintaining, relocating, and removing lights, cones, flexible channelizers, tubular markers, drums, delineators, or other devices as directed shall be included in the cost of maintaining traffic.

The cost of furnishing and placing cones or tubular markers in accordance with 801.08 and drums in accordance with 801.09, the watcher in accordance with 107.12, repair or replacement of damaged or inoperative traffic control devices, and traffic maintenance in accordance with 104.04 shall be included in the cost of maintaining traffic.

1200

Additional materials necessary to place the portable changeable message sign in a secure and level manner for site conditions shall be included in the cost of the pay item. All costs to furnish, install, program, activate, deactivate, change messages, move, replace, and maintain the PCMS shall be included in the cost of the pay item.

The cost of IP cellular phone service shall be included in the cost of the pay item.

The cost of the vehicle detection, solar panel, battery cabinet, program timing module, signal heads, wiring, trailer, and all hardware required shall be included in the cost of the portable signal.

- 1210 The cost of installing, maintaining, and subsequent removal of signs, construction warning lights, assembly supports, and all necessary hardware shall be included in the cost of road closure sign assembly.

The cost of installation, maintenance, and removal or closure of the temporary crossover, including excavation, compaction, subgrade preparation, and reshaping damaged median area shall be included in the cost of temporary crossover.

- 1220 The cost of removal of earth cover, removal of drums, reshaping damaged median areas, and closure or removal of temporary crossover shall be included in the cost of temporary crossover, refurbish.

The cost of placement, maintenance and replacement of temporary pavement markings shall be included in the cost of the markings.

The cost of cleaning existing pavement and removal of buzz strips shall be included in the cost of buzz strips. Damage to the pavement caused by removal of buzz strips and temporary pavement markings shall be repaired as directed with no additional payment.

- 1230 No payment will be made for temporary pavement markings which are in the standard pavement marking pattern, and which are to be in service from December 1 through the following March 31 due to the Contractor's failure to complete the work as scheduled. However, payment will be made for these markings if the failure to complete the work as scheduled is due to conditions beyond the Contractor's control.

The cost of furnishing, installing, maintaining, and subsequent removal of temporary raised pavement marker shall be included in the cost of temporary raised pavement marker.

- 1240 The cost of delineation of temporary traffic barrier shall be included in the cost of temporary traffic barrier.

Damage done to pavement by removal of temporary traffic barriers and anchors shall be repaired with no additional payment.

SECTION 802 – SIGNS

802.01 Description

This work shall consist of furnishing the material for and erecting traffic signs in

accordance with 105.03. Signs shall be installed as required unless written approval is obtained from the District Traffic Engineer to make modifications at specific locations.

Existing ground mounted signs to be reset shall be removed without damage, stored and re-installed as shown on the plans.

10

Signs shall be stored in such a manner that they do not come in contact with surface run-off water. Signs shall be stored so that moisture accumulation or heat build-up does not occur.

All signs shall be marked for identification as shown on the plans. The marking shall consist of a type II sheeting material, with a class I adhesive, shown on the QPL of Reflective Sheeting. It shall be applied to the back of the sign on the lower corner closest to the nearest edge of pavement and shall not be covered by the sign's supports.

20

MATERIALS

802.02 Materials

Materials shall be in accordance with the following:

	Concrete	702 or 901.08
	Fasteners.....	919.01(d)
	Overhead Sign Structure.....	910.19
	Reinforcing Bars.....	910.01
	Sign Posts	910.14
30	Traffic Signs.....	919.01

Materials used for temporary construction signs, temporary traffic signs, and temporary panel signs shall meet the requirements herein. The basis for use of the materials will be by visual inspection with no additional testing, evaluation, or documentation.

CONSTRUCTION REQUIREMENTS

802.03 Location of Signs and Sign Structures

40 Sign and sign structure locations shall be staked, and the Engineer will either approve the locations or give written notice of necessary changes. The provisions of 109.03 will not apply to posts ordered prior to approval of staked locations.

Two days notice shall be provided for inspection and approval of staked locations.

All signs shall be adjusted to eliminate specular reflection.

802.04 Working Drawings

50 Working drawings shall be submitted in accordance with 105.02 for all strain poles and structural frames, except breakaway posts. Roadway cross sections and

bridge dimensions shall be checked, as applicable, in the field prior to preparation of working drawings. If the no-load camber is not shown on the plans, the Contractor shall furnish this information on the working drawings.

802.05 Excavation and Backfill

The finished pavement or shoulder section shall not be damaged during excavation.

60 The Engineer shall be notified in writing of class X material in accordance with 206.02 encountered within the limits of the traffic sign supports foundation excavation. The Engineer will determine the design for the installation of the foundations. Excavation of class X material shall be in accordance with 206.

The excavation for sign posts shall be made as nearly as possible to neat lines. Sign post encasement shall not be formed except in sandy soil, or as directed.

802.06 Placing Concrete

70 Placing concrete shall be in accordance with 702, except that foundations incorporated into sections of concrete barrier wall shall receive a finish in accordance with 702.21. Exposed concrete shall have a smooth surface and beveled edges.

Anchor bolt alignment shall be maintained during concrete placement. Temporary positioning place and associated nuts shall be removed upon completion of the foundation. The threads shall be protected during concrete placement. Any damage to galvanized coating shall be repaired prior to assembly.

Conduit and grounding shall be in accordance with 807.

802.07 Installing Supports

80

(a) Posts

Posts shall be vertical after installation. All damaged posts shall be removed and replaced with an acceptable post.

Square sign post foundations shall be reinforced anchor base or unreinforced anchor base as shown on the plans. If sign post type A or sign post type B is specified, square sign posts may be used. Splicing of square steel sign posts will not be allowed.

90 In locations where class X excavation is encountered if the total length of the anchor bolts cannot be used, they shall be cut off. A steel plate measuring 6 by 6 by 1/2 in. shall be welded to the bottom of the bolts. The plate shall have a hole cut which allows the bolt to pass through it and the plate and bolt shall be completely welded together around the circumference of the bolt on both sides of the plate. No butt welding is allowed. The length of the bolts shall allow the plate to be covered by 3 to 4 in. of concrete at the bottom of the foundation.

802.07

Base plate bolts for panel sign post installations shall be tightened in accordance with 711.65(d). Bolts at the fuse or hinge plate joint shall be tightened in accordance with 711.65(d) or by the direct tension indicator, DTI, method.

100

(b) Overhead Sign Structures

When erection of the structure has been started, it shall be completed the same day. The structure shall be loaded, to prevent vibration, by attaching signs or lighting supports the same day.

An oxidation inhibitor in accordance with 802.07(b)4 shall be applied to all surfaces that mate with a dissimilar material.

110 Fasteners for chord splice connections shall be high strength heavy hex bolts conforming to ASTM F3125, grade A325 with matching lock nuts having steel inserts. Installation shall be in accordance with 711.65. Other bolts and hardware shall conform to the requirements of 910.19.

Fasteners shall be tightened by turn-of-nut tightening, calibrated wrench tightening, or direct tension indicator tightening. The calibrated wrench shall be calibrated by an acceptable tension measuring device such as a Skidmore-Wilhelm.

The base plate bolt tightening shall be as follows:

- 120
- a. Lower nuts and washers shall be in full contact with the base plate,
 - b. The top nuts shall be tightened to 1/6 turn beyond snug fit,
 - c. The lower nuts shall be retightened to assure that full contact with the base plate has been maintained.

Damage that is detrimental to the structural integrity of the frame or aesthetic appearance shall be repaired.

130

No field welding will be allowed.

The grounding connection shall be located 12 in. from the bottom of the support and shall be easily accessible from the structure manhole.

Traffic shall be maintained in accordance with 801.16 during installation.

1. Trusses

140 When placed on blocks to produce the required camber, the truss sections shall fit together at the flange connections with a minimum gap of 1/16 in. on any flange assembly. The total of the gaps in any one connection shall not exceed 1/8 in. Gaps shall be shimmed with tapered shims before tightening the flange bolts.

Vertical truss members and vertical diagonals shall be machined to provide a snug tube-to-tube fit to the chord along the entire edge before welding. Horizontal truss members and horizontal diagonals shall be slotted for the dimensions shown on the plans and welded to the gusset plates. They shall be sealed against water penetration.

150 Chord flanges shall be machined from solid rounds. Mating surfaces shall be flat within 1/64 in. Flanges shall be given an additional finish if necessary to ensure contact between plates.

The cap bolts used to attach the top caps of end-support columns shall be located so as to miss the J hook.

The camber shown on the plans is for fabrication only. It shall be measured with the truss fully supported. The allowable camber tolerance is 25% of the specified camber value.

160 All signs and walkway brackets shall be placed as close to the brace points as possible. The Contractor shall verify that the dimensions are suitable for the type of fixture to be supplied.

2. Monotube

The required camber shall be achieved in accordance with the manufacturer's recommendations as detailed on the working drawings.

3. Cantilever Arms

170 Cantilever arms shall fit together at the flange connections between sections with a minimum gap of 1/16 in. on any flange assembly. The total of the gaps in any one connection shall not exceed 1/8 in. Double arm chords are octagonal tubular shape with 0.14 in./ft taper. Quadri-chord arms are circular shape with constant diameter.

4. Bridge Brackets

180 The location of the sign bracket may be shifted to avoid joints or stiffeners on the bridge. Before placing aluminum in contact with concrete, both the concrete and aluminum surfaces shall be coated with an aluminum-impregnated caulking compound. Where aluminum surfaces are to be placed in contact with steel, the steel surface shall be given one coat of zinc chromate paint and the aluminum surfaces shall be coated with an aluminum-impregnated caulking compound before placement. After the bolts have been tightened, the excess caulking compound shall be removed. All openings around the flanges shall be fully painted and shall be flush with the caulking compound.

802.08 Installing Signs

If new signs are to be installed on existing overhead sign structures, the existing mounting hardware, if applicable, may be reused. Bolts, nuts, and washers shall not be reused. Additional new hardware may be required to complete the mounting. All such

190 sign hangers protruding above the new signs shall be cut off flush to the top of the signs. Splicing or overlapping of sign hangers will not be allowed. All unused sign hangers and hardware shall be removed.

A minimum of two sign support bracket assemblies will be required for all signs having a width greater than 30 in. Signs 7 ft or less in height shall have sign support bracket assemblies mounted at a maximum spacing of 7 ft. Signs greater than 7 ft in height shall have sign support bracket assemblies mounted at a maximum spacing of 5 ft. Sign overhang beyond the end bracket assembly shall be not more than half the spacing of the bracket assemblies.

200 **(a) Sheet Signs**

Sheet signs shall be fastened to the post as shown on the plans. Rivets shall be used to fasten sheet signs mounted to panel or other sheet signs. Steel and plastic washers shall be placed as shown on the plans. Lock-nuts shall be tightened sufficiently so that the sign is held firmly against the post. If the sign sheeting is twisted or damaged, the sign shall be replaced.

Lock-nuts for cable span mounted signs shall be tightened so that the sign is held firmly against the cable. There shall be no deformation or twisting of aluminum sheeting, or damage to the reflective sheeting.

210

(b) Panel Signs

Panel signs shall be mounted as follows:

1. Up to and including 24 ft of sign width, clips shall be placed on both sides of each post at the top and bottom of the sign. Intermediate clips shall be placed one on each panel on each post and shall alternate left and right on each post.
- 220 2. Over 24 ft of sign width, double clips shall be used, one on the right side and one on the left side on each post per panel width, plus the sets necessary to attach the top and bottom of the sign.
3. Lock-nuts shall be torqued two full turns beyond snug fit.

Panels shall be bolted together on 24 in. centers with an allowable gap of no more than 1/16 in. between units. Panels shall be temporarily braced in accordance with the panel manufacturer's recommendations.

230

802.09 Removal, Resetting, or Relocation of Signs or Support Assemblies

Signs to be relocated shall be installed in accordance with the MUTCD and on new posts. Signs to be reset shall be installed in accordance with the MUTCD and on existing posts.

Signs or support assemblies to be removed shall be removed within five work days after the required replacement signs or support assemblies are installed. Concrete foundations shall be removed to a minimum depth of 1 ft below the ground surface. After concrete foundations have been removed, the area shall be backfilled and seeded or sodded in accordance with 621, or treated with a material which matches that in the surrounding area.

802.10 Roadway and Bridge Reference Signs

If existing roadway and bridge reference signs interfere with the prosecution of other work, such signs and posts shall be removed, stored, and then reinstalled within 25 ft of their original longitudinal location or as directed.

802.11 Method of Measurement

Sheet signs and panel signs will be measured by the square foot. Sheet signs will be measured as the smallest dimensions of a square or rectangle large enough to make the sign. However, triangular or trapezoidal signs will be measured as the smallest triangle or trapezoid required to make the sign.

If the pay unit for sheet signs is shown in the Schedule of Pay Items as each, the number of sheet signs specified, including posts, hardware, and erection, will be measured by the number of units installed.

Sign posts will be measured by the linear foot. Square sign posts will be measured from the top of the post to the termination of the post in the anchor base.

Traffic sign support foundations will be measured by the number of units of each type installed. No reduction will be made in a unit if class X material is encountered during foundation excavation.

If class X material is encountered during foundation excavation, the quantity to be measured will be that authorized and removed and in accordance with 206.10.

Structural steel, breakaway, will be measured by the pound. Such measurement will include the weight of breakaway sections such as stiffeners, base plates, and fuse plates.

Reference posts, including post, sign, and hardware, will be measured by the number of units installed.

Backfill of traffic sign support foundations will be measured in accordance with 211.09.

Overhead sign structures will be measured by the number of units of each type installed.

Overhead sign structures to be removed will be measured by the number of structures removed.

Existing ground mounted signs reset will be measured by the number of signs removed and reinstalled, complete in place.

802.12 Basis of Payment

290 The accepted quantities of sheet signs and panel signs will be paid for at the contract unit price per square foot, of the type and thickness specified, with legend, complete in place.

Sign post will be paid for at the contract unit price per linear foot for the type specified.

Structural steel, breakaway, will be paid for at the contract unit price per pound.

Ground mounted sign support foundations will be paid for at the contract unit price per each type specified.

300 Reference posts will be paid for at the contract unit price per each, complete in place.

Payment for class X material encountered during a foundation excavation will be made in accordance with 206.11.

Payment for backfill of support foundations will be made in accordance with 211.10.

310 The removal of signs, overhead structures, and sign assemblies, will be paid for at the contract unit price per each.

Existing ground mounted signs reset will be paid for at the contract unit price per each.

Payment will be made under:

	Pay Item	Pay Unit Symbol
320	Box Truss Sign Structure Foundation, _____ type	EACH
	Cable Span Sign Structure Foundation, _____ type	EACH
	Cantilever Sign Support Foundation, _____ type	EACH
	Overhead Butterfly Cantilever Sign Structure Foundation, _____ type	EACH
	Overhead Sign Structure, _____, Remove type	EACH

330	Overhead Sign Structure, Box Truss, _____ type	EACH
	Overhead Sign Structure, Bridge Bracket Assembly.....	EACH
	Overhead Sign Structure, Butterfly Cantilever.....	EACH
	Overhead Sign Structure, Cantilever, _____ type	EACH
	Overhead Sign Structure, Monotube	EACH
	Overhead Sign Structure, Tri-Chord, _____ type	EACH
	Reference Post.....	EACH
340	Sign and Supports, Wide Flange, Remove	EACH
	Sign Post, _____ type	LFT
	Sign Post, Square, _____, Reinforced Anchor Base..... type	LFT
	Sign Post, Square, _____, Unreinforced Anchor Base	LFT
	Sign, Double Faced, Sheet, With Legend, _____ thickness	SFT
350	Sign, Ground Mounted, Reset	EACH
	Sign, Overhead, Remove.....	EACH
	Sign, Panel, Relocate.....	EACH
	Sign, Panel, Remove.....	EACH
	Sign, Panel, With Legend.....	SFT
	Sign, Sheet Assembly, Relocate	EACH
	Sign, Sheet, and Supports, Remove.....	EACH
	Sign, Sheet, Relocate.....	EACH
	Sign, Sheet, Remove.....	EACH
	Sign, Sheet, With Legend.....	EACH
	Sign, Sheet, With Legend, _____ thickness	SFT
360	Structural Steel, Breakaway	LBS
	Tri-Chord Sign Structure Foundation, _____ type	EACH
	Wide Flange Sign Post Support Foundation, _____ type	EACH

The cost of staking sign and sign structure locations, including materials and labor, shall be included in the cost of the pay items in this section.

370 The cost of removal of signs, sign assemblies, sign lighting circuitry, supports, concrete foundations, backfill material, sodding, seeding, and necessary incidentals shall be included in the cost of overhead sign structure, remove.

The cost of walkway assembly, where applicable, shall be included in the cost of overhead sign structure.

802.12

380 The cost of roadway and bridge reference signs and posts to be removed, stored, and reinstalled shall be included in the cost of other pay items, unless otherwise specified. Roadway and bridge reference signs which are damaged by the Contractor shall be replaced with no additional payment.

The cost of the reinforced anchor base or unreinforced anchor base, angle bolts, and rivets shall be included in the cost of sign post, square.

No additional payment will be made if square sign posts are used in lieu of type A or type B posts.

390 The cost of all hardware to attach the sign to its structural supports, the reflective sheeting on both faces, and all legend shall be included in the cost of double-faced sheet signs.

The cost of all hardware necessary to assemble and attach the sign to its structural supports, all legend, and adjustments necessary to eliminate specular reflection shall be included in the cost of sheet sign or panel sign.

The cost of all necessary hardware including sign hangers, clips, and U bolts required for the mounting of signs to existing or new overhead sign structures shall be included in the cost of the sign.

400 The cost of modifying existing hardware to mount a new sign shall be included in the cost of the new sign.

The cost of identification markings for signs shall be included in the cost of the sign.

The cost of existing ground mounted sign removal, existing post removal, and storage shall be included in the cost of sign resetting. Existing signs or posts that are damaged by the Contractor shall be replaced with no additional payment.

410 The cost of sign removal, existing post removal, and all mounting hardware necessary to attach the existing sign to new posts, shall be included in the cost of the sign relocation.

The cost of concrete, reinforcement, stub, anchor bolts, conduit, and all necessary hardware shall be included in the cost of the support foundation.

The cost of furnishing and applying aluminum-impregnated caulking compound and zinc chromate paint as required in 802.07, shall be included in the cost of the pay items in this section.

420

The replacement of posts damaged by the Contractor's activities shall be without additional payment.

The cost of cutting the reinforcing bars and anchor bolts, furnishing the steel plate and welding the plate to the ends of the anchor bolts when class X excavation is encountered shall be included in the cost of the pay items in this section.

The cost of excavation, except for class X material, and necessary incidentals shall be included in the cost of the pay items in this section.

430

SECTION 803 – WELDING ALUMINUM ALLOYS

803.01 Description

This work shall consist of welding aluminum alloys for highway structures. The welding terms used shall be in accordance with definitions included in the AWS Definitions “MD” Welding and Cutting, AWS A3.0. Special conditions shall be fully explained by means of added notes or details.

The aluminum alloys to be welded under these specifications may be any of the following ASTM alloy designations:

10

- (a) wrought non-heat-treatable alloys 3003, 3004, 5052, 5083, 5086, 5456;
- (b) wrought heat-treatable alloys 6061, 6063; or
- (c) cast heat-treatable alloy 356.0.

MATERIALS

20

803.02 Materials

Materials shall be in accordance with the following:

Electrodes	924.01
Filler Material.....	924.01
Shielding Gases	924.01
Welding Rods	924.01

Material used for permanent backing shall be at least equivalent in weldability to the base metal being welded.

30

803.03 Welding Processes

The welding process shall be by the gas metal-arc process or the gas tungsten-arc process. Other processes may be used if prior approval is given.

(a) Preparation of Materials

Joint details shall be in accordance with design requirements and detail drawings. The location of joints shall not be changed without approval.

- 40 Edge preparation shall be by sawing, machining, clipping, or shearing. Gas tungsten-arc or gas metal-arc cutting may also be used. Cut surfaces shall meet the ANSI surface roughness rating value of 1000. Oxygen cutting shall not be used.

Surfaces and edges to be welded shall be free from fins, tears, and other defects which would adversely affect the quality of the weld. Dirt, grease, forming or machining lubricants, and organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing.

- 50 The oxide shall be removed from all edges and surfaces to be welded by wire brushing or by other mechanical methods such as rubbing with steel wool or abrasive cloth, scraping, filing, rotary planing, or sanding just prior to welding. If wire brushing is used, the brushes shall be made of stainless steel. Hand or power driven wire brushes which have been used on other materials shall not be used. Where mechanical methods of oxide removal are found to be inadequate, a standard chemical method shall be used. Welding shall be done within 24 h after chemical treatment. When gas tungsten-arc welding with direct current straight-polarity is being used, all edges and surfaces to be welded shall have the oxide removed by a standard chemical method.

- 60 Welding shall not be done on anodically treated aluminum unless the condition is removed from the joint area to be welded.

(b) Welding Procedure

- 70 All butt welds requiring 100% penetration, except those produced with the aid of backing, shall have the root of the initial weld chipped or machined out to sound metal before welding is started from the second side. Butt welds made with the use of backing shall have the weld metal fused with the backing. Where accessible, backing for welds that are subject to computed stress or which are exposed to view on the completed structure and which are not otherwise parts of the structure, shall be removed and the joints ground or machined smooth. In tubular members, butt welds subjected to computed stresses shall be made with the aid of permanent backing rings or strips.

The procedure used for production welding of any particular joint shall be the same as used in the procedure qualification for that joint.

- 80 All welding operations, either shop or field, shall be protected from air currents or drafts so as to prevent any loss of gas shielding during welding. Adequate gas shielding shall be provided to protect the molten metal during solidification. The work shall be positioned for flat position welding whenever practicable. All weld joints shall be dry at the time of welding.

The size of the electrode, voltage and amperage, welding speed, gas or gas mixture, and gas flow rate shall be suitable for the thickness of the material, design of joint, welding position, and other circumstances attending the work. Gas metal-arc

welding shall be done with direct current, reverse polarity. Gas tungsten-arc welding shall be done with alternating current or with direct current, straight polarity.

90 When the joint to be welded requires specific root penetration, the Contractor shall make a sample joint and a macro etched cross section of the weld to demonstrate that the joint welding procedure to be used is attaining the required root penetration. The sample joint shall have a length of at least 1 ft and shall be welded with the electrode, polarity, amperage, voltage, speed, gas mixture, and gas flow rate that are proposed to be used in production welding. Evidence on record may be accepted in lieu of the receding test.

100 Where preheat is needed, the temperature of preheat shall not exceed 350°F for heat-treated alloys and 600°F for non-heat-treated alloys. The temperature shall be measured by temperature indicating crayons or by pyrometric equipment. Heat-treated alloys shall not be held at the maximum preheat temperature or at temperatures near the maximum for more than 30 minutes.

(c) Weld Quality

Welds will not be accepted if they contain cracks in the welds or in the adjacent base metal, copper inclusions, or porosity in excess of that allowed by the AWS D1.2 Structural Welding Code.

Lack of fusion, incomplete penetration, or tungsten or oxide inclusions will be acceptable only if small and well dispersed.

110 Undercut shall be no more than 0.01 in. deep when its direction is transverse to the primary stress in the part that is undercut. Undercut shall be no more than 1/32 in. deep when its direction is parallel to the primary stress in the part that is undercut. Overlap shall not be allowed. All craters shall be filled to the full cross section of the welds. Welds having defects greater than the levels of acceptance specified herein shall be considered as rejected unless corrected in accordance with 803.03(e).

(d) Inspection

120 All welds shall be inspected visually to determine compliance with 803.03(c). In addition, all welds subjected to computed stress shall be inspected by the dye penetrant method except as specified below. For highway sign structures, the dye penetrant method shall be used on butt welds in columns and main chord members; on fillet welds connecting columns to bases and main chord members, including the associated flanges, gussets, or main load carrying brackets or members; and on fillet welds connecting flanges to the main truss chord members. The dye penetrant tests shall be performed in accordance with ASTM E165, method B. Dye penetrant inspection may be omitted provided that the inspector examines each layer of weld metal with a magnifier of 3X minimum before the next successive layer is deposited.

(e) Corrections

130 In lieu of rejection of an entire piece or member containing welding which is

unacceptable, the corrective measures listed below may be allowed if approval is obtained prior to making each repair. Defective welds shall be corrected by removing and replacing the entire weld, or as follows:

1. Cracks in Welds or Base Metal

The full extent of cracks shall be determined by dye penetrant method or other positive means. The cracks shall be removed throughout their length and depth, and rewelded.

140

2. Excessive Porosity and Lack of Fusion

All defective portions shall be removed and rewelded.

3. Copper or Tungsten Inclusions

All defective portions shall be removed and rewelded.

4. Excessive Concavity of Crater, Undercut and Undersize Weld

The weld shall be cleaned and additional weld metal shall be deposited.

5. Overlap

150

Overlap shall be reduced by removal of the excess weld metal.

The defective areas shall be removed by chipping or machining. Oxygen cutting shall not be used. Before rewelding, the joint shall be inspected to ensure all the defective weld has been removed. If dye penetrant has been used to inspect the weld, all traces of penetrant solutions shall be removed with solvent, water, heat, or other suitable means before rewelding.

803.04 Qualification of Procedures, Welders, and Welding Operators

160

Joint welding procedures shall be qualified previously by tests prescribed in the AWS D1.2 Structural Welding Code. Evidence of previous qualification of the joint welding procedures to be employed may be accepted.

All welders and welding operators shall be previously qualified by tests in accordance with the AWS D1.2 Structural Welding Code. Evidence of previous qualification of the welders and welding operators to be employed may be accepted. The same process and type of equipment that is required for execution of the contract work shall be used in qualifying welders and welding operators.

SECTION 804 – DELINEATORS

804.01 Description

This work shall consist of furnishing and erecting delineators in accordance with 105.03 and 107.12. Delineators shall be installed as required unless approval is obtained from the District Traffic Engineer to make modifications.

MATERIALS

10 **804.02 Materials**

Materials shall be in accordance with the following:

Delineator Posts.....	910.15
Delineators.....	926.02
Flexible Delineator Posts.....	926.01

The types of delineators shall be:

- 20 (a) D1 – single
- (b) D2 – double
- (c) D3 – triple.

Hardware for mounting delineators on posts shall be aluminum alloy in accordance with 919.01(d)2; stainless steel or galvanized steel in accordance with 919.01(d)1; or aluminum pull-through blind rivets. Bolts and lock-nuts or rivets shall be 3/16 in. diameter.

The types of flexible delineator posts shall be:

- 30 (a) type I - ground mounted
- (b) type II - surface mounted.

CONSTRUCTION REQUIREMENTS

804.03 Delineator Visibility

Delineator reflector units shall be positioned so as to be visible for a distance of 1,000 ft on tangent sections or at maximum visibility distances on curves. These locations shall be established under normal weather and atmospheric conditions when illuminated by the upper beam of standard automobile headlights.

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804.04 Posts

Posts shall be installed in accordance with 802.07.

804.05 Flexible Delineator Posts

These posts shall be installed according to the manufacturer’s recommendations and shall be set so that the top is no more than 1/2 in. from any vertical plane through the bottom.

804.06 Method of Measurement

50 Delineators with posts, delineator posts, and flexible delineator posts will be measured by the number of units of the type specified.

804.07 Basis of Payment

The accepted quantities of delineators, delineators with post, delineator post, and

30 Signal handholes shall be Type I or Type II as shown on the plans.

Pedestrian push buttons shall be the type designated in the contract documents, APS or Non-APS.

Joint sealant material shall be compatible with the roadway materials. If polyethylene duct loop wire is used, only sealant in accordance with 906.02(a)1 shall be used.

40 Timber poles to be furnished shall be in accordance with the current ANSI specifications and dimensions. They shall be of the length and class specified, be fully treated in accordance with 922.10(b), and dry. Minimum circumference at the top and at a point 6 ft from the butt shall be in accordance with ANSI specifications.

Steel strain poles greater than 24 ft in length shall be in accordance with 922.10(a).

The battery cabinet and program timing module for solar powered flashing beacons shall be from the QPL of Traffic Signal and ITS Devices.

CONSTRUCTION REQUIREMENTS

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805.03 General Requirements

The Contractor shall maintain existing traffic signals in operation until the Engineer determines that the progress of the work necessitates their removal. The new installation shall not interfere with the operation of the existing signal. The work shall proceed in such a manner that the signals are not out of service at any two adjacent intersections at any time. When the operation of an existing traffic signal needs to be interrupted before the new signal is placed in operation, the traffic shall be controlled at all times. The work shall be scheduled so that the interruption is limited to a minimum amount of time and at off peak hours. The new span and catenary installation shall not interfere with the operation of the existing traffic signal. Traffic shall be controlled at all times during the changeover when the existing traffic signal is turned off and the new signal is turned on. This changeover shall take place such that the interruption is limited to a minimum amount of time.

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When directed, temporary stop signs shall be erected at the intersection. When no work is in progress, the intersection shall have at least two operating signal faces for each approach. When the new installations are completed, all existing signal equipment and materials including timber poles, steel poles, and cast-iron handhole rings and covers which have not been used in the new installation shall be carefully removed. Regardless of the right to materials found on the project, as set out in other sections of these specifications, items designated in the contract documents, and field identified by the Department, as traffic signal equipment to be salvaged by the Department or local unit of government shall be stored at a secure site until such time as it is transported to the designated location, when designated as a pay item, or

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salvaged by the Department or local unit of government. The Contractor shall verify that the field identification placed by the Department has not been removed by vandalism or natural causes. If the Contractor has reason to believe that field identifications have been removed, the Department shall be contacted. The Contractor shall be responsible for all damage or loss of this equipment and shall repair or replace the damaged or lost equipment as directed. All signal equipment removed and not designated to be salvaged shall become the property of the Contractor and shall be disposed of in accordance with 202.

All existing painted metallic signal equipment to be reused, such as pedestals, bases, controller cabinets, signal weatherheads, pipe arms, shall be cleaned and painted with two coats of highway yellow enamel in accordance with 909.02(c). Existing metallic signal heads to be reused shall be painted with two coats of black or highway yellow enamel as directed by the Engineer and in accordance with 909.02(c). Aluminum poles and signal support structures shall not be painted.

Existing concrete foundations, which have not been used in the new installation, shall be removed to a minimum of 4 in. below the adjacent grade. The openings shall be filled with concrete and the surface finished and broomed, if they are located in sidewalk areas. Otherwise, they shall be filled with acceptable material conforming with the surrounding area.

Existing signal handholes to be removed, shall be filled after removing rings and covers, with B borrow with a minimum of 4 in. of concrete on top to bring it up to grade in a sidewalk area. Surfaces shall be finished and broomed. Otherwise, they shall be filled with acceptable material conforming with the surrounding area.

The signal controller timings will be provided and the Engineer shall be present when the signal intersection is to be placed in operation.

All electrical wiring terminations and splices; controller and cabinet set-up; and testing, review, and turn-on of all operational apparatus at each location shall be done by or in the presence of and under the responsible charge of an employee of the Contractor who holds an IMSA Traffic Signal Construction Technician Level II certification or an IMSA Traffic Signal Field Technician Level II certification. Installation inspections, troubleshooting, maintenance and repair of these systems shall be accomplished by, or in the presence of and under the responsible charge of, an employee of the Contractor who holds an IMSA Traffic Signal Construction Technician Level II certification. Supervision of non-electrical, traffic signal related construction work and traffic control shall be done by a person holding, at a minimum, an IMSA Work Zone Temporary Traffic Control Technician certification or an equivalent certification approved by the Department.

Before starting work, the Contractor shall provide the names of the Level II Traffic Signal Construction Technicians, the Level II Traffic Signal Field Technicians, and Work Zone Temporary Traffic Control Technicians who have been assigned to

perform signal related work, and a photocopy of each such person's certification card. If the Level II Traffic Signal Construction, or Field Technicians, or Work Zone Temporary Traffic Control Technicians are dismissed from the work, all signal related work requiring such certified personnel on the project site shall cease until the names and photocopies of certification cards for replacement personnel are provided to the Engineer.

130 Electrical work shall be executed in accordance with the requirements of the National Board of Fire Underwriters, the State Fire Marshal, and the power company which will furnish the electric service. The work shall be in accordance with any local regulations that may apply. The Department will arrange and provide for power service which the power company will bring to the point designated on the plans. Prior to the start of construction, the schedule of activities shall be coordinated with the power company and they shall be contacted again at least 14 days prior to the time the service work is to be completed.

140 The Department will obtain permits from local officials, companies, or individuals for the use of poles, right-of-way, or other property incidental to the installation of traffic signal. Although entering into the contract implies permission and authority to cut into and push under pavement, sidewalks, and alleys, any damage to underground utilities or interruption of such service shall be the responsibility of the Contractor. The Contractor shall be in accordance with local regulations as well as 107.08. Protective devices shall be in accordance with 107.12 and 801.

150 The location of signal heads, controllers, signal poles, signal cantilever structures, detector housing, disconnect hangers, and other installation items will be shown on the plans. However, a change in the location of an item may be ordered during the progress of the work. The work shall be completed as shown on the plans except for those changes specifically authorized in writing.

Flashing beacons shall flash at a rate for each beacon of 50 to 60 times per minute with the illuminated period from 1/2 to 2/3 of the total cycle. Second beacons, if specified, shall flash alternately with the exception of intersection control beacons which shall flash simultaneously.

805.04 Pole Installation

160 Working drawings for strain poles or cantilever structures shall be provided in accordance with 105.02. Metal poles shall be erected on concrete foundations and shall be reasonably plumb after installation of signal heads. The handhole side of the pole shall be at right angles to the direction of the signal cantilever arm or span, catenary, and tether. Signal cables shall be brought up inside the poles. Any steel pole, signal cantilever arm, or hardware not galvanized shall be painted with structural steel coating system in accordance with 619.09(a). The surface shall be prepared in accordance with 619.08(a) and 619.08(d). Paint shall be applied in accordance with 619. All rust, scale, and dirt shall be cleaned from the metal surface so that paint adheres to the surface.

The construction of concrete foundations shall be in accordance with 805.13. Timber poles shall be set a minimum of 7 ft in the ground and raked 12 in.

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805.05 Placing Signal Heads

Signal cantilever arm and span mounted signal heads shall have 17.5 ft minimum and 22.5 ft maximum clearance over the roadway unless there are visual obstructions which require lowering the signal head. A signal head over the roadway shall not have a clearance of less than 15 ft. Such signal heads shall be located over the intersection as shown on the plans. Such signal heads shall have a uniform clearance, which will be determined. Signal heads not mounted over a paved roadway, on the top or side of a pole, shall not be less than 10 ft or more than 15 ft above the sidewalk or, if none, above the pavement grade at the center of the roadway. Signal faces shall be directed to the proper approach lane in each direction. Flasher signal faces that supplement signs shall be mounted with the bottom of the housing at not less than 3 ft or more than 13 ft above the edge of pavement. Flasher signal faces that supplement signs shall be directed towards oncoming traffic. Pedestrian signal faces shall be mounted with the bottom of the housing at not less than 7 ft or more than 10 ft above the sidewalk. The pedestrian signal shall be in line with the pedestrian's vision at the appropriate crosswalk being used. Pedestrian push-buttons shall be mounted at a height of 3 1/2 to 4 ft above the sidewalk as shown on the plans. A pedestrian actuated signal sign shall be mounted immediately above the push-button.

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Signal heads shall be assembled and wired with one conductor, type THW, stranded wire. Where splices are made, a 2 ft minimum length of cable or wire in excess of that required for a continuous run shall be provided. Splices shall be twisted together and soldered or approved type connectors used. Each splice shall be completely insulated by wrapping with an approved tape and sealed with an approved electrical coating material. Splices shall be made in such manner that the connections are moisture proof. The cables coming out of the signal weatherhead shall be looped to form a drip loop. The drip loop shall be made so that the cables coming out of the weatherhead loop down below the elevation of the weatherhead to prevent water from following the cable into the weatherhead. If used, the splice indicated above shall be located in the top of the coils of cable forming the drip loop.

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Except for signal heads installed on existing traffic signal cantilever structures, all overhead signal heads shall have backplates, unless otherwise indicated on the plans. Backplates shall not be cut or altered upon installation.

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Signal heads shall not be installed until all other work has been completed. If it becomes necessary to mount signal heads for more than 2 h before the lights are to be turned on, the signal heads shall be hooded by placing sacks or similar cover over them so as to conceal them from traffic. Hooded signal heads are not allowed to be in place for more than five days. No signal head shall be left over night with the lights out unless it is hooded. Signal heads shall be securely mounted. The polycarbonate signal face shall be used only when securely supported on both ends of the assembly. In a span cable installation, a tether cable would satisfy this requirement.

When installing push buttons with accessible pedestrian signals, APS, features the Contractor shall verify that the audible tone is discernible from the mid-point of the crosswalk.

805.06 Grounding

220 All signal supports, signal controller supports, and entrance switches shall be grounded in accordance with the applicable requirements of 807.12.

805.07 Wire and Cable Installations

230 All cable runs attached to utility poles shall have code clearance relative to utility cables. They shall be no less than 18 ft above the ground level except over railroad tracks when a minimum of 27 ft clearance shall be maintained. All cable runs shall be installed in continuous lengths without splices between terminals except when necessary at handholes, junction boxes, pole signal bases, and pedestal bases. The type of cable and the number of conductors as well as the gauge shall be as shown on the plans unless otherwise specified.

Cable rings shall be used to support the signal cable on the signal span cable. They shall be spaced 12 in. on center. Cable shall be pulled through the conduit to the terminal panel in the controller cabinet. Caution shall be used to prevent damage to the cable when it is being pulled through conduit.

240 Coded cable conductors shall be used throughout the installation. Cable conductors shall be tagged at all detector housings, handholes, signal pole bases, and controller cabinets. At the ends of each cable, the tag shall be placed between 4 and 8 in. from the end of the wire and on the outer jacket. At all other locations, the tag shall be placed in the middle of the length of cable stored at the location. The tag shall be 1/2 in. wide, thermal printed black on yellow or black on white, polyester or nylon tape with permanent adhesive and shall be water, chemical and scratch resistant. The font shall be arial, size 10px. Tags shall be installed flag style around the cable with the backs of the tag ends placed together. Tags shall identify the cables by their use. The following are the uses which shall be indicated by the tags:

1. Power
2. Pedestrian Signal
- 250 3. Pedestrian Actuation
4. Signal
5. Detection Loop Identification
6. Interconnect.

Signal cables shall be tagged to identify the direction of travel. Detector lead-in cables shall be tagged throughout the installation with the corresponding loop tag information.

260 The tagging material and fastening shall be approved prior to proceeding with this work. The color coded wires shall be connected properly. The white wire shall be the

common or ground. Wire used for all identical indications of any individual phase shall be color coded and, where possible, shall use red wire to connect red lenses, orange wire to connect yellow lenses, and green wire to connect green lenses. Signal heads shall be assembled and wired before being installed. The testing of the loops shall be documented in the Loop Testing Table provided by the State.

805.08 Controller Cabinet, Signal Service, and Detector Housing Installation

270 Three document packets shall be prepared in accordance with 922.02(b) for each cabinet. Each packet shall be labeled with the name of the contract number, the intersection, the commission number of the signal, and the date of installation. One paper packet shall be placed in the cabinet, one paper packet shall be submitted to the Engineer, and one electronic packet shall be submitted to the Asset Manager in the Department's Traffic Management Division within two days after the signal is turned on. Information in the packets shall include all approved changes to the signal installation. All detector loop lead-in tags and detector rack labels shall reflect all approved changes to the signal installation.

280 Additional detector loop amplifier units and detector racks shall be supplied as directed by the Engineer. Additional detector racks shall include all cables or harnesses including, but not limited to a SDLC cable for each added rack, interface panels and a BIU to provide a complete and functional installation. Additional auxiliary BIU panels shall include all cables or harnesses including, but not limited to a SDLC cable for each additional auxiliary BIU panel, terminal strip on BIU panel and BIU to provide a complete and functional installation.

290 For signal cabinets installed by the Contractor, where no detector loop or lead-in work is included in the contract, the Contractor shall perform detector loop tagging, testing, and vehicle simulator testing in accordance with 805.09, only to the extent of documenting the test readings and confirming that all existing detector loops are connected correctly and all detector related equipment in the cabinet is operating correctly.

300 The controller cabinet shall be mounted securely on a pole, pedestal, or concrete foundation. All cabinets on concrete foundations shall be installed with the anchor bolts inside. Controller cabinets on poles or pedestals shall be mounted at a height of 38 in. \pm 2 in. Pole mounted controller cabinets shall be fastened with two stainless steel bands as shown on the plans. Signal cables and lead-in cable shall be run in conduit from the controller cabinet to the signal support base and to detector housing as indicated on the plans. Galvanized steel elbows shall be used on the detector housing as shown on the plans.

The Contractor shall wire the entrance switch and bring service cable up the riser and out the weatherhead and leave 4 ft of cable outside the weatherhead. The utility company, at their option, may bring the service cables to the load side of the entrance switch. Meter bases, if required, shall be obtained from the power company.

310 A minimum of 12 in. and a maximum of 18 in. of loop wire duct will be allowed
 in the detector housing for each loop lead. Concrete used in the installation of detector
 housings shall be in accordance with 506.04(a), except 506.05 will not apply and
 calcium chloride shall not be used. A CMDS in accordance with 506.03 shall be
 submitted, however, utilization of the Department provided spreadsheet is not
 required. Where a portion of the road is closed or where there is no vehicular traffic,
 then class A concrete in accordance with 702 may be used. The concrete shall be
 placed flush with existing surface and shall be covered with a steel plate during the
 setting time.

805.09 Loop Wire Detector Installation

320 This work shall consist of placement and testing of loop wire detectors in
 accordance with the installation details shown on the plans.

(a) Layout

330 The number, size, arrangement, and locations of loops shall be as shown on the
 plans except that loop spacing shall be adjusted to avoid PCCP joints. Loops shall be
 of a regular octagon shape with sides of 2 1/2 ft in length or a circular shape with a
 diameter of 6 ft. Loops placed longitudinally adjacent in the same lane shall be spaced
 15 ft from the center of one loop to the center of the next loop. Loops shall be arranged
 so that no loop wire will be bent at an angle less than 120°. Regardless of
 configuration, the loop installation shall match the intention of the loop tagging table.

Prior to installation, loop layout shall be approved in writing by the District
 Traffic Engineer. The Contractor shall notify the District Traffic Engineer a minimum
 of two business days prior to the date that loop layout approval is required. All
 roadway centerlines, edge-lines and stop-bars pertinent to loop layout shall be
 accurately and clearly identified at the time loop layouts are reviewed for approval.
 An outline shall be painted where the loops are to be placed. The Contractor shall
 ensure that the final installed location of each loop matches the intention and
 functionality of the approved layout for loop spacing, lane width and geometry.

(b) Installation

340 All loops and lead-in cables shall be tagged according to the plans and 805.07.

350 The slots shall be saw-cut as shown on the plans. A diamond cutting blade shall
 be used for sawing all loops. All saw-cut loops shall have individual saw cuts to the
 detector housing. Joints shall be overlapped such that the saw cut at the corner is full
 depth. Prior to installing roadway loop wire in the roadway saw cuts, the saw cuts shall
 be cleaned in accordance with the manufacturer's requirements for the joint sealant to
 be used. After proper cleaning, the loop wire shall be installed. All loops shall be wired
 clockwise as viewed from above. Loops shall be wired with four turns or as specified
 then gently tamped with a blunt non-metallic tool. Backer rod 2 to 4 in. in length shall
 be spaced every 12 in. around the saw cut above the wire and gently tamped to hold
 the loop wire snug in the bottom of the saw cut. Backer rod shall not be continuous

around the saw cut. After installation of the loop wire, the saw cut shall be sealed with a joint sealant material. The sealant shall be poured into the saw cut making a water tight seal. The joint sealant material shall be installed in accordance with the manufacturer's recommendations and 906.02. However, the joint configuration shall not apply. A copy of the sealant manufacturer's written application instructions shall be submitted to the Engineer prior to any sealant operations. If the Contractor elects to use a sealant complying with 906.02(a)2, the sealant material shall be heated in a
360 kettle or melter constructed as a double boiler with the space between the inner and outer shells filled with oil or other heat-transfer medium. This melter shall have a positive temperature control and a mechanical agitator. A backer rod shall be used for both cold applied sealants and hot poured sealants. The sealant material shall fill the saw cut as shown on the plans. All excess joint sealant on the pavement surfaces shall be promptly removed.

The black lead-in wire shall be spliced to the loop wire which goes back to the field. Such wire shall be tagged as "Out/Loop (No.)". The white lead-in wire shall be spliced to the loop wire which comes in from the field. Such wire shall be tagged as
370 "In/Loop (No.)".

(c) Splices

For each loop cable and lead-in cable entering a handhole, there shall be 6 ft of cable jacket remaining on each wire after the splice is complete. For each loop cable and lead-in cable entering a detector housing, there shall be 2 ft of cable jacket remaining on each wire after the splice is complete.

For all loop splices, there shall be a maximum of 1/2 in. of non-jacketed wire measured from the end of each cable jacket to the edge of the splice waterproofing
380 material. The splice of the loop wire and lead-in cable shall be soldered and waterproofed at the detector housing or handhole. Waterproofing shall consist of the use of heat shrink tubing which has an internal coating sealant material. The heat shrink tubing shall not be heated by means of a direct flame tool.

(d) Testing and Acceptance

All testing and acceptance procedures performed by the Contractor shall be performed in the presence of the Department personnel assigned by the Engineer. The Contractor shall notify the Engineer a minimum of two business days prior to the date testing is to be performed.
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The Contractor shall meter all new loop wire detectors or a new bank of loop wire detectors by means of instruments capable of measuring electrical values for installed loop wires and lead-in cables. The instruments shall measure inductance in microhenries, resistance in ohms, induced AC voltage in volts, and leakage resistance in megohms. All measuring tests shall be performed at the detector housing before the loop wire is spliced to the lead-in cable, and at the cabinet after the loop wire is spliced to the lead-in cable.

1. Electrical Testing

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a. Megohm Test Before Splice is Made at Detector Housing for Loop Wire

One of the megohm probes shall be connected to ground and the other probe shall be connected to the “in” or “out” loop wire. The remaining loop wire shall be isolated. The test shall then be performed.

b. Megohm Test Before Splice is Made at Detector Housing for Lead-in Cable

410 The two wires and shield of the lead-in cable at the cabinet shall be isolated and taped. The test shall consist of recording four readings taken at the detector housing or handhole as follows:

- (1) Connect the first megohm probe to ground and the second probe to the shield. Record the reading.
- (2) Connect the first megohm probe to the first lead-in wire and the second probe to the shield. Record the reading.
- 420 (3) Connect the first megohm probe to the second lead-in wire and the second probe to the shield. Record the reading.
- (4) Connect the first megohm probe to the first lead-in wire and the second probe to the second lead-in wire. Record the reading.

The lowest of the four readings taken above shall be recorded on the testing document for acceptance.

430

c. Megohm Test After Splice is Completed at Cabinet

This test shall be performed after the splice at the detector housing is completed. A water solution of one tablespoon of baking soda per pint of water shall be placed in a metal container. The metal container shall be grounded and the splice shall be fully submerged in the solution for 2 minutes. With the splice submerged, the shield of the lead-in shall be connected to ground at the cabinet. One megohm probe shall then be connected to ground and the other probe connected to one of the lead-in wires and the reading recorded.

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2. Delay Amplifier Settings and Vehicle Simulator Test

After all detector loop testing is complete, the detector amplifiers shall be installed and settings adjusted for proper operation at the intersection.

The frequency setting shall be adjusted using the amplifier’s display so that adjacent loops in the roadway that are connected to different loop amplifiers have a

minimum difference of 5 kHz. This operating frequency setting does not apply to loops that are adjacent to each other in the roadway but are connected to the same loop amplifier.

- 450 The sensitivity setting shall be adjusted using the amplifier's display. With an average size front wheel drive vehicle with the front axle centered over the back loop of a series of loops, the sensitivity shall be adjusted in accordance with the manufacturer's recommendations.

The count output shall be enabled for all loops designated as counting loops. The number of loops setting shall be set for loops designated for counting purposes and shall be set to the number of loops connected to that loop amplifier.

- 460 This test shall be performed by dragging a test vehicle across the loops using a non-conducting string. The test vehicle shall be fabricated with an 8 ft length of No. 6 bare copper wire formed into a 2 1/2 ft diameter circle. The two ends shall then be electrically spliced.

- 470 The test shall be started with all detector amplifiers turned 'Off' except for one approach. All amplifiers for that approach shall be turned 'On' and adjusted to the proper settings. All traffic for the approach being tested shall be stopped and not allowed to cross any loops during the test procedure for that approach. The simulator shall be dragged slowly across each loop system in the same direction as to simulate a vehicle driving through the loop system. As the simulator crosses each loop an IMSA level II certified Signal Technician shall verify that a call is displayed exclusively on the corresponding loop amplifier, controller detector input and controller phases. After completely verifying the loops on the first approach the amplifiers shall be left 'On', and the amplifiers for the next approach to be tested shall be turned 'On' and adjusted to the proper settings. The same procedure shall be followed for each remaining approach.

- 480 With large intersections, as the test proceeds, it may become difficult to verify that the calls are going to the correct detector inputs. In this case, traffic control shall be used to stop vehicles before reaching the loops for as many approaches as needed to accurately complete the testing to the inspector's approval. Testing may be paused between lanes to allow traffic to clear.

3. Acceptance Criteria

The Contractor shall record all test readings, in triplicate, on tabular forms provided by the Department or by copying the one included elsewhere herein. The Contractor shall complete, sign, and date the forms before submitting them to the District Traffic Engineer. The District Traffic Engineer will use these forms for recording the Department's readings on the corresponding space provided.

- 490 In order for the loop detector installation to be accepted, the electrical values shall be as follows:

- 500
- a. Inductance shall be between 80 and 800 μ H. Inductance shall be determined by means of digital readout meter which drives the field loop system.
 - b. Resistance shall be less than or equal to 8 ohms.
 - c. Induced AC voltage shall be less than or equal to 3 volt.
 - d. Leakage resistance shall be greater than 100 megohms.

Loop wire or lead-in cable failing to meet this requirement shall be replaced at no cost to the Department.

805.10 Other Vehicle Detection Systems

When required, the Contractor shall furnish and install an alternative vehicle detection system from the QPL of Traffic Signal and ITS Devices.

510 805.11 Steel Conduit

- Conduit shall be installed to a depth of no less than 2 ft or more than 5 ft below the finished grade unless otherwise specified or approved. Pockets or traps where moisture might accumulate shall be avoided. Conduit shall be placed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed unless otherwise specified. If specified, cuts in pavement areas shall be no greater than 24 in. wide. All cuts in the pavement and sidewalk areas shall be sawed. Sidewalk removal and replacement shall be to the nearest tooled joint. Jacking and drilling pits shall be kept at least 2 ft clear of the edge of any type of pavement or paved shoulder. Excessive use of water that may cause undermining of the pavement shall be avoided.
- 520 Continuous conduit runs shall not exceed 200 ft in length, unless otherwise shown on the plans.

- Expansion fittings as detailed on structure plans shall be installed where conduit crosses an expansion joint in the structure. Where it is deemed inadvisable to install expansion fittings in closely confined areas, the installation of approved flexible tubing may be allowed. Such expansion joints or tubing shall be the same size as the conduit. Any existing underground conduit to be incorporated into a new signal installation shall be cleaned with a mandrel and blown out with compressed air before cable is drawn into pipe. All new conduit runs shall be cleaned and swabbed before cables are
- 530 installed. All conduit ends shall be capped and shall remain capped until the Contractor is ready to pull cable into the conduit, at which time the caps shall be removed and conduit bushings placed on each end to protect the cable. The inside surface of the conduit shall be kept clean. Conduit to be installed, indicated on the plans for future use of signal cables, shall be left in place with a pull cord on its entire length.

Larger size conduit may be used with no additional payment, but when it is used, it shall be for the entire length of the run from outlet to outlet. Conduit runs as shown

on the plans are for bidding purposes only and may be changed, with permission, to avoid underground obstructions. A change order may be authorized if the conduit runs
 540 can be made on the opposite side of the street to that shown on the plans in order to avoid obstruction and traffic inconvenience or to avoid unnecessary tearing up of existing pavement.

805.12 PVC, HDPE, and Fiberglass Conduit

The method of installing PVC, HDPE and rigid fiberglass conduit underground shall be the same as for steel conduit where applicable except trenches for the conduit in areas with class X material as described in 206.02 shall be backfilled with 2 in. of natural sand before the conduit is placed in the trench. Materials excavated may be used for backfill, if approved. If the Engineer deems it necessary, approved B borrow
 550 shall be placed over the conduit to a depth of 12 in. and the remainder of the trench shall be filled with excavated material.

Schedule 40 or 80 PVC, Schedule 40 HDPE, or rigid fiberglass conduit may be used for conduit placed in trenches with expansion fittings used every 200 ft unless otherwise indicated on the plans. Schedule 80 HDPE, or steel shall be used for conduit that is jacked or bored. Schedule 80 PVC or rigid fiberglass shall be used for conduit on bridges or other structures. A No. 6 AWG copper or No. 14 AWG aluminum ground wire shall be included in all PVC, HDPE, and rigid fiberglass conduit.

805.13 Foundations

560 Foundations for traffic signal structures, cabinets, and pedestals of the type specified shall be constructed, or existing M foundations shall be modified, as shown on the plans or as directed. Pedestal bases shall be plumb and firmly attached to the anchor bolts either by using leveling nuts or shims if top of the foundation is not level. Grouting shall be used when necessary to fill any gap between pedestal base and foundation. Pipe pedestals shall be screwed tightly into the bases and secured with a stainless steel pin. Power and signal cables shall then be pulled from the base into the cabinet. Curing of concrete shall be in accordance with 702.22.

570 The foundation concrete for traffic signal cantilever structures shall be placed monolithically and shall have no construction joint. Structure bases shall be plumb and attached to the anchor bolts using leveling nuts. A tooled line or other type of permanent marking shall be provided on the top of the foundation to indicate the direction of the conduits.

During excavation of the foundation, all material shall be removed to the full depth as shown on the plans, except if class X material is encountered, the work shall be performed in accordance with 206.02(b).

805.14 Final Clean-Up

580 When the installation is completed, all disturbed portions of sidewalk, pavement, shoulders, driveways, and sod, shall be cleaned and any excess excavation or other materials shall be disposed. All cutting in the sidewalk and pavement areas shall be

done with a saw. Sidewalk removal and replacement shall be to the nearest tool joint. Unless otherwise directed, cuts in pavement areas shall be no greater than 12 in. in width.

805.15 Method of Measurement

590 Controller and cabinet; controller cabinet foundation; disconnect hanger; handhole, signal; loop detector delay amplifier; loop detector rack; pedestrian push button; pedestrian signal head; signal cantilever structure, combination arm; signal cantilever structure, drilled shaft foundation type; signal cantilever structure, dual arm; signal cantilever structure, single arm; signal cantilever structure, single arm, combination arm; signal cantilever structure, spread footing foundation type; signal detector housing; signal pole; signal pole foundation; signal service; span catenary and tether; traffic signal head; and traffic signal head, retrofit; will be measured by the number of units installed.

600 The pay length for a signal cantilever arm or combination arm will be the length shown in the Schedule of Pay Items.

Conduit of the type specified will be measured by the linear foot from outside to outside of foundations. All signal cable will be measured by the linear foot.

Saw cut for roadway loop detector and sealant will be measured by the linear foot for the full depth of slot cut in the pavement as shown on the plans or as directed.

610 If class X material is encountered during foundation excavation, measurement will be made in accordance with 206.10.

Traffic signal installation, flasher installation, miscellaneous equipment for traffic signals, and final cleanup in accordance with 805.14 will not be measured for payment. Reinforcing bars will not be measured for payment.

Traffic signal equipment removal will be measured per each installation to be removed. Transportation of salvageable signal equipment will not be measured.

805.16 Basis of Payment

620 Traffic signal installation and flasher installation, all of the type, new or modernized, and the location number specified, will be paid for at a contract lump sum price.

If specified as pay items, controller and cabinet; controller cabinet foundation; disconnect hanger; handhole, signal; loop detector delay amplifier; loop detector rack; pedestrian push button; pedestrian signal head; signal cantilever structure, single arm; signal cantilever structure, combination arm; signal cantilever structure, single arm, combination arm; signal cantilever structure, dual arm; signal cantilever structure, drilled shaft foundation type; signal cantilever structure, spread footing foundation type; signal detector housing; signal pole; signal pole foundation; signal service; span

	Signal Cantilever Structure, Combination Arm _____ ft.....	EACH
	length	
680	Signal Cantilever Structure, Drilled Shaft Foundation, _____	EACH
	type	
	Signal Cantilever Structure, Dual Arm ___ ft, ___ ft.....	EACH
	length length	
	Signal Cantilever Structure, Single Arm _____ ft.....	EACH
	length	
	Signal Cantilever Structure, Single Arm ___ ft,	
	length	
	Combination Arm ___ ft.....	EACH
	length	
690	Signal Cantilever Structure, Spread Footing	
	Foundation, _____	EACH
	type	
	Signal Detector Housing.....	EACH
	Signal Pole, _____, _____ ft	EACH
	type length	
	Signal Service.....	EACH
	Signal Pole Foundation, _____ in. x _____ in. x _____ in.....	EACH
	Span, Catenary, and Tether	EACH
	Traffic Signal Equipment, Remove	EACH
700	Traffic Signal Head, _____, Section, _____	EACH
	no. lens size	
	Traffic Signal Head, _____ Section, Retrofit	EACH
	no.	
	Traffic Signal Installation, _____, Location No. _____	LS
	type	
	Transportation of Salvageable Signal Equipment	LS

710 The cost of the controller and cabinet, conduit, foundations, vehicle detection, pedestrian signals, signal heads, signal poles, signal service, signal cable and all equipment or materials required to complete the installation shall be included in the cost of traffic signal installation.

The cost of the controller and cabinet, conduit, foundations, signal heads, signal poles, signal service, signal cable and all equipment or materials required to complete the installation shall be included in the cost of flasher installation. For a solar powered flasher, the cost of the solar panel, battery cabinet, program timing module, signal heads, wiring, and all hardware required to complete the installation shall be included in the cost of flasher installation.

720 The cost of the controller assembly, standard loop detector racks, all wiring, hardware, and associated equipment required to operate the intersection shall be included in the cost of controller and cabinet.

805.16

The cost of concrete, conduits, grounding bushings, ground rod, ground wire, drainage, anchor bolts, and all hardware required to complete the installation shall be included in the cost of controller cabinet foundation.

The cost of all work and hardware required to properly install loop detector delay amplifier, counting or non-counting, as shown on the plans or as directed shall be included in the cost of loop detector delay amplifier.

730

The cost of concrete reinforcing pipe and ring or polymer concrete box, cover and attachment hardware, handhole bottom if required, and aggregate as shown on the plans shall be included in the cost of handhole, signal.

The cost of any supplementary loop detector rack, all wiring, hardware, detector panel, BIU, and associated equipment shall be included in the cost of the loop detector rack.

740

The cost of the push button, pedestrian actuated signal sign, any accessible pedestrian signal components, and all hardware required to complete the installation shall be included in the cost of pedestrian push button.

The cost of signal face hook-up wire, pole plates and arms for side mounts, pipe arms, signal brackets, bulbs, weatherhead, and all additional hardware required to assemble a combination of pedestrian signal indications as shown on the plans shall be included in the cost of pedestrian signal head.

750

The cost of the slot cut on the pavement, backer rod, loop sealant, and all testing in accordance with 805.09 shall be included in the cost of saw cut for roadway loop and sealant.

The cost of all work and hardware required to properly install overhead or underground signal cable, signal, fiber optic, or interconnect, as shown on the plans or as directed shall be included in the cost of signal cable.

The cost of signal pole section 2 and combination arm, all hardware including the metal skirt base plate, where necessary, to complete the installation as shown on the plans shall be included in the cost of the signal cantilever structure, combination arm.

760

The cost of concrete, reinforcing bars, conduits, ground rod, ground wire, grounding bushings, anchor rods, and all hardware required to complete the installation of the drilled shaft or spread footing foundation for signals shall be included in the cost of signal cantilever structure, drilled shaft or spread footing foundation.

The cost of signal pole and dual arms, all hardware including the metal skirt base plate, where necessary, to complete the installation as shown on the plans shall be included in the cost of the signal cantilever structure, dual arm.

770 The cost of signal pole section 1 and single arm, all hardware including the metal skirt base plate, where necessary, to complete the installation as shown on the plans shall be included in the cost of the signal cantilever structure, single arm.

The cost of signal pole section 1, 2 and single arm, combination arm, all hardware including the metal skirt base plate, where necessary, to complete the installation as shown on the plans shall be included in the cost of the signal cantilever structure, single arm, combination arm, when structure with single arm and combination arm is required in the same contract.

780 The cost of aluminum casting, enclosure concrete, conduit and elbow, and all hardware required to complete the installation shall be included in the cost of signal detector housing.

For a steel signal pole, the cost of the base plate, metal skirt base plate, handhole and cover grounding lug, 2 in. pipe cable entrance, J hook, and top cover as shown on the plans shall be included in the cost of signal pole.

790 For a timber signal pole, the cost of downguys, anchor rods, downguy guards, and hub-eyes as shown on the plans, and all hardware required to complete the installation shall be included in the cost of signal pole.

For a signal pedestal, the cost of the pedestal metal base, pedestal pole, pole cap, and all hardware required to complete the installation shall be included in the cost of signal pole.

The cost of concrete, reinforcing bars, conduits, ground rod, ground wire, grounding bushings, anchor rods, and all hardware required to complete the installation of the signal pole foundation shall be included in the cost of signal pole foundation.

800 The cost of weatherhead, 1 in. conduit riser, entrance switch, 1 to 2 in. conduit reducer, ground rod, ground wire, and all hardware required to complete the installation, including the meter base when required and supplied by the utility company shall be included in the cost of signal service.

The cost of steel pole bands or straight eye bolts, span, catenary, and tether of wire rope cables, cable rings, type A support cable, wire rope clips, safety cable, thimble, service sleeve, and all hardware required to complete the installation as shown on the plans shall be included in the cost of span, catenary, and tether.

810 The cost of signal face hook-up wire, pole plates and arms for side mounts, mid-mast arm mount, pipe arms, signal brackets, visors, louvers, bulbs, span hanger, backplates, balance adjuster, weatherhead, and all additional hardware required to assemble a combination of signal faces as shown on the plans shall be included in the cost of traffic signal head.

807.01

The cost of removing the existing traffic signal head, salvaging the existing LED indicators, replacing the existing signal head with a new housing and backplate, and reinstalling shall be included in the cost of traffic signal head, retrofit.

820

The cost to repair or replace damaged or lost salvageable traffic signal equipment shall be at no additional cost to the Department.

The cost of excavation, backfill, final cleanup in accordance with 805.14, the cost of re-painting existing metallic equipment to be re-used and necessary incidentals shall be included in the cost of the pay items in this section.

SECTION 806 – BLANK

SECTION 807 – HIGHWAY ILLUMINATION

807.01 Description

This work shall consist of installing wire, cable, conduit, lighting standards, luminaires, lamps, and incidental materials in accordance with 105.03.

Lighting installations shall be in accordance with the National Electrical Code and the National Safety Code.

10

MATERIALS

807.02 Materials

Materials shall be in accordance with the following:

	Casting for Handholes	922.17(a)
	Coarse Aggregate, Class D or Higher, Size No. 53	904.03
	Concrete, Class A	702
	Conduit	922.19
	Highway Illumination Materials.....	920.01
20	Line Hardware	922.10(e)1
	Paint.....	909
	Reinforced Concrete Pipe.....	907.02
	Reinforcing Bars.....	910.01

Manufacturers’ descriptive and technical literature for major items shall be submitted for approval. Where it is normal trade practice to furnish a warranty, a warranty shall be furnished on all major items such as luminaires, lamps, poles, brackets, cable-duct, wire and cable, fuse connectors, and ballasts. The effective date of the warranty shall commence on the date of final acceptance. These items shall bear the seal of approval of the UL.

30

All flexible conduit shall be galvanized steel, polyvinyl jacketed, and watertight.

Reinforcing bars shall be epoxy coated.

CONSTRUCTION REQUIREMENTS

Existing highway illumination shall be maintained on all projects unless discontinuance of the highway illumination is specifically allowed.

40

807.03 Working Drawings

Working drawings shall be submitted in accordance with 105.02 for light pole assemblies, luminaires, and external drive assemblies.

Working drawings for each luminaire model submitted shall include the luminaire specifications and data sheets.

For contracts not utilizing the QPL for Luminaires, working drawings for luminaires shall also include the Illumination Engineering Society of North America, IESNA, photometric distribution file if the file number varies from what is shown on the plans. The IESNA photometric distribution file shall be in either Visual, developed by Acuity Brands Lighting, or AGi32 from Lighting Analysis, Inc.

50

Working drawings for conventional light pole shall show the outside shaft diameter, height, wall thickness, mast arm length and rise, mast arm diameter and thickness, handhole details, grinding details, materials required, and complete anchor-bolt details including bolt circle-projection and hardware. If a breakaway base is required, its details shall be shown.

When requested, sufficient design data shall be furnished with the drawings to verify that conventional light pole is in accordance with wind load, deflection, vibration, and breakaway requirements. All of the above shall be based on the light pole details shown on the plans. After approval, the Engineer shall be advised of where changes to the Installation Summary sheets are being made because of existing roadside conditions. Where necessary, additional light pole working drawings shall be submitted for approval.

60

If a light pole is designed to support a larger luminaire than that specified, such information shall be shown on the working drawings. A type C certification in accordance with 916 shall be provided for the breakaway devices certifying that the breakaway devices are in accordance with the breakaway criteria of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

70

Working drawings for high mast towers shall show the pole height, number of sections, the pole shaft data for each section, luminaire lowering ring assembly, handhole details, materials required, welding details, and complete anchor bolt details including bolt circle-projection and hardware.

80 If the high mast is a non-standard design, the following design calculations and data shall be submitted for approval prior to the fabrication of a high-mast pole.

- (a) general dimensions of all component parts;
- (b) the maximum moments, the section modulus required, and the section modulus furnished at the base of the pole, at all splices, at the connection of the ring, and at least every 20 ft;
- 90 (c) calculation of stresses in the base plate, connection attachment, and anchor bolts;
- (d) maximum deflection at the top of the structure under the specified loading; and
- (e) the dimensions and wiring diagrams of the external drive system connection to the pole in accordance with 920.01(b)7.

The working drawings shall include the dimensions and wiring diagram of the standard connections of the external drive system.

100

807.04 Excavation

All excavation for the roadway lighting installation shall be performed in accordance with the dimensions, elevations, and grades shown on the plans or as directed. If class X material is encountered, foundation excavation shall be completed in accordance with 206.

(a) Trench Excavation

Excavation may be accomplished either manually or with mechanical trenching equipment. The blades of road patrols or graders shall not be used to excavate the trenches. The depth of trenches shall be a minimum of 2 ft. Walls of trenches for cable-duct or conduit shall be essentially vertical. The bottoms of trenches shall be smooth and free from aggregate larger than 1/2 in. Bracing, shoring, and sheathing shall be provided as necessary. If the excavation, through accident or otherwise, is below the required level, the excess excavated area shall be refilled in a satisfactory manner with no additional payment. The accumulation of water in excavated areas shall be prevented by the use of pumps or other approved means. When rocks or other materials which might damage the cable-duct or conduit are encountered, the excavation shall be extended to a depth of at least 27 in. and backfilled with a 3 in. compacted layer of sand or earth containing no particles that would be retained on a 1/4 in. sieve. No extra payment will be made for this additional excavation or backfill.

120

(b) Foundation Excavation

If possible, excavation for concrete foundations shall be accomplished by means of drilling with an auger of sufficient size to admit the width of the foundation. Work

shall be so scheduled that all open excavations are poured with concrete during the work day they are dug. No excavations shall remain open over night or over a weekend or holiday. Accumulated water shall be removed from the excavation before concrete is poured. If class X material is encountered, foundation excavation shall be completed in accordance with 206.02(b).

130

(c) Landscape Replacement

Where roadside shrub plantings interfere with the location of illumination installations, the plantings shall be reset at other locations and at such times as directed, all in accordance with 622. The cost of this work will not be paid for directly, but shall be included in the cost of other pay items.

All slopes for foundation grading shall be sodded. Sod shall be placed in accordance with 621.

140

807.05 Backfilling

All suitable materials removed from the excavated areas shall be used in refilling cable-duct and conduit trenches. No excavated materials shall be wasted without authorization. Materials authorized to be wasted shall be disposed of as approved. Backfill for trenches shall be placed in layers not to exceed 6 in., loose measurement. The first layer shall be sand or earth containing no particles or lumps that would be retained on a 1/4 in. sieve. The second layer shall contain no particles or lumps that would be retained on a 1 in. sieve. Subsequent layers shall contain no particles or lumps that would be retained on a 3 in. sieve. The second layer and each subsequent layer shall be compacted with pneumatic hand-tampers to prevent any future settlement of the backfilled area. Backfilling of cable-duct and conduit trenches around light pole foundations, handholes, manholes, and other structures shall be in accordance with the applicable provisions of 211. Finish grading of earthwork shall be accomplished in a satisfactory manner.

150

807.06 Placing Conduit

Conduit shall be placed as shown on the plans and in accordance with applicable provisions of 805.11. Conduit shall be of a size to readily enable the passage of the cable-duct being used.

160

Conduit installed under pavement shall extend a minimum of 2 ft beyond the edge of the paved surface or improved shoulder. The ends of such conduit shall terminate a nominal 2 ft below the ground surface. The ends shall be pitched so as to provide a positive drain to the surrounding soil. The ends shall be protected by threaded cap fittings until the time of installation of cable or cable-duct. Threaded bushing fittings shall be used on all ends before cable installation.

170

Conduits installed in bridge railing concrete sections shall terminate a minimum of 2 ft beyond the end of the bridge railing outside of the paved surface and a minimum of 2 ft under the ground surface. Existing conduit shall be extended as necessary to satisfy these requirements.

Hot dipped galvanized, malleable pipe straps and spacers shall be used to attach conduit to bridge structures. Galvanized steel conduit hangers or pipe clamps will not be allowed. Pipe straps of the proper size shall be installed 4 ft center to center along the conduit. When fastening pipe straps to concrete, a 3/8 in. by 2 1/2 in. galvanized steel lag screw, with an approved sleeve, shall be used; however, other approved expansion anchors may be used. The pipe strap and spacer shall be bolted to the steel beams.

- 180 Conduit for service supply shall be mounted on a service pole, either company or State owned, near the right-of-way line. For simple supply circuits, one straight, continuous, conduit riser shall be used. The top end shall terminate with a weatherhead device, and the lower end shall terminate at least 2 ft below ground level with a threaded grounding bushing fitting. Unless otherwise directed, the weatherhead shall be 24 ft above the ground. However, the actual elevation of the weatherhead shall meet the requirements of the utility concerned.

807.07 Connections in Base of Light Pole

- 190 Conductors shall be electrically bonded to each other, as required to satisfy circuit requirements, by means of compression type fittings of the style and type shown on the plans. Inhibitor compound shall be used on each compression connection. Conductor identification shall be maintained by connecting like color connectors.

A multiple conductor compression fitting shall be used to connect supply conductors and an insulating link used to provide an extension as shown on the plans. These fittings shall be covered with snap-on fiber or plastic covers designed to protect them from electrical contact. Taping will not be allowed. The bare extension of the supply conductor from the multiple fitting to the insulation link shall be no longer than necessary to admit the application of the snap-on cover for the multiple fitting.

- 200 The pole circuits shall be connected by means of easily separated, single conductor connector kits. The connector kit on the “hot” side of the pole circuit shall be fused. The connector kit for the neutral side shall not be fused. Fuses shall be of the “KTK-10” series with a rated capacity three times the operating amperage of the luminaire. If the required capacity is not a standard size, the next larger size fuse shall be used.

The connector kit on the “hot” side of the pole circuit shall have the following features:

- 210
- (a) a line side and load side housing made of plastic or water resisting synthetic rubber suitable for direct burial in the ground or installation in sunlight;
 - (b) a water seal between the two housings;
 - (c) each housing permanently marked “Line Side” or “Load Side”;

- 220 (d) a spring loaded, 90% minimum conductivity, contact suitable for gripping the “KTK-10” cartridge fuse in each housing. These contacts shall be fully annealed;
- (e) an interior arrangement for each housing that will adequately receive and rigidly maintain the fuse contacts;
- (f) a terminal on each housing designed for a crimp type connection to the conductor that securely retains the conductor in the proper position;
- 230 (g) a water seal between the conductor and the housing;
- (h) a disconnecting means that shall retain the fuse on the load side when disconnected and keep the conductive parts of the line side inaccessible; and
- (i) sufficient silicone compound provided and used to lubricate the metal parts and the rubber housings or boots for easy assembly.

240 The neutral side connector kit shall be similar in all respects to that described for the hot side except that a dummy fuse shall be used for the purpose of completing the electrical circuit. The bayonet disconnect feature of the connector kits shall be part of the load side of both the neutral side and the hot side conductors. The line side shall have a socket to receive the bayonet. These kits shall be installed in the pole circuit between the luminaire terminals and the compression connection to the underground distribution circuit as shown on the plans. A separate insulated conductor shall be used to connect the neutral of the underground distribution circuit and the neutral of the pole circuit to the ground lug in the pole base from the point at which both neutrals are connected together by a compression connection. The bayonet disconnect features from the neutral side and the hot side connector kits as cited above shall be included

250 in the sign structure circuitry when luminaires are installed on the sign structures. Consecutive roadway luminaires in a circuit shall be alternately connected to opposite load conductors R or B as specified in the plans to balance the load. Sign luminaires on individual structures shall be similarly connected.

807.08 Placing Wire and Cable

(a) Underground

260 All underground distribution conductors shall be continuous runs between splice points. Unless otherwise authorized, splice points shall be inside the bases of light poles, inside handholes, in service distribution boxes, at point of connection to power supply in switch boxes, or in junction boxes. All splices shall be made with the proper connector in accordance with 807.07.

1. Through Cable-duct in Trench

Cable-duct shall be placed either in a trench or plowed into place. Cable-duct shall be installed without sharp bends or kinks and in straight runs so as to enable withdrawal of a conductor and the installation of new conductor without additional excavation or backfill.

270 Plowed cable-duct shall be installed at a minimum depth of 2 ft in a single cavity gored into the earth by a vibrating plow blade. The equipment used for plowing the cable-duct shall be designed specifically for that purpose with the power and versatility to easily and accurately bury the various sizes of cable-duct under all normal soil conditions. This equipment shall place the cable-duct without twisting, kinking, or damaging it in any way. Dragging or pulling the cable-duct from the start of the trenching operation will not be allowed. Where two ducts are to be installed parallel to each other, the distance between them shall be no less than 12 in. and no more than 24 in.

280 The plastic duct of the cable-duct shall be terminated 4 in. above the top of foundations or 4 in. inside handholes with sufficient excess conductors as directed. All terminations of this plastic duct shall be beveled and free from any sharp edges or burrs. Insulation of the electrical conductor shall not be damaged when cutting the duct.

2. Through Cable-duct in Conduit

The underground distribution circuit shall be protected by galvanized steel conduit when installed under pavement, in road shoulders, or elsewhere as shown on the plans or as directed.

290 Cable-duct shall be pulled through the entire length of galvanized steel conduit if at all possible. If this is not possible, written authorization shall be obtained to allow the duct to be cut away and the conductors installed in the conduit with a minimum of 2 ft of duct extended into the conduit. Where so authorized, the plastic duct shall be terminated in the proper transition fitting attached to the end of the conduit and each conductor of the cable-duct assembly shall continue undamaged and uninterrupted through the galvanized steel conduit to the other end of the conduit where a transition to the cable-duct shall be used again and the cable-duct shall continue uninterrupted to the next designated splice point. All transitions from galvanized steel conduit to cable-duct shall be accomplished with the proper adapter. This adapter shall provide a durable, watertight transition that has a smooth uniform interior.

300

3. Cable Markers

The location of underground conduits or cable-ducts shall be marked with cable markers. The marker shall be placed at all changes in direction, where the underground distribution circuit is split, and at a maximum of 400 ft intervals on straight runs. Cable markers shall be a slab of concrete 2 ft square by 4 in. thick, with the word "Cable" die impressed into the surface of the marker, a minimum depth of 3/8 in. with letters a minimum of 2 in. high. Arrows showing the direction of the cable shall be die

310 impressed or saw cut a minimum depth of 3/8 in. into the marker surface.

Curing of the concrete shall be in accordance with 702.22. The cable marker shall have a smooth metal trowel finish without scaling.

(b) In Conduit Risers

Cable-duct shall enter the bottom of the conduit riser with a sweeping radius bend and continue up the riser to within 3 in. of the top of the conduit riser. At this point the plastic duct shall be terminated and the conductors shall continue uninterrupted and undamaged into the service cabinet, underpass switchbox, or through the weatherhead
320 with sufficient excess to make the required connections.

(c) Through Conduit in Bridge Coping

Where a cable-duct underground distribution circuit is run through conduit installed in bridge coping, the duct shall be cut away and the conductors shall be installed in the conduit with at least 2 ft of duct extended into the conduit. The conductors, through this transition, shall be continuous between authorized splice points. Where more than one light pole is to be installed on the same side of the bridge structure and connected to the same distribution circuit, the cables pulled between these light poles shall be of the same type and size used in the cable-duct underground
330 distribution circuit.

(d) Aerial Cable

Aerial cable for overhead distribution circuits shall be supported and terminated as shown on the plans. The aerial cable shall have a sag of no more than 5% of the distance between lighting poles except where slack spans are indicated on the plans. Aerial cables shall have a minimum vertical clearance of 18 ft.

807.09 Lighting Handholes

Handholes shall not be placed in areas subject to flowing or ponding water.
340 Handholes shall be installed with the top flush with adjoining surfaces. Precast handholes with integral bottoms will be considered acceptable.

Multiple compression fittings and insulating links installed in handholes shall be taped and waterproofed by application of an approved waterproofing device. The insulation around the area to be waterproofed shall be cleaned before applying the waterproofing device. These waterproofing devices shall be designed for insulating multi-conductor cables with a minimum voltage carrying capacity of 600 volts.

Handholes of an alternative material will be allowed as a substitute for a street
350 and alley handhole providing that they meet the requirements of 922.17(b) and can be placed at a location which meets both of the following conditions:

- (a) there is no evidence of vehicles traveling over the area where the handhole is to be located; and

807.10

- (b) it is located a minimum of 15 ft from the edge of pavement, unless it is protected by guardrail, non-mountable curb, a structure, or an non-traversable ditch.

360 The handhole shall be backfilled with sand or earth containing no particles that would be retained on a 1/4 in. (6.3 mm) sieve. The backfill shall be placed as shown on the plans. No additional payment will be allowed for this backfill.

807.10 Concrete Foundations For Light Poles

Foundations shall be class A concrete in accordance with 702. Footings may be either round or square in shape as shown on the plans.

370 Anchor bolt circle dimensions shall be furnished and the anchor bolts shall be in accordance with 920.01(a)7. A rigid template shall be used to center the anchor bolts in the foundation. Unless otherwise specified, the template shall be oriented so that the mast arm of the light pole is perpendicular to the center line of the roadway.

Each foundation installation shall have provisions for grounding the light pole in accordance with 807.12. The tops of the concrete foundations shall be constructed level and only shims used to rake the light pole will be allowed. Shims shall not be used with break-away couplings. Each foundation shall have an imprinted arrow or arrows on the top of the foundation to indicate the direction of the cable duct run.

380 Foundations for high mast towers shall be constructed prior to constructing foundations for conventional roadway lighting.

(a) Cast-in-Place Foundations

390 If the sidewalls of the excavated areas remain firm and stable, concrete may be poured directly against the dirt below the level of the top 6 in. form. Otherwise, the concrete foundation shall be fully formed by means of a paper preformed liner or other approved means. However, the foundation shall be formed to the proper size for the top 6 in. before concrete is poured. If a paper liner is used, it may be withdrawn as the concrete is placed or it may be left in place permanently. If the liner is left in place, all voids between the excavation walls and the form shall be filled and compacted using coarse aggregate No. 53. If the liner is withdrawn, the top 12 in. of the foundation shall remain formed until the concrete has obtained initial set.

(b) Precast Foundations

Precast foundations shall be complete with reinforcing bars, tie bars, anchor bolts, and entry sleeves located to provide a level mounting for the light pole after installation. The grounding coil, as shown on the plans, may be used for grounding light pole set on precast foundations. Foundation backfill shall consist of coarse aggregate No. 53.

(c) Grading of Foundations

400 Foundation projection above the finished grade shall be as shown on the plans.

The excavated material may be used for this grading if it is not granular in nature and will readily stabilize and support the growth of sod. If the excavated material is unsuitable, it shall be properly disposed of and approved materials used. The area shall be sodded. Sodding will be in accordance with 621.

807.11 Placing Light Poles

(a) Light Poles Under 45 ft in Height

410 The light pole assembly shall consist of a metal pole, a shoe base, a frangible breakaway base or coupling where shown on the plans, and a metal mast arm for attaching the luminaire. The unit shall be assembled on the ground. Pole circuit wiring shall be installed and the luminaire shall be attached prior to erection. The factory finish of the pole assembly shall be protected from marks, blemishes, scratches, or other damage. Slings and chokers for lifting purposes shall be of nylon or other approved material. Chains, metal rope, or other abrasive materials shall not be used for lifting devices. If damage to the factory finish occurs, repair or replacement shall be as directed.

420 The base plate shall be designed to carry the pole assembly. The plate assembly shall be supported by a transformer base, which shall be in accordance with the breakaway requirements in the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

After erection and attachment to the foundation, the pole assembly shall be plumb. The luminaires shall be level in both horizontal areas. Shims shall not be used with breakaway couplings. Shimming will be allowed on other types of installations to rake the pole assembly to obtain the desired attitude of the luminaire where the combined weight of the pole and mast arm requires it and the luminaire saddle will not allow the
430 adjustment. The mast arm shall be perpendicular to the axis of roadway travel unless special orientation is noted on the plans. Unless otherwise specified, the lighting system shall consist of metal pole supports for the luminaires with an underground electrical supply system.

(b) High Mast Towers of 60 ft Height and Over

High mast tower pole sections shall be mechanically fitted in the field using factory supplied hydraulic jack or hoist puller that shall produce a minimum force of 10,000 lb per side. Field assembly procedures and assembly apparatus requirements shall be submitted for approval. Field welds will not be allowed except where shipping
440 limitations prevent permanent factory assembly. Prior approval for field welds is required.

The pole shall be erected on the lower set of the anchor bolt nuts and secured with the top nuts. The adjustments to plumb the pole shall be made prior to the final tightening of the top nuts.

The pole shall be plumbed under no wind conditions before sun-up, after sun-down, or on an overcast day. The deviation from vertical shall not exceed 1/4 in.

within any 10 ft of height.

450

When installing the high mast power cable, one end of the power cable shall be securely connected to the luminaire ring. The other end of the power cable shall be secured to the support and terminated 3 ft below this support with a heavy duty three-wire electrical plug. Adjustments of the three support cable lengths shall be made prior to lowering the ring for the first time. After the support cables have been adjusted and the luminaires installed on the ring, at least one complete cycle operation of the ring shall be conducted on each structure.

460 As shown on the plans, should the ring provide more luminaire attachment positions than luminaires to be installed, counterweights of the same weight of the luminaire shall be installed on those positions.

807.12 Grounding

Ground wire shall be No. 4 AWG solid bare copper. Ground rods shall be 1/2 in. diameter by 8 ft long copper weld ground electrodes except where larger sizes are specified. The top of the ground rod shall be driven at least 6 in. below grade. Ground rods shall not be installed within the light pole sign structure, or high mast tower foundations.

470 The ground wire shall be connected to the top or side of the ground rod. The ground rod, ground wire connection shall be made by a thermo weld process. The wire and ground rod shall be free of oxidized materials, moisture, and other contaminants prior to inserting the wire and the ground rod into the properly sized mold. The welding material shall sufficiently cover and secure the conductor to the rod. The completed connection shall be non-porous.

As an acceptable substitute to this process, a mechanical ground grid connection of an approved type may be used. Tap type clamps, parallel type clamps, U-bolt flat clamps, and crossover clamps will not be accepted.

480

Luminaire poles shall be grounded by connecting the free end of the ground wire to the grounding lug in the transformer base or pole. The free end of the ground wire shall enter the pole base through the entry sleeve installed in the foundation.

The neutral conductor of the underground distribution circuit shall be connected to the ground lug in the transformer base or pole. This connection shall include a quick-disconnect type connector kit so that in the event of a pole knockdown the connection will readily break without damage to the buried conductor.

490 The breaker boxes for the sign and underpass circuits shall be grounded by connecting the free end of the ground wire to the neutral grounding terminal in the breaker box and connecting this terminal to a grounding lug securely fastened to the metal interior of the breaker box. The conduit terminating in the breaker box and the sign or underpass luminaire housing shall have a good, clean, tight connection and act

as a grounding conductor for these luminaires. The neutral conductors of the feed and distribution circuits for underpass and sign illumination shall be connected to the neutral grounding terminal in the switch box or breaker box. The neutral conductor of the distribution circuit for underpass and sign illumination shall be grounded in each luminaire by connecting a jumper from the neutral terminal of the luminaire to a ground lug fastened to the metal housing of the luminaire.

Sign structures shall be grounded at one sign column by connecting the free end of the grounding wire at that column to the grounding lug in the column base.

A type I service for supply of electrical energy shall consist of a conduit riser to a weatherhead. This conduit shall be grounded at the lower end by means of a standard strap grounding connection to the ground wire and ground rod. A type II service shall consist of a multiple number of conduits from underground to the bottom of the service cabinet and a single conduit to a weatherhead from the top of the service cabinet. All of these conduits shall be connected by a single ground wire from the grounding terminal to a grounding bushing for each conduit within the interior of the service cabinet. In addition a ground wire from the grounding terminal of the service cabinet shall be connected through a conduit to a ground rod.

Bridge railing conduits shall be grounded at each end of the bridge railing by means of a standard grounding strap connected to a ground wire and ground rod. The ends of the conduits terminating in a bridge anchor location shall provide ground continuity by means of a grounding bushing on each conduit end and the connection of the bushing to a ground wire.

All equipment used in the highway lighting system shall be grounded. If necessary, additional grounding shall be installed as directed.

807.13 Luminaires

(a) Installation

Luminaire installation shall consist of the physical placing of the luminaire. Each installation shall include the furnishing and placing of the light source as designated. Luminaires shall be compatible with other lighting materials as specified in 920.01.

1. Roadway Luminaires

Each luminaire shall be leveled in both directions in the horizontal plane after the light pole has been erected and adjusted. Rotary adjustment of the mast arm and vertical adjustment of roadway luminaires to obtain an installed level position in both directions shall be accomplished by means of the bolted saddle arrangement used to attach the luminaires to the mast arm. For certain light source types such as metal halide lamp socket positions may be shown on the plans by type of Illuminating Engineering Society of North American, IES, and light pattern. The specified lamp socket position or comparable arrangement of LEDs shall be used to obtain the desired light pattern delivery. Proper connections shall be made to provide operation at the

voltage being supplied. Replacements needed because of faulty or incorrect voltage connections shall be made with no additional payment. All roadway luminaires provided for an intersection, interchange, or contiguous highway segment shall be the same type, model, and wattage.

2. Sign Luminaires

Connections in which plain and galvanized steel are in contact shall be protected such that aluminum surfaces shall receive one coat of zinc chromate primer. Steel surfaces shall be prepared in accordance with 619.08(a), and 619.08(d), and painted
550 with the structural steel paint system in accordance with 619.09(a). All paint shall be allowed to cure before assembly. Conduit fittings, if required, shall be watertight. Required conduit shall be either rigid or flexible as necessary. Conduit shall not be clamped to a sign panel.

Sign luminaires shall be mounted on overhead sign structures on two metal channels located at the extremity of the sign walkway support brackets. The distance between lighting unit support channels shall be 7 in. These channels shall be located in such a manner that they readily receive the mounting bolts from the rear of the sign luminaire. The installation of the sign luminaire shall consist of the physical placement
560 of the luminaire on the channels.

Sign luminaires shall be connected to a phase conductor and a neutral conductor. The luminaires shall be alternately connected to opposite phase conductors to balance the load. The connections in the base of the sign structure shall be in accordance with 807.06. Conductor splicing shall be in junction boxes, in-ground handholes, inside handholes of sign structures, and circuit breaker enclosures. All sign luminaires provided for an interchange or contiguous highway segment shall be the same model.

3. Underpass Luminaires

Underpass luminaires shall be mounted on the vertical side surfaces of bridge bent structures or suspended by means of pendants supported by angle-iron struts or clips fastened to the structural beam members of the bridge. All parts of the pendent pipe assembly shall be hot-dipped galvanized after threads are cut. Silicone caulking compound shall be applied to the threads during assembly of the pendent. Underpass luminaires may require separately mounted ballasts which shall be installed in close proximity to the luminaires.

Underpass luminaires shall be connected to a phase conductor and a neutral conductor. The luminaires shall be alternately connected to opposite phase conductors
580 to balance the load. Conductor splicing will only be allowed in junction boxes, in-ground handholes, and circuit breaker enclosures. All underpass luminaires provided for an interchange shall be the same model.

4. High Mast Luminaires

The aiming of the luminaires shall be as shown on the plans. During the aiming and adjustment process, the luminaire shall be oriented to conform to its raised position

and the ring properly tethered to prevent rotation. The long axis of the luminaire shall be parallel to the aiming direction as shown on the plans. All high mast luminaires provided for an interchange shall be the same model and wattage.

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(b) Warranty

A non-prorated manufacturer's written warranty, against loss of performance, defects in materials and defects in workmanship, shall be provided to and in favor of the Department. The warranty shall cover a period of 10 years from the date of shipping of the luminaire. The warranty shall cover all components of the luminaire, including but not limited to driver and light source. Loss of performance is defined to include, but is not limited to, the luminaire or any of its components falling out of compliance with the specification in place at the time of installation, which includes but is not limited to the following: there is no light output from 10% or more of the LEDs, the luminaire is operating below the lumen maintenance curve, or the color temperature shifts more than 500K outside of the specified color temperature range. The warranty shall stipulate that repaired or replacement luminaires shall be shipped to the appropriate Department District Office, at no cost to the Department, within 30 days after the manufacturer's receipt of failed luminaires. Replacement luminaires shall be the same model or a model that is equal to, or better, in terms of photometrics, energy consumption, and reliability. Warranty documents shall include the manufacturer's name, address to which failed luminaires are to be shipped for replacement, and the contact person's name, phone number, and e-mail address. Warranty documents shall provide the estimated life cycle of the lamp, LEDs, plasma emitter and power driver. A type C certification in accordance with 916 shall be provided for the luminaires.

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807.14 Sign, Underpass, Roadway, High Mast Lighting Location, and Luminaire Identification

All high mast towers, roadway light poles, underpass lighting installations, and sign lighting installations shall have an identification code number as shown on the plans. In addition, each luminaire at a sign or underpass installation shall be individually identified with a single capital letter.

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The code number shall be displayed on the light pole, sign structure column, and high mast tower as shown on the plans. The underpass code number shall be displayed near the breaker box at a location as directed.

The code number for the light pole and sign structure column shall be applied to the pole, as specified by the manufacturer, by using individual, pressure sensitive, adhesive backed tags. The code number for the high mast tower shall be applied to an aluminum plate which is mounted with spacers away from the structure as shown on the plans.

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A luminaire identification sticker shall be provided on each luminaire and on the light pole or tower that supports the luminaire. The sticker shall be titled "LUMINAIRE" and contain the following: light source type, luminaire manufacturer,

model, wattage, LED or lamp model, power drive model, surge protection device model, date of shipping, and warranty period. The luminaire identification sticker shall be attached underneath the light pole/tower ID tag, shall face the roadway, and shall have 3/4 in. lettering, and be no greater than 8 in. by 8 in.

807.15 Service Point Power Entry

640 The utility's requirements for service locations shall be coordinated. Unless otherwise specified, a pole shall be furnished for the service point. If the utility requires metering or is specified on the plans of the lighting system, a meter socket shall be obtained from and installed in accordance with the requirements of the utility. Grounding shall be in accordance with 807.12 and shall be a part of the service installation.

Energy shall be provided with 120/240 V service or 240/480 V service with the proper KW capacity on poles located immediately inside the right-of-way at locations designated on the plans. Electrical materials incorporated in the work shall be compatible with the service voltages supplied by the local utility.

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The service voltages supplied by the local utility shall be checked for compliance with the planned voltages. If a discrepancy exists, it will be resolved as directed before work is started or any electrical equipment is purchased.

(a) Types of Service Points

Service point installations shall be of two types as shown on the plans.

1. Type I Service Point

660 This service point installation shall consist of class 5 timber pole, 2 3/4 in. galvanized steel conduits, weatherhead, photocell, and multiple relay switch. The conduit riser shall be fastened and supported on the pole by means of galvanized hook pipe straps and secured to the pole by means of a galvanized lag screw all of the proper size for the conduit being installed. Cable-duct shall be installed in the conduit riser in accordance with 807.08(c). The conductors shall extend beyond the weatherhead a minimum of 4 ft. The conductors outside of the weatherhead shall be ringed to prevent moisture from entering the conduit enclosure.

2. Type II Service Point

670 This service point installation shall consist of a service cabinet with a single galvanized steel or aluminum conduit riser to the weatherhead. A multiple number of galvanized steel conduits shall extend from the bottom of the service cabinet in accordance with 807.06. Underground cable-duct shall be installed in accordance with 807.08(a). Connections, connectors, and fixtures shall be as shown on the plans.

The service cabinet shall be secured to the pole by means of a galvanized steel channel post or other approved device.

(b) Sign and Underpass Circuits

680 The illumination circuits for sign structures with an overhead power supply shall be protected by circuit breakers mounted on the end support.

Circuits for adjustable end support sign structures, bridge bracket signs, or underpasses shall be protected by circuit breakers mounted on the bridge or sign structure and connected to the underground distribution circuit in a handhole.

Circuits for sign structures with an underground power supply shall be protected by fuse connector kits in the base of the sign support. The fuse connector kits shall include bayonet disconnect features for the “neutral” side and “hot” side.

690 **807.16 Testing of Highway Lighting System**

(a) Testing Lighting Circuitry

All necessary equipment and apparatus properly calibrated for testing the lighting circuits shall be furnished. The supplying utility shall be given advance notice of the test scheduling so their representative may witness the testing procedures if desired. Each main lighting circuit, including its branches, shall be tested for insulation resistance and continuity after it is completely installed but before the pole circuits, underpass circuits, sign circuits, and grounding circuits are connected.

700 The insulation resistance test shall be made with a megohm meter and the resistance to ground shall be no less than 50 megohms in all lighting circuit power cables. The meter shall be set for the voltage rating of the insulation. The continuity test shall be made with an ohmmeter properly scaled for measuring the resistance of the power cables. This test shall verify the following:

1. That each power cable is continuous to its termination points.
- 710 2. That the cable coding at junction and termination points is consistent with cable coding at the supply point.
3. That power cables are not crossed with the neutral or each other.
4. That the main circuit through each of its branches does not have unusual resistance values.

720 The entire completed installation shall be tested by circuit or by such portions as may be selected and at night if directed. Tests shall demonstrate the following:

1. That all power, lighting, and control circuits are continuous, free from short circuits, and free from unspecified grounds.

- 730
2. That all circuits are properly connected in accordance with applicable wiring diagrams.
 3. That all circuits are operable which shall be demonstrated by continuous operation of each lighting circuit for at least 1 h.
 4. That voltage at the ends of each lighting circuit and at inter points is within allowable limits. A maximum of 10% voltage drop will be allowed for each complete circuit.

(b) Testing and Inspecting Luminaires

740 The lighting system from the service point through the last luminaire shall be subjected to 14 days of normal operation prior to final acceptance. This testing procedure may be conducted separately on each circuit or on the entire system.

740 Normal operation is defined as the luminaires being on during the darkness hours and off during the daylight hours as controlled by the service point photocells and relay switches. Malfunctioning equipment shall be replaced or repaired before final inspection. The pattern of light and correlated color temperature delivered to the pavement by roadway, high mast, and underpass luminaires will be inspected at night. At this inspection, the proper tools, equipment, and personnel shall be available to make all adjustments. These items shall specifically include a bucket truck capable of reaching all luminaires in the system, safety equipment, and a level to determine the proper luminaire position.

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807.17 Pay Item and Installation Summary Sheets

Prior to final inspection, two sets each of installation summary and pay item summary, each marked Final Record, shall be furnished for the light pole as installed. The installation summary shall show the effective mounting height, mast arm length, foundation elevation, pay item, type of base, and catalog number or drawing for each light pole furnished. The pay item summary shall indicate the pay item, quantity, effective mounting height, mast arm length, and type of base for each type of light pole furnished.

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807.18 Method of Measurement

Luminaire, light pole with mast luminaire arm, high mast tower, identification number, connector kit, multiple compression fitting, insulating link, foundation, handhole, service point, and cable marker will be measured by the number of units installed. Pole circuit conductor and circuit conductor in conduit will be measured by the linear foot. Pole circuit conductor will be measured from the base of the light pole to the terminal block of the luminaire. Pole line extension will be measured in a straight line between each pole.

Conductor in bridge conduit will be measured by the linear foot from end to end

770 of conduit or from the end of conduit to the last bridge light pole foundation entry. An allowance of 5 lft will be made for each foundation entry. An allowance of 2 lft will be made for each junction box.

Removal of existing light structure, which shall include the pole, mast arm, and foundation, will be measured by the number of units removed.

Cable-duct and conductor in underground duct or conduit will be measured by the linear foot as follows:

- 780 (a) From the face of the concrete foundation to the center of the handhole or face of the next concrete foundation. An allowance of 5 lft will be made for each entry at foundations. An allowance of 2 lft will be made at handholes for connection purposes.
- (b) From light pole bases or handholes to switch boxes at underpasses. An allowance of 4 lft will be made at the switch box for electrical connections.
- 790 (c) From end to end of the conduit when the cable is in conduit under a roadway surface or shoulder. No measurement will be made for cable-duct in conduit where it is part of a service point, sign installation, or underpass lighting system.

807.19 Basis of Payment

Luminaire will be paid for at the contract unit price per each for the type specified. Service point will be paid for at the contract unit price per each for the type specified. Light pole will be paid for at the contract unit price per each for the estimated mounting height, length of mast arm, and base type specified. High mast tower will be paid for at the contract unit price for the specified mounting height.

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Lighting foundation, concrete, with grounding will be paid for at the contract unit price per each for the size specified. If class X material is encountered during lighting foundation excavation, payment will be made for such excavation in accordance with 206. Partial payment for lighting foundation in the amount of 80% will be made if all such work is complete except for finish grading and sodding. The remaining percentage of payment will be made upon completion of the finish grading and sodding.

810 Connector kit will be paid for at the contract unit price per each for fused or unfused, as specified. Multiple compression fitting and insulation link will be paid for at the contract unit price per each for waterproofed or non-waterproofed, as specified. Cable-duct marker, high mast tower winch drive, and handhole, lighting will be paid for at the contract unit price per each. Sign, underpass, and roadway lighting location identification will be paid for at the contract unit price per each. Circuit installation will be paid for at the contract unit price per each for the type, structure number, and

number of luminaires specified. Light structure, remove and portable tower lighting drive system will be paid for at the contract unit price per each.

820 Wire will be paid for at the contract unit price per linear foot for the designation, copper gauge, housing, and number of conductors specified. Pole circuit cable, type THWN, stranded will be paid for at the contract unit price per linear foot for the copper gauge and number of conductors specified. Conduit, steel, galvanized, 2 in. diameter will be paid for at the contract unit price per linear foot.

Payment will be made under:

	Pay Item	Pay Unit Symbol
830	Cable, Pole Circuit, THWN, No. _____ Copper, Stranded, _____/C.....	LFT
	Cable-Duct Marker.....	EACH
	Circuit Installation, Str. No. __, __ Luminaires..... no.	EACH
	Conduit, Steel, Galvanized, 2 in.	LFT
	Connector Kit, Fused.....	EACH
	Connector Kit, Unfused.....	EACH
	Handhole, Lighting.....	EACH
	High Mast Tower, ___ ft E.M.H.	EACH
	High Mast Tower Winch Drive.....	EACH
840	Insulation Link, Non-Waterproofed	EACH
	Insulation Link, Waterproofed	EACH
	Light Pole, ___ ft E.M.H., ___ ft Mast Arm, ___ Base.....	EACH
	Light Structure, Remove	EACH
	Lighting Foundation, _____ Concrete, with Grounding, type	EACH
	Luminaire, High Mast	EACH
	Luminaire, High Lumen Roadway	EACH
	Luminaire, Low Lumen Roadway.....	EACH
	Luminaire, Sign.....	EACH
850	Luminaire, Underpass.....	EACH
	Multiple Compression Fitting, Non-Waterproofed	EACH
	Multiple Compression Fitting, Waterproofed.....	EACH
	Portable Tower Lighting Drive System.....	EACH
	Service Point, _____..... type	EACH
	Sign, Underpass, and Roadway Lighting Location Identification	EACH
	Wire, ____, No. _____ Copper, in ____, _____/C..... designation gauge housing	LFT
860		

The cost of circuit breakers; breaker enclosures; conduit; flexible conduit; conduit fittings; grounding; weatherhead; aerial cable termination; and incidentals required

from the last luminaire to the point of attachment by the utility, the bottom of the riser at the structure base, or the connector kits in the base of the sign supports shall be included in the cost of circuit installation.

If not listed in the Schedule of Pay Items, the cost of connector kit, fused or unfused, multiple compression fitting and insulation link, waterproofed or non-waterproofed, shall be included in the cost of the other items.

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The cost of aerial distribution service, drops to sign structures branching off from the pole line extension, weatherheads and risers required to connect the line extension to the underground electrical distribution circuit, all anchorage guy wires, hardware, aerial cable, electrical connections, timber poles, and incidentals required to complete the pole line extension shall be included in the cost of cable, pole circuit.

The cost of the mast arm, J-support hook for pole circuit, handhole with cover, shoe base, transformer base or frangible coupling if required, installation of the pole on the foundation with the pole circuit shall be included in the cost of light pole.

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The cost of the pole; lowering system including winch assembly, power cable, and support cable; concrete pad; luminaire ring; anchor bolts and nuts; lightning rod assembly; grounding system; and all incidental materials necessary to complete the installation shall be included in the cost of high mast tower. The cost of excavation, concrete, sleeves for cable-duct, non-metal pipe, reinforcing bars, backfill, finish grading, and sodding shall be included in the cost of lighting foundation.

The cost of wood poles, multiple relay switches, service cabinet, photocells, photocell receptacles, weatherhead, conduit, and other miscellaneous items shall be included in the cost of the service point.

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The cost of lamps, LED arrays, plasma emitters, drivers, optical systems, weatherproof housings, surge protection devices, electrical connections, and installation of the luminaire on the pole shall be included in the cost of luminaire.

The cost of snap-on coverings in light pole bases and waterproof coverings in underground handholes shall be included in the cost of multiple compression fitting.

The cost of maintaining highway illumination during the life of the contract shall be included in the cost of other pay items.

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SECTION 808 – PAVEMENT TRAFFIC MARKINGS

808.01 Description

This work shall consist of furnishing and installing, or removing, pavement traffic markings and snowplowable raised pavement markers in accordance with the MUTCD, these specifications and as shown on the plans. Markings shall be installed

as required unless written approval is obtained from the District Traffic Engineer to make modifications at specific locations.

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MATERIALS

808.02 Materials

Materials shall be in accordance with the following:

	Beads	921.02(e)
	Cones.....	801.08
	Multi-Component	921.02(c)
	Preformed Plastic	921.02(b)
	Snowplowable Raised Pavement Markers.....	921.02(d)1
20	Thermoplastic	921.02(a)

A Certification, Other, in accordance with 916, shall be provided by the manufacturer that certifies the paint meets all IDEM and EPA regulatory requirements for VOC levels and lead, chromium or other heavy metals.

CONSTRUCTION REQUIREMENTS

808.03 General Requirements

30 Permanent pavement markings shall be placed on the surface course in a standard pavement marking pattern. Center lines shall be placed on two-way two-lane roads, lane lines shall be placed on multi-lane divided roads, and both center lines and lane lines shall be placed on multi-lane undivided roads.

40 The pavement shall be cleaned of all dirt, oil, grease, excess sealing material, excess pavement marking material and all other foreign material prior to applying new pavement traffic markings. New paint pavement markings may be placed over sound existing markings of the same color. New thermoplastic, preformed plastic, or multi-component markings may be applied over sound existing markings of a compatible type if allowed by manufacturer’s recommendations, a copy of which shall be supplied to the Engineer prior to placement; otherwise, existing markings shall be removed in accordance with 808.10 prior to placement of the new markings. Removal of pavement marking material shall be in accordance with 808.10. The pavement surface shall be dry prior to applying pavement traffic markings.

50 Control points required as a guide for pavement traffic markings shall be spotted with paint for the full length of the road to be marked. Control points along tangent sections shall be spaced at a maximum interval of 100 ft. Control points along curve sections shall be spaced so as to ensure the accurate location of the pavement traffic markings. The location of control points shall be approved prior to the pavement traffic marking application.

808.04 Longitudinal Markings and Milled Corrugations

All longitudinal lines shall be clearly and sharply delineated, straight and true on

tangent, and form a smooth curve where required. Lines shall be square at both ends, without mist, drip or spatter.

A solid line shall be continuous. A broken line shall consist of 10 ft line segments with 30 ft gaps. A dotted line shall consist of 3 ft line segments with 9 ft gaps unless otherwise indicated on the plans.

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All lines shall be gapped at intersections unless otherwise specified or directed.

The actual repainting limits for no-passing zone markings will be determined by the Engineer.

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A new broken line placed over an existing broken line shall laterally match the existing broken line, and the new line segments shall not extend longitudinally more than 10% beyond either end of the existing line segments. A new dotted line placed over an existing dotted line shall laterally match the existing dotted line, and the new line segments shall not extend longitudinally more than 6 in. beyond either end of the existing line segments.

(a) Center Lines

Center lines shall be used to separate lanes of traffic moving in opposite directions. All center line markings shall be yellow in color and 4 in. in width. They shall be placed such that the edge of the marking, nearest to the geometric centerline of the roadway, shall be offset 4 in. from the geometric centerline.

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The center line of a multi-lane roadway shall be marked with a double solid line. The two lines forming the double solid line shall be spaced 8 in. apart and shall be equally offset on opposite sides of the geometric centerline.

The center line of a two-lane, two-way roadway, where passing is allowed in both directions, shall be marked with a broken line.

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The center line of a two-lane, two-way roadway, where passing is allowed in one direction only, shall be marked with a double line, consisting of a broken line and a solid line. The broken line and the solid line shall be spaced 8 in. apart and shall be equally offset on opposite sides of the geometric centerline. The solid line shall be offset toward the lane where passing is prohibited. The broken line shall be offset toward the lane where passing is allowed.

The center line shall be placed within the milled corrugation when center line rumble stripes are specified. Placement of the center line marking in the milled corrugation does not alter the pavement marking performance requirements of 808.07.

(b) Lane Lines

Lane lines shall be used to separate lanes of traffic moving in the same direction. Normal width lane line markings shall be white in color and shall be 5 in. wide on interstates and freeways, and 4 in. wide on all other roads. They shall be offset 4 in. to

the right of longitudinal pavement joints or divisions between traffic lanes. Wide lane lines for lane drops, route splits, or auxiliary lanes shall be white in color and shall be 8 in. wide. White solid lines shall be used to mark lane lines only when specified or directed.

(c) Edge Lines

110 Edge lines shall be used to outline and separate the edge of pavement from the shoulder. Edge line markings shall be 4 in. in width and shall be placed such that the edge of the marking nearest the edge of the pavement shall be offset 4 in. from the edge of the pavement except as otherwise directed. Right edge lines shall be marked with a white solid line and left edge lines shall be marked with a yellow solid line.

The edge line shall be placed in the milled corrugation when edge line rumble stripes are specified. Placement of the edge line marking in the milled corrugation does not alter the pavement marking performance requirements of 808.07.

(d) Barrier Lines

120 Barrier lines shall be used as specified or directed. Barrier line markings shall be solid lines of the size and color specified or as directed.

(e) Markings in Retrofitted Corrugations

In sections where corrugations are being placed in the existing surface, all existing pavement markings shall be removed in accordance with 808.10 and any existing sealants shall be removed by routing or grinding. Temporary pavement markings placed in accordance with 801.12 shall be offset a sufficient distance from the longitudinal joint so as to not obstruct the installation of the corrugations or the application of the liquid asphalt sealant.

130 The Contractor shall make a record of the existing pavement marking locations so that such markings may be replicated later with the appropriate adjustments for edge line rumble stripes. This record shall show longitudinal and transverse dimensions. The record shall be submitted to, and is subject to approval by the District Traffic Engineer prior to the removal of existing pavement markings. The District Traffic Section shall be notified two weeks prior to applying pavement markings to allow the District Traffic Section time to verify the pavement marking plan.

808.05 Transverse Markings and Pavement Message Markings

(a) Transverse Markings

140 Transverse marking lines shall be used as specified or directed to delineate channelizing lines, stop lines, crosswalk lines, and parking lines. Parking lines for ADA accessible parking spaces shall be 4 in. wide and blue in color. Unless otherwise specified or directed, all other parking lines shall be 4 in. wide and white in color. All other transverse markings shall consist of all necessary lines, of the width specified or directed and shall be in accordance with the MUTCD.

(b) Pavement Message Markings

150 Pavement message markings shall be used as specified or directed for railroad crossing approaches, intersection approaches, crosswalk approaches, ADA accessible parking space symbols, and other messages applied to the pavement with pavement marking material. The markings shall consist of all necessary lines, words, and symbols as specified or directed, and shall be in accordance with the MUTCD.

808.06 Curb Markings

Curb markings shall consist of reflectorized paint which shall cover the face and top of the curb. The existing curb and gutter area shall be cleaned of dirt, dust, oil, grease, moisture, curing compound, and unsound layers of other materials before paint is applied to the curb surface.

160 **808.07 Pavement Marking Material Application, Equipment, and Performance Requirements**

All double line markings, such as a no passing zone or the center line of an undivided multi-lane roadway, shall be applied in one pass. When a hand-propelled machine is used, the single pass application of double line markings will not be required and control points shall be spaced at a maximum of 10 ft longitudinally.

170 For contracts with completion dates when conditions do not enable application of the specified marking materials, or grooving for durable marking materials, other materials may be substituted with an appropriate unit price adjustment if approved by the Engineer.

180 Markings shall be installed in accordance with the manufacturer's recommendations, except that the minimum requirements stated herein shall also apply. Products specifically designed for application temperatures below the stated minimums herein are not required but may be used if approved by the Engineer. When directed, the Contractor shall provide the Department with original copies of all necessary current manufacturer's installation manuals prior to beginning installation work, and no installation work shall begin prior to the Department's receipt of these manuals. These manuals shall become the property of the Department.

The markings shall be protected from traffic until dry to eliminate tracking.

The markings shall meet or exceed the following performance criteria:

1. Color. The daytime and nighttime color of the applied markings shall be in accordance with ASTM D6628 when determined in accordance with ASTM E811 and E1349.
- 190 2. Durability. The pavement markings shall have a minimum resistance to wear of 97% in accordance with ASTM D913.
3. Retro-reflectivity. Contracts with 50,000 ft or more of longitudinal paint line or 10,000 ft or more for each type of

longitudinal durable marking line applied shall have retro-reflectivity measured, except markings placed on seal coat pavements placed in accordance with 404. Longitudinal lines shall meet required minimum initial and retained average retro-reflectivity measurements.

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All other contracts and markings, except parking lines, shall meet the required longitudinal line minimum measurements and will be measured by the Department at the discretion of the Engineer, except that quality adjustments will not apply. Retained retro-reflectivity is the value at the time of the warranty expiration in accordance with 808.09 and will be measured by the Department at the discretion of the Engineer.

210 Retro-reflectivity testing equipment shall be furnished, calibrated, and operated in accordance with ITM 931. The markings shall be tested in a period of not less than 14 days to not more than 30 days after the materials are applied. The retro-reflectivity equipment shall remain the property of the Contractor.

The measurement of retro-reflectivity shall be supervised or performed at all times by an operator trained and certified by the unit's manufacturer. A report as described in the ITM and including the specified test results and calculations shall be prepared and provided to the Engineer within three days of each day of testing.

220 Quality adjustments will be applied to the payment of markings as indicated in the table below. The required minimum initial and retained average retro-reflectivity values for longitudinal line measured in mcd/m²/lx are as follows:

Material Type	White	Yellow	Quality Adjustment*	Retained White	Retained Yellow
Paint	≥ 250	≥ 175	1.00	n/a	n/a
Required Minimum	150 to 249	125 to 174	0.70		
Thermoplastic	≥ 300	≥ 200	1.00	see 808.09	see 808.09
Required Minimum	250 to 299	150 to 199	0.70		
Multi-Component	≥ 300	≥ 200	1.00	see 808.09	see 808.09
Required Minimum	250 to 299	150 to 199	0.70		
Preformed Plastic	≥ 650	≥ 450	1.00	see 808.09	see 808.09
Required Minimum	550 to 649	350 to 449	0.70		
* Quality Adjustments do not apply to the retained retro-reflectivity values					

(a) Traffic Paint

1. Application

Traffic paint shall be applied only when the ambient air and pavement temperature is 40°F or higher and will remain 40°F or higher for 2 h after application.

230 The markings shall be protected from traffic until dry to eliminate tracking.

The wet film thickness of the traffic paint shall be a minimum of 15 mils. Painted lines and markings shall be immediately reflectorized by applying beads at a uniform minimum rate of 6 lb/gal. of traffic paint. Only standard or modified standard beads shall be used for paint markings.

2. Equipment

240 Traffic paint shall be applied with a spray type machine capable of applying the traffic paint under pressure through a nozzle directly onto the pavement. The truck-mounted machine shall be equipped with the following:

- a. air blast device for cleaning the pavement ahead of the application;
- b. guide pointer to keep the machine on an accurate line;
- c. spray guns which can be operated individually or simultaneously;
- 250 d. agitator or recirculation system as appropriate;
- e. control device to maintain uniform flow and application;
- f. capability of heating the material to application temperatures;
- g. automatic device which will provide a line of the required pattern; and
- 260 h. automatic bead dispenser which is synchronized with the marking application.

A hand-propelled machine may be used to apply markings. A brush may be used if approved to apply some markings.

3. Performance Requirements

The color and durability requirements shall be met for a minimum of 90 days after application.

270

Pavement marking segments which are found to have an average retro-reflectivity reading below the minimum required shall be re-stripped with no additional payment. Pavement markings segments which have more than four of 16 individual readings below the minimum required shall be re-stripped with no additional payment. The re-stripping shall begin within 14 calendar days of the completion of the retro-reflectivity measurement. Line segments may be re-stripped with no additional payment. Following each re-stripping, additional retro-reflectivity measurements shall be made with no additional payment. Quality adjustments will be based on the final retro-reflectivity measurements. The alignment of all re-stripped pavement markings shall be placed
280 within $\pm 1/4$ in. in width and ± 2 in. in length of the original placed markings. Re-stripping will not be allowed more than two times, after which removal and replacement of the markings will be required.

(b) Durable Pavement Marking Material

Durable pavement marking material consists of thermoplastic, preformed plastic, or multi-component markings.

290

Durable pavement marking materials used for center lines, lane lines, or edge lines shall be installed within a groove in the pavement unless otherwise shown on the plans.

Durable pavement marking materials used for barrier lines, pavement message, and transverse markings shall be surface applied unless otherwise indicated on the plans.

1. Grooving for Durable Pavement Markings

a. Application

300

The pavement shall be grooved prior to the placement of longitudinal durable pavement markings, excluding bridge decks and approach slabs. The groove or recess shall be installed in a single pass using dry cut equipment that utilizes diamond cutting blades and that is approved by the pavement marking manufacturer. If there are no markings on the pavement, a guide line shall be placed using paint without glass beads as a template for the grooving operation. The groove shall be at least 1 in. and no more than 2 in. wider than the pavement marking to be placed.

The Contractor may leave a gap in the grooving for longitudinal lines that delineate the radii of lane usage transitions, driveways, intersections, or adjacent to curb that does not have a curb offset to the marking of at least 12 in.

310

The depth of the groove shall be in accordance with the manufacturer's recommendations and shall be at minimum 5 mils greater than the thickness of the marking material including exposed glass beads, up to maximum allowable depth of 150 mils. A continuous groove shall not be allowed for broken or dotted lane lines. The groove may extend up to 3 in. at either end of a lane line. Grooves shall be no closer than 2 in. to the edge of a longitudinal joint.

b. Groove Finish and Cleaning

320 The grooved surface shall be cleaned with vacuuming equipment immediately following the grooving operation. The surface shall be clean and dry prior to pavement marking installation. The finished groove surface shall have a fine corduroy-like appearance with a maximum variation in depth of 10 mils.

2. Thermoplastic

a. Application

330 Thermoplastic marking shall be applied in molten form by conventional extrusion, by ribbon type extrusion, or spray when the pavement and ambient air temperatures are 50°F and rising. Heat bonded preformed thermoplastic may be used for transverse or message markings. The average final thickness of each 36 in. length of thermoplastic marking shall be no less than 90 mils and no more than 125 mils. Immediately following the application of the thermoplastic markings, additional retro-reflectorization shall be provided by applying beads to the surface of the molten material at a uniform minimum rate of 8 lb/100 sq ft of marking. Individual passes of markings shall not overlap or be separated by gaps greater than 1/4 in. longitudinally.

b. Equipment

340 The equipment used for the application of thermoplastic markings shall consist of a kettle for melting the material and an applicator for applying the markings. All of the equipment required for melting and applying the material shall maintain a uniform material temperature within the manufacturer specified limits, without scorching, discoloring or overheating any portion of the material.

350 A truck-mounted machine shall be equipped with the following: an air blast device for cleaning the pavement ahead of the marking operation; a guide pointer to keep the machine on an accurate line; at least two spray guns which can be operated individually or simultaneously; agitators; a control device to maintain uniform flow and application; an automatic device which will provide a broken line of the required length; and an automatic bead dispenser which is synchronized with the marking application.

A hand-propelled machine may be used to apply markings.

The equipment for applying heat bonded preformed plastic shall be in accordance with the manufacturer's recommendations. An open flame shall not come into direct contact with the pavement.

c. Performance Requirements

360 When the initial average retro-reflectivity measurement is below the required minimum the segment of line shall be removed and replaced with no additional payment. Pavement markings segments which have more than four of 16 individual readings below the minimum required shall be removed and replaced with no additional payment.

3. Preformed Plastic

a. Application

The markings shall be applied when the air temperature is a minimum of 40°F and rising. A primer is required if the ambient air temperature is below 50°F. The pavement surface shall be primed with a binder material in accordance with the manufacturer's recommendations.

If there is a dispute regarding installation, the manufacturer shall provide a trained representative to ensure that the installation is properly performed.

b. Performance Requirements

When the initial average retro-reflectivity measurement is below the required minimum the segment of line shall be removed and replaced with no additional payment. Pavement markings segments which have more than four of 16 individual readings below the minimum required shall be removed and replaced with no additional payment.

4. Multi-Component

a. Application

This material shall be applied only when the pavement and ambient air temperatures are 40°F and rising. The wet film thickness of the marking material shall be a minimum of 20 mils. Immediately following the application of the markings, additional reflectorization shall be provided by applying beads to the surface of the wet marking at a uniform minimum rate of 20 lb/gal. of marking.

b. Equipment

The machine used to apply the marking material shall precisely meter each component, and produce and maintain the necessary mixing head temperature within the required tolerances. The machine shall be equipped in accordance with 808.07(a)2.

c. Performance Requirements

Pavement marking segments which are found to have an average retro-reflectivity reading below the required minimum shall be re-stripped with no additional payment. Pavement markings segments which have more than four of 16 individual readings below the minimum required shall be re-stripped with no additional payment. The re-stripping shall begin within 14 calendar days of the completion of the retro-reflectivity measurement. Line segments may be re-stripped with no additional payment. Following each re-stripping, additional retro-reflectivity measurements shall be made with no additional payment.

Quality adjustments will be based on the final retro-reflectivity measurements. The alignment of all re-stripped markings shall be placed within $\pm 1/4$ in. in width and ± 2.0 in. in length of the original placed markings. Re-stripping will not be allowed more than two times, after which removal and replacement of the markings will be required.

410

808.08 Marking Protection and Maintenance of Traffic

Protection of the traveling public, of the pavement marking crews, and of the pavement markings shall be provided during the marking operation through the use of proper equipment, traffic control devices, safety devices, and proper procedures. Traffic control devices shall be placed in accordance with 107.12. Flaggers shall be provided for traffic control as directed.

(a) Vehicle Signs

420 Each vehicle in the marking operation shall display the slow moving vehicle emblem when operating at speeds of 25 mph or less. The slow moving emblems shall be removed when the vehicles are operating at speeds greater than 25 mph. The paint crew signs shall be 24 in. high by 96 in. wide, with 12 in. series C black letters on an orange encapsulated lens reflective background. Type A and C flashing arrow signs shall be in accordance with 923.04.

(b) Vehicle Warning Lights

430 All amber flashing warning lights and amber strobe lights mounted on vehicles used in the marking operation shall be in accordance with 801.14(d). All vehicles used in the marking operation shall have a minimum of one flashing amber warning light or amber strobe light which is visible in all directions.

(c) Cones

Cones shall be used to protect marking material which requires more than 60 s drying time. Cones shall remain in place until the marking material is dry or firm enough not to track or deform under traffic. Cones shall be removed as soon as possible and shall never be left in place overnight. Edge lines shall not require protection with cones.

The maximum spacing of cones shall be as follows:

440

	40 mph or less	over 40 mph
Broken Lines	every line segment	every fifth line segment
Solid Lines	20 ft to 30 ft	

(d) Front Escort Vehicles

A front escort vehicle shall be used if the marking vehicle extends across the center line while operating. This front escort vehicle shall be equipped with a forward facing paint crew sign, a rear facing slow moving vehicle emblem, and a red flag mounted at least 10 ft above the pavement.

(e) Marking Application Vehicles

450 Marking application vehicles such as edgeliner or centerliner trucks shall have a rear facing type A or type C flashing arrow sign, an amber flashing warning light mounted near the center of the truck bed, and an amber strobe light mounted on each rear corner of the truck bed. The amber flashing warning light and the amber strobe

lights shall be mounted on retractable supports and shall be operated at a height of 12 ft above the pavement unless otherwise directed.

(f) Rear Escort Vehicles

If cones are not required, a rear escort vehicle shall follow a marking application vehicle at a distance of 100 to 500 ft. If an additional rear escort vehicle is required due to drying time or heavy traffic volume, it shall follow the first rear escort vehicle
460 at a maximum distance of 1,000 ft, and may operate in the travel lane or on the paved shoulder.

If cones are required, the cone setting truck shall follow the marking application vehicle and shall be followed by a rear escort vehicle. The cone pick up truck shall be followed by another rear escort vehicle.

All rear escort vehicles shall be equipped with a rear facing type C flashing arrow sign mounted above a rear facing paint crew sign. On two-lane two-way roads, this type C flashing arrow sign shall be operated with the arrowhead turned off. The supply
470 truck may be used as a rear escort vehicle providing it is empty and is equipped with the required traffic control devices.

808.09 Warranty for Durable Pavement Marking Material

Durable pavement marking material shall be warranted against failure resulting from material defects or method of application, or the result of snowplowing and deicing activities. The material shall be warranted to retain its color, adherence to the pavement, and shall be free of other obvious defects or failures. Grooved durable pavement markings shall also be warranted to retain retroreflectivity as specified below.
480

All pavement traffic markings which have failed to meet the warranted conditions shall be replaced with no additional payment.

For the terms of the warranty a unit shall be defined as a 1,000 ft section of line of specified width in any combination or pattern.

(a) Surface Applied Durable Pavement Marking Warranty

The warranty period for surface applied durable markings shall be 180 days beginning with the substantial completion date for the contract as defined in 101.63,
490 but not prior to November 1 of the calendar year in which the last pavement markings were installed. If more than 3% of a unit or 3% of the total of any one intersection or set of transverse markings fails, the failed portion shall be replaced. All pavement markings required to be replaced under the terms of this warranty shall be replaced within 60 days of the notification of failure.

(b) Grooved Durable Pavement Marking Warranty

The warranty period for durable markings placed in a groove shall be two years beginning with the substantial completion date for the contract as defined in 101.63,

500 but not prior to November 1 of the calendar year in which the last pavement markings were installed. The retained retro-reflectivity, $\text{mcd/m}^2/\text{lx}$, as determined by ITM 931 shall meet or exceed the minimum values at all times during the warranty period as follows:

Material	Year	White	Yellow
Thermoplastic	1	225	150
	2	175	125
Multi-Component	1	225	150
	2	175	125
Preformed Plastic	1	400	300
	2	300	200

If more than 5% of a unit or 5% of the total fails, the failed portion shall be replaced. All pavement markings required to be replaced under the terms of this warranty shall be replaced within 60 days of the notification of failure.

808.10 Removal of Pavement Markings

510 Pavement markings which conflict with revised traffic patterns and may confuse motorists shall be removed immediately before, or immediately following, any change in traffic patterns as directed or approved.

Removal of pavement markings shall be to the fullest extent possible without materially damaging the pavement surface. Pavement marking removal methods shall be sandblasting, steel shot blasting, waterblasting, grinding, or other approved mechanical means. Grooving will not be allowed. Grinding will only be allowed under the following conditions:

- 520 (a) when removing durable pavement markings, or
- (b) when removing non-durable markings where another course of material is to be placed on the existing course.

Painting over existing pavement markings to obliterate them will not be allowed.

530 When a blast method is used to remove pavement markings, the residue, including sand, dust and marking material, shall be vacuumed concurrently with the blasting operation or removed by other approved methods. Accumulation of sand, dust or other residual material, which might interfere with drainage or constitute a traffic hazard, will not be allowed.

All damage to the pavement caused by pavement marking removal shall be repaired by approved methods with no additional payment.

808.11 Snowplowable Raised Pavement Markers

Snowplowable raised pavement markers shall be used as supplemental

delineation at the locations shown on the plans or as directed.

540 **(a) Surface Preparation**

The pavement or bridge deck surface shall be cleaned of dirt, dust, oil, grease, moisture, curing compound, and loose or unsound layers of all materials which would interfere with the proper bonding of the marker to the pavement or bridge deck.

(b) Location

550 Marker locations shall be accurately laid out and approved prior to the installation operation. Markers shall not be located on surfaces that show visible evidence of cracking, checking, spalling or failure of underlying materials. Markers shall not be located within the intersection of a public road. Any marker location, which falls on any of the restricted areas, shall be moved a longitudinal distance not to exceed 10% of the required marker spacing. If this adjusted location still falls within a restricted area, then that marker location shall be deleted. Marker locations shall be as shown on the plans.

(c) Reflector Color

The color combinations of the reflectors shall be as shown on the plans unless otherwise directed. When replacement prismatic reflectors are specified, such reflectors shall not be ordered until the quantity and color combinations have been determined and approved.

560

(d) Installation

Marker installation shall be in accordance with the manufacturer's recommendations. The pavement surface temperature and the ambient air temperature shall be at least 50°F. The pavement surface shall be dry at the time of marker installation. The installation slot shall be clean and dry before the adhesive is applied. The slot shall be filled with sufficient adhesive to provide a water tight seal between the marker base and the pavement, and to fill all voids between the marker base and the surfaces of the slot. The marker shall be placed in the slot so that the tips of the snowplow deflecting surfaces are below the pavement surface.

570

If the pavement surface is newly placed HMA, the pavement shall be allowed to cure for two days prior to installing the markers.

Installation of markers on new concrete pavement or bridge decks or on newly overlaid bridge decks shall not be done until after the pavement or bridge deck is ready to be opened to traffic as specified elsewhere herein.

The number of slots cut in one day shall not exceed the number of markers which will be installed in that day. No slots shall be left open overnight.

580

(e) Removal of Markers

Markers designated for removal shall be as located on the plans or as otherwise specified or directed. If the pavement surface or bridge deck surface is to be removed,

the markers shall be removed prior to any surface removal operation.

The markers shall be removed with a jackhammer or other approved equipment. The area of the pavement or bridge deck disturbed by the marker removal shall not exceed 3 in. in depth or extend more than 3 in. out from any side of the marker base. The marker removal operation shall stop if it is determined that excessive damage is occurring to the pavement, or bridge deck.

The resulting holes shall be filled with the appropriate patching material as described herein or as otherwise directed. Concrete pavement which is to be overlaid as part of the contract and HMA pavement shall be patched with HMA intermediate materials. Concrete pavement which is not to be overlaid as part of the contract and concrete bridge decks shall be patched with concrete patching material from the QPL of Rapid Setting Patch Materials. Overlaid bridge decks and bridge decks which are to be overlaid as part of the contract shall be patched with patching material which is compatible with the deck overlay material. All patching material shall be placed in accordance with the appropriate specifications for the patching material.

Removed markers shall become the property of the Contractor and removed from the jobsite prior to the completion of the work.

(f) Replacement of Prismatic Reflectors

Reflectors designated for replacement shall be as shown on the plans or as otherwise directed. Prior to placement of the new reflector, the castings shall be cleaned of all remaining butyl pad materials. All loose or foreign material shall be satisfactorily removed by sandblasting, wire brush, or other approved mechanical means. Removed reflectors shall be disposed of properly off the project site.

808.12 Method of Measurement

Broken or dotted lines, placed or removed, will be measured by counting the number of broken or dotted lines placed and multiplying the number of counted lines by the length of the broken or dotted line. Solid lines will be measured as the total distance in linear feet of solid lines placed or removed. The material, type, color, or width of broken, dotted, or solid lines to be removed will not be considered when measuring such lines for payment.

Except as otherwise specified, transverse marking lines will be measured as the total distance in linear feet of lines placed or removed. Transverse marking yield lines will be measured transversely including the entire extent of the marking line and gaps. Curb markings will be measured by the linear feet along the front face of the curb. Grooving for pavement markings will be measured as the total distance of grooving for each pavement marking line in linear feet. Pavement message markings will be measured by the total number of each type placed. A railroad crossing pavement message marking shall include the two R's, the X, and the three stop lines per traffic lane. Railroad crossing pavement message markings will be measured by the total number of each marking place. Lane indication arrow pavement message markings

- 630 will be measured by the number of lane indication arrowheads placed. Removal of pavement message markings will be measured in square yards using areas shown in the following table. The material will not be considered when measuring such markings for pavement.

Pavement Message Markings	
Description	Area
“Ahead”	3.1 SYS
Combo Arrow	3.1 SYS
“Exit”	2.5 SYS
“Left”	2.5 SYS
“Only”	2.5 SYS
Railroad “R”	0.6 SYS
“Right”	3.2 SYS
“RXR”	7.7 SYS
“School”	3.9 SYS
“Stop”	2.6 SYS
Straight Arrow	1.4 SYS
“Turn”	2.6 SYS
Turn Arrow	1.7 SYS
“XING”	2.5 SYS

- 640 Snowplowable raised pavement markers will be measured by the number placed or removed. Prismatic reflectors will be measured by the number furnished and installed. Each two-way prismatic reflector will be measured as one reflector. No measurement will be made of the adhesive or the hole patching material used in the placement or removal of snowplowable raised pavement markers.

808.13 Basis of Payment

- 650 Lines and transverse markings placed will be paid for at the contract unit price per linear foot for the material, type, color, and width specified. Grooving for pavement markings will be paid for at the contract unit price per linear foot. Curb markings will be paid for at the contract unit price per linear foot for curb painting, of the color specified. Pavement message markings placed will be paid for at the contract unit price per each, for the material and message specified. Lines and transverse markings removed will be paid for at the contract unit price per linear foot. Pavement message markings removed will be paid for at the contract unit price per square yard.

Snowplowable raised pavement markers, furnished and installed, or removed will be paid for at the contract unit price per each. Prismatic reflectors will be paid for at the contract unit price per each. Each two-way prismatic reflector will be paid for as one reflector.

Payment for furnishing, calibrating, and operating retro-reflectivity testing equipment will be paid for at the contract price for lump sum. The cost of report preparation shall be included in the cost of retro-reflectivity testing. Adjustments to

660 the contract payment with respect to retro-reflectivity of performance based pavement markings will be included in a quality adjustment in accordance with 109.05.1.

The Engineer may waive retro-reflectivity testing due to weather limitations. Retro-reflectivity testing will be waived for markings applied after October 31 and before April 1. If retro-reflectivity testing is waived, no payment will be made for retro-reflectivity testing. If retro-reflectivity testing is not waived by the Engineer due to weather or waived by the seasonal time restriction and retro-reflectivity testing is not performed, no payment will be made for retro-reflectivity testing and payment for the marking items will be made at 70% of the unit price.

670

Payment will be made under:

	Pay Item	Pay Unit Symbol
	Curb Painting, _____ color	LFT
	Grooving for Pavement Markings	LFT
	Line, _____, _____, _____, _____ in..... material type color width	LFT
680	Line, Remove	LFT
	Pavement Message Marking, _____, _____ material message	EACH
	Pavement Message Marking, Remove	SYS
	Prismatic Reflector	EACH
	Retro-Reflectivity Testing	LS
	Snowplowable Raised Pavement Marker	EACH
	Snowplowable Raised Pavement Marker, Remove.....	EACH
	Transverse Marking, _____, _____, _____, _____ in..... material type color width	LFT
690	Transverse Marking, Remove.....	LFT

No additional payment will be made for the removal and or replacement of markings that fail to meet the performance or warranty conditions of 808.07 and 808.09.

The cost of removal of existing prismatic reflectors shall be included in the cost of prismatic reflectors.

700 Beads, binder material for thermoplastic and preformed plastic, adhesive for snowplowable markers, patching material for snowplowable marker removal, guide lines for grooving operations, pavement cleaning and surface preparation, and all necessary incidentals shall be included in the cost of the pay items.

SECTION 809 – ITS CONTROLLER CABINETS AND FOUNDATIONS

809.01 Description

This work shall consist of furnishing and installing ITS cabinets and foundations in accordance with 105.03.

MATERIALS

809.02 Materials

10 Materials shall be in accordance with the following:

ITS Controller Cabinet	925
Padlock.....	925.04(aa)

Materials for ITS cabinet foundations shall be in accordance with 805.02.

CONSTRUCTION REQUIREMENTS

809.03 General

20 ITS cabinet foundations shall be installed in accordance with 805.13.

A seal of silicone caulking compound shall be placed between each controller cabinet and the concrete foundation after the cabinet placement.

A rubber duct seal shall be used to seal all conduits that enter the bottom of the cabinet.

The input power source to the cabinets shall be 240 volts AC and 60 amps.

30 One laminated 11 by 17 in. site drawing shall be included in the data pocket of each cabinet.

809.04 Grounding

All ITS controller cabinets and foundations shall be grounded in accordance with the ITS grounding specification.

809.05 Cabinet Wiring

40 Wiring within ITS cabinets shall be neatly arranged and ty-wrapped, or enclosed in expandable braided polyester sleeving. All cabinet wiring harnesses shall be neat, firm, routed, and mechanically supported to minimize crosstalk, electrical interference, and to prevent inadvertent pulling. AC power cables shall be routed and bundled separately from shielded control cables which include, but are not limited to, logic voltage, video cables, and RF cables.

All conductors, except for the equipment-grounding conductors, shall be individually labeled at each termination with a unique identifier. All terminal blocks

shall be labeled in accordance with the appropriate standard schematic drawings on the plans.

- 50 Conductors used in cabinet wiring shall terminate with properly sized captive terminals, spade type terminals, or shall be soldered. All crimp-style connectors shall be applied with a proper tool that prevents opening of the handles until the crimp is completed.

No more than three conductors shall be brought to any one terminal. Two flat metal jumpers, straight or U-shaped, may also be placed under a terminal screw. At least two full threads of all terminal screws shall be fully engaged when the screw is tightened. No live parts shall extend beyond the barrier.

- 60 Connectors, or devices plugging into connectors, shall be provided with positive means to prevent any individual circuit from being broken due to vibration, pull on connecting cable, or some similar disruptive force.

809.06 Field Testing

Cabinets and ITS components shall be field tested in accordance with the field test procedure furnished by the Department and the test results shall be submitted to the ITS Electronics Technician of the Operations Support Division. The Contractor shall record all test readings, in triplicate, on the field test procedure form. The Contractor shall complete, sign, and date the forms before submitting them to the ITS

- 70 Electronics Technician.

All necessary equipment and personnel shall be provided to ensure the tests are safely conducted. The Electronics Technician shall be present to witness the tests. A cabinet shall pass every test to be accepted. If the cabinet fails, the problem shall be corrected and a new test shall be arranged.

The technician shall be given at least 36 h advance notice of the test.

809.07 Clean-Up

- 80 When the installation is completed, all disturbed portions of the construction area shall be cleaned and all excess excavation or other materials shall be disposed of in accordance with 104.05 and 203.10. The site shall be restored to its original condition.

809.08 Method of Measurement

ITS controller cabinet foundations will be measured per each installed, complete and in place. ITS controller cabinets will be measured by the number of units installed, complete and in place.

809.09 Basis of Payment

- 90 ITS controller cabinet foundations will be paid for at the contract price per each. ITS controller cabinets, complete, in place, will be paid for at the contract unit price per each.

Payment will be made under:

Pay Item	Pay Unit Symbol
ITS Controller Cabinet Foundation	EACH
ITS Controller Cabinet	EACH

100

The cost of all cabinet accessories, mounting hardware, anchor bolts, handles, setup and wiring shall be included in the cost of the ITS controller cabinet.

The cost of all grading necessary for installation of the foundations and the final clean-up of the area shall be included in the cost of the ITS controller cabinet foundation.

The cost of padlocks shall be included in the cost of the ITS controller cabinet.

DIVISION 900 – MATERIALS DETAILS

SECTION 901 – PCC MATERIALS

901.01 Hydraulic Cement

(a) General

At the time cement is incorporated into the work, it shall meet the quality requirements of these specifications.

10 Cement which has been in storage may be tested prior to use, and if tests show that it does not meet the requirements specified, it will be rejected.

A means for storing and protecting the cement against dampness shall be provided. Cement which has become partially set or which contains lumps or caked cement will be rejected. Cement salvaged from discarded or used sacks shall not be used.

20 Different kinds or brands of cement, or cement of the same brand from different mills, even if tested, shall not be mixed during use unless allowed, and then only as directed. They shall not be used alternately in any one pour for any structure, unless otherwise approved.

(b) Portland Cement

Portland cement shall conform to the requirements of the following cited specifications except as noted.

1. Requirements

Cement	Specifications
Air-Entraining Portland Blast-Furnace Slag Cement	AASHTO M 240, Type IS-A
Air-Entraining Portland Cement	AASHTO M 85, Type IA or IIIA
Air-Entraining Portland-Pozzolan Cement	AASHTO M 240, Type IP-A
Portland Blast-Furnace Slag Cement	AASHTO M 240, Type IS
Portland Cement	AASHTO M 85, Type I, II, or III
Portland-Limestone Cement	AASHTO M 240, Type IL
Portland-Pozzolan Cement	AASHTO M 240, Type IP

The exceptions to AASHTO M 240 are as follows:

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- a. The amount of pozzolan shall be limited to 20% \pm 5% by weight of the portland-pozzolan cement for the types IP and IP-A.

- b. The pozzolan in the portland-pozzolan cements, types IP and IP-A, shall be in accordance with ASTM C618, class C or class F with the loss on ignition of the pozzolan limited to a maximum of 3%.
- 40 c. The pozzolan in the portland-pozzolan cements, types IP and IP-A, shall be interground with the portland cement clinker.

2. Acceptance Criteria

Portland cements and blended cements will be accepted based upon the manufacturer's or manufacturer/distributor's documented ability to consistently furnish these materials in accordance with the applicable AASHTO requirements.

a. General Requirements

- 50 Cements shall comply with the applicable requirements of 901 and will be accepted by certification from qualified manufacturers or manufacturer/distributor. The manufacturer is defined as the plant producing the cement. A manufacturer or manufacturer/distributor shall become qualified by establishing a history of satisfactory quality control of cement produced as evidenced by results of tests performed by a testing laboratory which is regularly inspected by the Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology. Proof of such inspection shall be furnished upon request. All certifications shall be prepared by the manufacturer or distributor in accordance with the applicable requirements of 916. If a manufacturer or distributor elects to supply portland cement
- 60 with a higher sulfur trioxide content in accordance with footnote B from Table 1 in AASHTO M 85, it shall supply all of the required supporting data to the Department's Division of Materials and Tests prior to supplying such cement. A QPL of Cement Sources will be maintained by the Department.

The manufacturer or manufacturer/distributor shall conduct sufficient tests to ensure that adequate quality control is maintained and that cement furnished is in accordance with the specification requirements. Documentation pertaining to cement shipped on certification shall be maintained for a period of at least three years and shall be provided when requested.

- 70 Random samples of cement will be obtained at the concrete plant. If the sample is not in accordance with the specification requirements, an investigation will be conducted. A copy of the findings and conclusions resulting from the investigation will be furnished to the Contractor. Unless the investigation finds the Department is responsible for the failure to comply, the cost of the investigation plus any required corrective action will be assessed to the Contractor.

b. Requirements for Domestic Source Qualification

- 80 Cement manufacturers requesting to be qualified to supply cement shall provide the following:

- 90
- (1) For the initial qualification, the manufacturer shall provide to the Department's Division of Materials and Tests a QCP in accordance with the applicable requirements of ITM 806. The QCP shall also include the location and type of samples taken, and a monthly summary of mill test data for the previous year's production. A current Safety Data Sheet shall be submitted as an integral part of the initial qualification package.
 - (2) To maintain qualification, a monthly average of mill test data shall be submitted to the Department's Division of Materials and Tests. If a specific type of cement is not manufactured in a given month, the monthly submittal shall state "No type _____ cement was manufactured during the month of _____, 20____".

100 **c. Requirements for Foreign Source Qualification**

Foreign cement manufacturers or their domestic distributors requesting to be qualified to supply cement shall provide the following:

- 110
- (1) For the initial qualifications, the manufacturer and distributor shall provide to the Department's Division of Materials and Tests a QCP in accordance with the applicable requirements of ITM 806. The QCP shall also include the location and type of samples taken, and a summary of complete test results from the proposed cement source. A current Material Safety Data Sheet shall be submitted as an integral part of the initial qualification package. The QCP shall explain the linkage between the cement being furnished and the manufacturer's/distributor's quality control data, relative to ship-loads, barge-loads, railroad car-loads, and other applicable loads.
 - (2) Once the initial qualifications have been met, the manufacturer or distributor shall be required to furnish the cement test results for each shipment prior to Department cement usage for the first five cement shipments, which are intended for Department use. The test results for all five of these cement shipments shall fully comply with the required material specifications. If not, this requirement will be continued for subsequent cement shipments until five consecutive
- 120

901.02

130 cement shipment test results fully comply with the required material specifications, or Department source approval is withdrawn due to the inability to consistently supply satisfactory cement.

(3) To maintain qualification after compliance with the previous requirements, a monthly submission of all cement shipment test results for cement which is intended for Department usage shall be submitted to the Department's Division of Materials and Tests. If no cement shipments are received during a given month, the monthly submittal shall state "No cement was received during the month of _____, 20____".

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d. Certification

Only manufacturers and manufacturer/distributors included on the QPL of Cement Sources may furnish cement on certification.

A sample certification form addressing all of the required information is included in ITM 804. Alternate procedures and forms will be considered when requested, and will be approved if there is a positive link between the cement furnished and the manufacturer's quality control data.

150

(c) Masonry Cement

Masonry cement shall be in accordance with ASTM C91, except the air content test and the water retention test may be waived.

(d) Rapid Hardening Hydraulic Cement

Rapid hardening hydraulic cement shall be calcium sulfoaluminate, CSA, cement furnished from a manufacturer or manufacturer/distributor on the Department's list of Cement Sources. A source may be added to the QPL by completing the requirements of ITM 806, Procedure U.

160

901.02 Fly Ash Used as a Pozzolan

(a) General

Fly ash is the finely divided residue that results from the combustion of ground or powdered coal. In general, class F fly ash is produced from burning anthracite or bituminous coal and class C fly ash is produced from burning lignite or subbituminous coal.

170 Fly ash will be accepted from one of the sources on the QPL of Pozzolan Sources. Fly ash from different sources or different types of fly ash shall not be mixed or used alternately in the same construction unless authorized in writing. Fly ash will be subject to random assurance sampling and testing by the Department. Failure of these

random samples to meet the specified requirements will be cause for suspension of the fly ash source approval.

(b) Acceptance Criteria

Acceptance is based upon the supplier's documented ability to consistently furnish material in accordance with the specified requirements.

1. Requirements

180 The fly ash shall be in accordance with AASHTO M 295 for class C or class F, with the following exceptions:

Loss on Ignition, LOI, max. %	3
Autoclave Expansion or Contraction, max. %	0.5
Fineness: Amount retained when wet-sieved on No. 325 (45 µm) sieve, max. %	30

190 On days when fly ash is being accumulated for use as a pozzolan, the supplier shall obtain a minimum of one sample per day and furnish test results for moisture content, loss on ignition, and No. 325 (45 µm) sieve residue for each sample.

For each 2,000 t produced, a complete AASHTO M 295 analysis shall be performed on a sample composited randomly from the daily samples. The method of randomization shall be subject to approval by the Department.

2. Test and Calibration Procedure

The testing procedures followed shall be in accordance with ASTM C311 or other methods approved in writing by the Department.

200 The minimum frequency for calibration of test equipment is:

- a. The No. 325 (45 µm) sieve shall be calibrated every 100 determinations or every six months, whichever comes first.
- b. The muffle furnace used for LOI determinations shall have a newly installed thermocouple every six months.
- c. The analytical balances and scales shall be calibrated each year.
- 210 d. The concrete compression machine shall be calibrated annually.
- e. The Blaine apparatus shall be calibrated annually.
- f. All instrumentation used for rapid chemical analysis shall comply with applicable requirements of ASTM C114 using NIST Fly Ash reference materials.

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3. Documentation

Fly ash suppliers requesting approval shall supply the following:

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- a. For the initial approval, a current Materials Safety Data Sheet and a summary of results for all specified tests for six consecutive months shall be submitted. No test results shall be more than one year old at the time of request.
- b. To maintain approval, a summary of results for all specified tests shall be submitted monthly. The results of the daily tests shall be available by telephone during normal working hours.
- c. The fly ash suppliers shall furnish a QCP in accordance with the applicable requirements of ITM 806. The QCP shall ensure the Department of a continuous supply of fly ash complying with the requirements. This QCP will be reviewed to determine its adequacy.

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d. Certification:

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- (1) For source approval, the supplier shall furnish a Certification, Other indicating the class of fly ash, the name, location, and unit of the generating plant. It shall state that all fly ash shipped for use on Department projects will be produced under appropriate quality control and shall be in accordance with the specified requirements. It shall further indicate that the power company will participate in appropriate inspection and assurance testing. A sample certification form is provided in ITM 804.
- (2) For certification of test reports, the test results generated in accordance with 901.02(b)1 shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility, and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving fly ash represented by these results.

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901.03 Slag Cement Used as a Pozzolan

(a) General

Slag cement shall consist of the non-metallic product, consisting essentially of silicates and aluminosilicates of calcium and other bases, that is developed in a molten

condition simultaneously with iron in a blast furnace. A glassy granular material is formed when molten blast furnace slag is rapidly chilled by immersion in water. This material is then ground to cement fineness, producing slag cement.

270 Slag cement will be accepted from one of the sources on the QPL of Pozzolan Sources. Slag cement from different sources or different grades of slag cement shall not be mixed or used alternately in the same construction unless approved in writing. Slag cement will be subject to random assurance sampling and testing by the Department. Failure of these random samples to be in accordance with the specified requirements will be cause for suspension of the slag cement source approval.

(b) Acceptance Criteria

280 Slag cement will be accepted based on the manufacturer's or manufacturer/distributor's documented ability to consistently furnish these materials in accordance with the applicable ASTM and AASHTO requirements.

1. Requirements

Slag cement shall be in accordance with ASTM C989 for grade 100 or 120.

For each 2,500 t produced, a complete ASTM C989 analysis shall be performed on a sample composited randomly from the daily samples. The method of randomization shall be subject to approval by the Department.

2. Test and Calibration Procedure

290 The testing procedures followed shall be in accordance with ASTM C989 or other methods approved in writing by the Department.

The minimum frequency for calibration of test equipment is:

- a. The No. 325 (45 μ m) sieve shall be calibrated every 100 determinations or every six months, whichever comes first.
- b. The analytical balances and scales shall be calibrated each year.
- 300 c. The concrete compression machine shall be calibrated annually.
- d. The Blaine apparatus shall be calibrated annually.
- e. All instrumentation used for rapid chemical analysis shall be in accordance with the applicable requirements of ASTM C114 using NIST reference materials.

3. Documentation

310 Slag cement suppliers requesting approval shall supply the following:

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- a. For the initial approval, a current Safety Data Sheet and a summary of results for all specified tests for six consecutive months shall be submitted. No test results shall be more than one year old at the time of request.
 - b. To maintain approval, a summary of results for all specified tests shall be submitted monthly. The results of the daily tests shall be available by telephone during normal working hours.
 - c. The slag cement suppliers shall furnish a QCP in accordance with the applicable requirements of ITM 806. The QCP shall ensure the Department of a continuous supply of slag cement which is in accordance with the requirements. This QCP will be reviewed to determine its adequacy.
 - d. Certification:
 - 330 (1) For source approval, the supplier shall furnish a Certification, Other indicating the grade of slag cement, the name, location, and type of manufacturing facility. It shall state that the slag cement shipped for use on Department projects will be produced under appropriate quality control and shall be in accordance with the specified requirements. A sample certification form addressing all of the required information is provided in ITM 804.
 - 340 (2) For certification of test reports, the test results generated in accordance with 901.03(b) shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility, and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving slag cement represented by these results.

901.04 Silica Fume Used as a Pozzolanic Mineral Admixture

350 (a) General

Silica fume will be accepted from one of the suppliers on the QPL of Pozzolan Sources. Silica fume from more than one of these suppliers shall not be mixed or used alternatively in the same construction unless authorized in writing. Silica fume will be subject to random assurance sampling and testing by the Department. Failure of the random samples to meet the specified requirements will be cause for suspension of the silica fume supplier's approval.

(b) Acceptance Criteria

360 Acceptance of silica fume will be based on the manufacturer's documented ability to consistently furnish material in accordance with the specified requirements.

1. Requirements

The silica fume shall be in accordance with AASHTO M 307 with the following exceptions:

- a. Reactivity with cement alkalies shall not be required.
- b. The oversize, amount retained on the No 325 (45 μ m) sieve, in accordance with ASTM C1240, shall be conducted.
- 370 c. The oversize, amount retained on the No. 325 (45 μ m) sieve, shall not be more than 10%.
- d. Accelerated pozzolanic activity index, in accordance with ASTM C1240, shall be conducted in lieu of strength activity index.
- e. The accelerated pozzolanic activity index shall be a minimum of 85% at seven days.
- 380 f. The increase of drying shrinkage of mortar bars at 28 days shall be conducted in accordance with ASTM C1240.
- g. The increase of drying shrinkage of mortar bars at 28 days shall be not more than 0.10%.

2. Frequency of Testing

- a. The manufacturer shall obtain a minimum of one sample for each 400 t of material produced. Test results for moisture content, and loss on ignition, shall be furnished for each sample.
- 390 b. For each 2,000 t produced, a complete AASHTO M 307 analysis shall be performed on a sample composed randomly from daily samples. The method of randomization shall be subject to approval by the Department. The optional chemical requirements identified in AASHTO M 307 shall be reported in addition to the increase of drying shrinkage of mortar bars as well as the standard chemical and physical requirements.
- 400

3. Test and Calibration Procedure

The minimum frequencies for calibration of test equipment shall be as follows:

- a. The analytical balances and scales shall be calibrated annually.
- 410 b. The concrete compression machine shall be calibrated annually.
- c. The Blaine apparatus shall be calibrated annually.
- d. All instrumentation used for rapid chemical analysis shall be in accordance with AASHTO T 105.

4. Documentation

Silica fume suppliers requesting approval shall supply the following to the Department's Division of Materials and Tests:

- 420 a. For initial approval, a current Material Safety Data Sheet and a summary of results for all specified tests for six consecutive months shall be submitted. No test results shall be more than one year old at the time of the request.
- b. To maintain approval, a summary of results for all specified tests shall be submitted monthly.
- 430 c. A QCP in accordance with the applicable requirements of ITM 806 shall be submitted. The QCP shall ensure the Department a continuous supply of silica fume complying with the material requirements and calibration procedures. This QCP will be reviewed by the Department's Division of Materials and Tests to determine its adequacy.
- d. Certification:
 - 440 (1) For approval, the supplier shall furnish a Certification, Other indicating the name, location, and type of manufacturing facility, which includes the metallurgical process and furnace. It shall state that the silica fume shipped for use on Department projects will be produced under appropriate quality control and shall be in accordance with the specified requirements. A sample certification is provided in ITM 804.
 - (2) For certification of test reports, the results generated in accordance with 901.04(b) shall be summarized and

450 submitted monthly. The reports shall state the name and location of the testing facility, and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving silica fume represented by these results.

901.05 Chemical Anchor System

Chemical anchor systems shall be furnished from the QPL of Chemical Anchor Systems. Chemical anchor systems may be added to the QPL by completing the requirements of ITM 806, Procedure F and passing required laboratory testing.

460 **(a) Requirements**

Chemical anchor systems shall be in accordance with the following:

1. Chemical anchor systems shall be two part systems which are capable of anchoring deformed steel reinforcing bars and grouting load transfer dowels.
2. Chemically anchored steel reinforcing bars shall be capable of withstanding a tensile load equal to the yield strength of a #7, grade 60, epoxy coated, deformed steel reinforcing bar.
- 470 3. Chemical anchor systems shall be capable of filling the entire annular space between the concrete and the steel reinforcing bar or dowel and remain in place until the chemical anchor is completely cured.

(b) Laboratory Testing

The Department will test chemical anchor systems in accordance with ITM 807.

901.06 PCC Sealer/Healers

480 PCC sealer/healers shall be furnished from the QPL of PCC Sealer/Healers. PCC sealer/healers may be added to the QPL by completing the requirements in ITM 806, Procedure F and passing required laboratory testing.

(a) Requirements

PCC sealer/healers shall be in accordance with the following:

1. PCC sealer/healers shall be two part systems, capable of sealing and healing cracks in PC pavement.
- 490 2. PCC sealer/healers shall be capable of restoring the original integrity of a PCC beam broken in flexure.
3. All four beams used for testing sealer/healers shall break at a location different from the original break or with a flexural strength greater than or equal to 550 psi.

901.07

4. The viscosity of PCC sealer/healers shall be sufficient to penetrate a crack 1/32 in. wide and 6 in. in depth.

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(b) Laboratory Testing

The Department will test PCC sealer/healers in accordance with ITM 808.

901.07 Rapid Setting Patch Materials

Rapid setting patch materials shall be selected from the QPL of Rapid Setting Patch Materials. A rapid setting patch material may be added to the QPL by completing the requirements in ITM 806, Procedure F.

(a) Normal Weather Mixes

510 Normal weather rapid setting patch materials shall be used for ambient temperatures of 32 to 85°F.

(b) Hot Weather Mixes

Hot weather rapid setting patch materials shall be used for ambient temperatures above 85°F.

(c) Requirements

Rapid setting patch materials shall be capable of being utilized in patches ranging from 1 in. to full depth without bonding agents.

520

These products shall not contain soluble chlorides as an ingredient of manufacture or require chemical additives. The color shall be similar to PCC.

They shall be single packaged dry mix requiring only water just prior to mixing. They shall be packaged in 40 to 60 lb bags with a neat yield of approximately 0.40 cu ft and shall allow at least a 50% extension, by weight with a 3/8 in. or a 1/2 in. round aggregate. The minimum shelf life shall be 12 months.

Mixing shall be conducted with small concrete mixers or with a drill or paddle mixer and shall be suitable for finishing with hand tools.

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Rapid setting patch materials shall be in accordance with ASTM C928 with the following exceptions.

Physical Tests	Specifications	Requirements
Setting Time: Normal Weather Hot Weather	ASTM C266 Initial at 72°F Final at 72°F Initial at 95°F Final at 95°F	10 – 20 min 12 – 35 min 10 – 20 min 12 – 35 min
Compressive Strength, min.* 1 h 2 h 24 h 28 days	ASTM C109	72°F, Normal 2,000 psi 3,000 psi 5,000 psi 8,000 psi
Compressive Strength, min.* 3 h 24 h 28 days	ASTM C109	95°F, Hot 3,000 psi 5,000 psi 8,000 psi
Relative Dynamic Modulus Procedure B, 300 cycles	ASTM C666	95% min.
Slant Shear Bond Strength, min. 28 days	ASTM C882	2,500 psi
Flexural Strength, 24 h mortar only mortar – aggregate extension	ASTM C78	500 psi 600 psi
Length Change, maximum 28 days (air storage)	ASTM C157 modified C928	-0.075%
Scaling Resistance 5 cycles 25 cycles 50+ cycles	ASTM C672	0 rating, No scaling 0 rating, No scaling 1.5 rating, Very slight to Slight scaling
* Material used shall be neat rapid setting patch material mixed in accordance with the manufacturer's installation instructions.		

540 All rapid setting patch materials complying with the specified physical requirements will be subjected to a field performance demonstration. The field performance demonstration will take place as directed. Rapid setting patch materials shall be used to patch a designated site, typical of a standard repair. The site will be evaluated after one year's exposure. Approval will be based on visible signs of distress, such as cracking, crazing, scaling, spalling, wearing, edge fraying, corner cracking, or debonding.

(d) Test Report

Testing shall be performed by a recognized laboratory in accordance with ITM 806. Test reports shall not be more than five years old on January 1 of the approval year.

901.08 Packaged, Dry, Combined Materials for Mortar and Concrete

550 These materials shall be in accordance with ASTM C387. All packages shall be identified as conforming to ASTM C387. The markings shall also show the kind and type of material, the net weight in each bag, the yield in cubic feet or yield in square feet per inch of thickness, and the amount of water recommended for mixing to produce a 2 in. to 3 in. slump.

The following exceptions to ASTM C387 shall apply for packaged patching products used in accordance with 710. The limits of the following shall be shown on the type B certification.

Physical Tests	Specifications	Requirements
Compressive Strength, min. 24 h 28 days	ASTM C109 on 2 in. cubes (neat)	2,000 psi 5,000 psi
Length Change, max. 28 days (air storage) 28 days (water storage)	ASTM C157, modified C928	-0.09% +0.03%
Slant/Shear Bond Strength, min. 28 days	ASTM C882 modified*	2,000 psi
Modulus of Elasticity Minimum @ 28 days Maximum @ 28 days	ASTM C469	3,000,000 psi 5,000,000 psi
* Product scrubbed into substrate or as recommended by the manufacturer.		

560 **901.09 Air-Cooled Blast Furnace Slag for Retaining Walls**

If ACBF or coarse aggregate is used, and soil, B borrow, structural backfill, or coarse aggregate is to be placed above the ACBF or coarse aggregate, a single layer of geotextile shall be placed on top of the ACBF or coarse aggregate in accordance with 616.11. A type C certification in accordance with 916 shall be provided for the geotextile materials.

570 ACBF shall be in accordance with the pH, chlorides, sulfates, organic content, resistivity, and permeability requirements of structure backfill as listed in 211.03.1. It shall also be in accordance with ITM 212. Total sulfides shall also be determined in accordance with EPA 376.1, using the 100-mL pH water samples obtained during the ITM 212 test, and shall not exceed 400 ppm.

The ACBF shall have a maximum corrosion rate as follows if tested in accordance with ASTM G59.

- (a) Zinc corrosion rate, first two years 15 µm/yr/side
- (b) Zinc corrosion rate, to depletion..... 4 µm/yr/side
- (c) Carbon-steel corrosion rate..... 12 µm/yr/side.

580 901.10 Components of MSE Retaining Walls**(a) PCC Components****1. Face Panels**

Precast concrete face panels shall be produced from a source listed on the QPL of Certified Precast Concrete Producers, in accordance with ITM 813. Concrete shall have a compressive strength equal to or greater than 4,000 psi at 28 days.

590 The target water/cementitious ratio for the concrete mix design shall not exceed 0.435. The cement content and target water/cementitious ratio of the concrete mix design shall be sufficient to obtain the specified minimum 28-day compressive strength. Air entraining admixture and chemical admixture Type A, B, C, D, or E from the QPL of PCC Admixtures and Admixture Systems may be used.

Ground-reinforcement connection hardware and reinforcing bar lifting devices shall be set in place and secured prior to beginning casting, in accordance with the dimensions and tolerances shown on the working drawings.

a. Production Control Testing and Inspection

600 The manufacturer shall provide for all testing and inspection services during each day's production of the panels. The frequency of production control testing shall be based on a lot of 50 panels, or fraction thereof, for each day's production. Sampling and testing of the plastic concrete shall be in accordance with 505.01, or the ASTM equivalent. A minimum of one water/cementitious ratio, and slump, air content, and relative yield tests shall be run per production lot, per day. A minimum of two 6 in. by 12 in. cylinders shall be cast per day's production lot for compressive strength determination. Cylinders shall be cured in the same manner as the panels they represent. Relative yield, air content, and slump of the concrete shall be in accordance with 702.05. Compressive strength shall be determined in accordance with AASHTO
610 T 22 or ASTM C39, with lot acceptance based on the average of 2 cylinders tested at an age no greater than 28 days. Panels shall not be shipped until the compressive strength meets or exceeds the 28 day requirement.

If the cylinder-test results do not satisfy the requirements described herein, and additional cylinders for testing are not available, the manufacturer may core the panels. The wall manufacturer shall randomly select two panels from the lot for coring in accordance with AASHTO T 24 or ASTM C42. The wall manufacturer shall obtain one core on the backside of each panel with a device that produces uniform test samples without coring completely through the panel. Coring shall not be located
620 within 6 in. of the panel fasteners or the edges of the panels, and shall avoid the panel's reinforcing steel. The wall manufacturer shall fill the core holes with equivalent concrete materials or rapid setting patch materials, and trowel to produce a smooth finish. Excess material removed during troweling shall not be reused. If rapid setting patch material is used, mixing and curing shall be in accordance with the manufacturer's recommendations. Compressive strength testing shall be performed on

the cores. If the average strength-test results from the cores satisfy or exceed the requirements described herein, the production lot panels may be shipped.

b. Casting

630 The panels shall be cast on a flat area, with the front face of the form at the bottom, and the back face at the upper part. Tie strip guides shall be set on the rear face. The concrete in each unit shall be placed without interruption and shall be consolidated as necessary to prevent the formation of segregation or cleavage planes. Clear form oil from one manufacturer shall be used throughout the casting operation.

c. Curing

The panels shall be cured for a sufficient length of time such that the concrete develops the specified compressive strength.

640 **d. Removal of Forms**

The forms shall remain in place until they can be removed without damage to the unit.

e. Concrete Finish

The concrete surface for the front panel face shall have a surface finish produced from contact with the form. The rear face of the panel shall be screeded to eliminate open pockets of aggregate and surface distortions in excess of 1/4 in.

f. Tolerances

650 All panels shall be manufactured within the tolerances as follows:

(1) Panel Dimensions

Lateral position of tie strips shall be within 1 in. All other dimensions shall be within 3/16 in.

(2) Panel Squareness

Squareness, as determined by the difference between the two diagonals, shall not exceed 1/2 in.

660 **(3) Panel-Surface Finish**

Surface defects on smooth formed surfaces measured on a length of 5 ft shall not exceed 1/8 in. Surface defects on textured finished surfaces measured on a length of 5 ft shall not exceed 5/16 in.

g. Compressive Strength Verification

670 Verification of the panels compressive strengths will be conducted by the Engineer. The frequency of verification testing will be one test for every 750 panels per manufacturer with a minimum of one test per contract. One panel will be randomly selected and two locations will be selected for coring. In the presence of the Engineer, the Contractor shall obtain two 4 in. cores on the backside of the panel without coring completely through the panel. The Contractor shall refill the core holes with rapid

setting patch materials and trowel to produce a smooth finish. Excess material removed during troweling shall not be reused. Mixing and curing of the patching materials shall be in accordance with the manufacturer's recommendations.

680 The Engineer will test the cores in accordance with AASHTO T 24. The verification test results will be averaged and shall be in accordance with 901.10(a)1a. If the initial verification test results do not satisfy the requirements described herein, the Engineer will randomly select two different panels for additional verification testing. If the additional verification tests satisfy the requirements described herein, no further action is required. If the test results still do not satisfy the requirements described herein, installation of panels shall cease and the Engineer will conduct an investigation. Panels manufactured on the same dates as the panels cored for verification tests that have already been installed will be considered and adjudicated as a failed material in accordance with 105.03. The Engineer will conduct verification testing until three consecutive dates of production satisfy the strength requirements described herein. The Contractor or wall manufacturer shall make arrangements so that panels from three consecutive dates of production are accessible for coring. Installation of panels may resume once acceptable verification testing results are
690 achieved.

h. Rejection

Units shall be subject to rejection due to their failure to be in accordance with the requirements specified above. The following defects may result in rejection:

- (1) Defects which indicate imperfect molding.
- (2) Defects which indicate honeycombed or open texture concrete.
- 700 (3) Defects in the physical characteristics of the concrete, such as broken or chipped concrete, or color variations or dunnage marks on the front face due to excessive form oil or other reasons.

The Engineer will determine whether spalled, honeycombed, chipped, or otherwise defective concrete shall be repaired or be cause for rejection.

710 Repair of concrete, if allowed, shall be completed in a manner which is acceptable to the Engineer. Repair to concrete surfaces that are to be exposed to view after completion of construction shall be subject to approval.

i. Marking

The place and date of manufacture, and production lot number shall be shown on the rear face of each panel.

902.01

j. Handling, Storage, and Shipping

720 All panels shall be handled, stored, and shipped so as to eliminate the danger of chipping, cracks, fractures, or excessive bending stresses. Panels in storage shall be supported on blocking located immediately adjacent to tie strips to avoid bending the tie strips.

2. Coping

The coping may be precast or cast-in-place.

(b) Joint Spacers and Joint Covering

The horizontal and vertical joint spacers shall include compression blocks, pins, or other manufacturer's recommended materials to provide a uniform joint.

730 The joint cover shall be either a non-woven needle-punch polyester geotextile or a woven monofilament polypropylene. The joint cover shall be attached to the rear face of the panels with a manufacturer's recommended adhesive.

A letter certifying that the joint spacers and joint cover adhesive material supplied is in accordance with the manufacturer's recommendations shall be provided prior to use of the materials.

SECTION 902 – ASPHALT MATERIALS

902.01 Asphalt

Asphalt is defined as a cementitious material obtained from petroleum processes. Asphalts shall be sampled and tested in accordance with the applicable requirements of 902.02.

(a) Performance Graded Asphalt Binders

10 Performance graded asphalt binders shall be supplied by a supplier on the QPL of Performance-Graded Asphalt Binder Suppliers. A binder will be considered for inclusion on the QPL by following ITM 581.

Performance graded, PG asphalt binders shall be in accordance with the following:

GRADE	58-28	64-22	64-28	70-22	70-28	76-22
ORIGINAL BINDER						
Flash Point, minimum, °C	230					
Viscosity, maximum, 3 Pa·s, Test Temp, °C	135					
DSR, G*/sin δ (delta), minimum, 1.00 kPa, Test Temp. @ 10 rad/s, °C	58	64	64	70	70	76
ROLLING THIN-FILM OVEN RESIDUE						
Mass Loss, maximum, %	1.00					
DSR, G*/sin δ (delta), minimum, 2.20 kPa, Test Temp. @ 10 rad/s, °C	58	64	64	70	70	76
PRESSURE AGING VESSEL (PAV) RESIDUE						
PAV Aging Temperature, °C	100 (Note 1)					
DSR, G*/sin δ (delta), maximum, 5,000 kPa, Test Temp. @ 10 rad/s, °C	19	25	22	28	25	31
Physical Hardening	Report (Note 2)					
Creep Stiffness, S, maximum, 300 MPa, m-value, minimum, 0.300, Test Temp. @ 60 s, °C	-18	-12	-18	-12	-18	-12
Notes: 1. Oven temperature tolerance shall be ±0.5°C. 2. Physical Hardening is performed on a set of asphalt beams according to AASHTO T 313, Section 12.1, except the conditioning time is extended to 24 h ±10 minutes at 10°C above the minimum performance temperature. The 24 h stiffness and m-value are reported for information purposes only.						

- A PG 58-28 or PG 64-22 binder may be modified by in-line blending with styrene butadiene rubber, SBR, polymer latex at the HMA plant in accordance with ITM 581.
- 20 A PG 58-28 may be modified to a PG 64-28 and a PG 64-22 may be modified to a PG 70-22.

A type A certification in accordance with 916 shall be provided for SBR polymer latex. The results of the following shall be shown on the certification.

Property	Requirements
Total Polymer Solids, % by weight	60 – 72
Butadiene, % by weight, min.	68
Residual Styrene, % by weight, max.	0.1
Ash, % of total polymer solids by weight, max.	3.5
pH	9 – 11
Viscosity, Brookfield model RVF, Spindle No. 2 @ 20 rpm @ 25°C, max.	2,000

The minimum SBR polymer latex content shall be 2.5 %. The SBR polymer latex content may be reduced below the minimum content provided, if the following requirements are met:

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1. An AASHTO accredited laboratory shall blend the PG binder and SBR polymer latex at the proposed SBR polymer latex content and test and grade the modified PG binder in accordance with AASHTO M 320.
2. The laboratory test results verifying the blend and compliance with 902.01(a) shall be submitted to the Engineer for approval.
3. The source of the PG Binder or SBR polymer latex shall not be changed.

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1. Sampling

An acceptance sample and backup sample shall be taken from the asphalt delivery system at the HMA plant. A copy of a load ticket identifying the binder source shall be submitted with the samples. The Engineer will take immediate possession of the samples.

2. PG Binder Testing

The Department will perform complete testing in accordance with AASHTO M 320. Complete PG binder testing will consist of RTFO DSR and PAV BBR testing. Rotational viscosity and flashpoint tests are not required. If the material is not in accordance with the specifications, the material will represent one week of HMA production and be adjudicated as a failed material in accordance with 105.03.

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3. Appeals

If the Contractor does not agree with the acceptance test results, a request may be made in writing for additional testing. The appeal shall be submitted within 15 calendar days of receipt of the Department's written results. The basis of the appeal shall include complete AASHTO M 320 test results.

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(b) Asphalt Emulsions

Asphalt emulsions shall be from a supplier listed on the QPL of Asphalt Emulsion Suppliers. An emulsion will be considered for inclusion on the QPL by following ITM 593. Asphalt emulsions may contain additives to improve handling and performance characteristics. Failure of an emulsion to perform satisfactorily in the field shall be cause for rejection, even though it passes laboratory tests. The grade used shall be in accordance with the table for asphalt emulsions as shown herein. A type A certification in accordance with 916 shall be provided for the asphalt emulsion. The results of the tests listed in ITM 804 shall be shown on the certification.

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The requirements for asphalt emulsions are as follows:

RS-2, HFRS-2, and SS-1h shall be in accordance with AASHTO M 140 except the cement mixing test is waived.

CRS-2P and HFRS-2P shall be in accordance with AASHTO M 316. The distillation temperature shall be 350°F.

CSS-1h shall be in accordance with AASHTO M 208.

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1. Asphalt Emulsion Warranted Micro-Surfacing

The polymer modified asphalt emulsion shall be a quick-set, CSS-1h emulsion in accordance with AASHTO M 208 except the cement-mixing test is waived. The polymer material shall be milled or blended into the asphalt or blended into the emulsifier solution prior to the emulsification process. The minimum polymer solids content will be 3.0% based on the residual of the emulsion. Mix set additives shall be added as required to provide control of the quick-set properties. Additional requirements shall be in accordance with the following:

Characteristics	Test Method	Requirements
Residue by Distillation, % (Note)	AASHTO T 59	62+
Softening Point, °F (°C)	AASHTO T 53	140+ (60+)
Viscosity @ 140°F (60°C)	AASHTO T 202	8000+
Elastic Recovery @ 77°F (25°C), %	AASHTO T 301	60
Note: The distillation temperature for this test shall be 350°F (175°C).		

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2. Asphalt Emulsion Ultrathin Bonded Wearing Course

Characteristics		Test Method	Min.	Max.
Viscosity, Saybolt Furol @ 77°F (25°C), s		AASHTO T 59	20	100
Storage Stability Test, 24 h, % (Note 1)		AASHTO T 59		1
Sieve Test, %		AASHTO T 59		0.05
Residue by Distillation, % (Note 2)		AASHTO T 59	63	
Oil Distillate by volume of emulsified asphalt, %		AASHTO T 59		2
Demulsibility, %	w/35 mL, 0.02 N CaCl ₂ or	AASHTO T 59	60	
	w/35 mL, 0.8% DSS	AASHTO T 59		
Tests on Residue from Distillation				
Penetration (0.1 mm) at 77°F (25°C), 100g, 5 s		AASHTO T 49	90	150
Elastic Recovery @ 39°F (4°C), %		AASHTO T 301	58	
Notes: 1. After 24 h, the emulsion shall be a homogeneous color. 2. Except maximum temperature of 400 ±10°F (205 ±5°C).				

3. Asphalt Emulsion Recycling

Characteristics (Note 1)	Test Method	Min.	Max.
Viscosity, Saybolt Furol, @ 77 °F (25°C), SFS	AASHTO T 59	20	100
Sieve Test, No. 20, retained on sieve, %	AASHTO T 59		0.10
Storage Stability Test, 24 hr, %	AASHTO T 59		1
Residue by Distillation, % (Note 2)	AASHTO T 59	64	
Oil Distillate by volume of emulsified asphalt, %	AASHTO T 59		1
Penetration, 77°F (25°C), 100 g, 5 s, dmm	AASHTO T 49	50	200
<p>Notes: 1. The asphalt emulsion shall be selected for the project by the asphalt emulsion supplier based on the Contractor's mixture design. The penetration of the supplied asphalt emulsion shall be within ± 25 dmm of the penetration of the design asphalt emulsion. The asphalt emulsion shall be received on the job site at a temperature no greater than 120°F (50°C).</p> <p>2. Modified AASHTO T 59 – distillation temperature of $350 \pm 9^\circ\text{F}$ ($175 \pm 5^\circ\text{C}$) with a 20-minute hold.</p>			

Characteristics ⁽¹⁾	Test Method	AE-90	AE-90S	AE-NT	AE-F	AE-150	AE-PL
Test on Emulsion							
Viscosity, Saybolt Furol at 77°F (25°C), min.	AASHTO T 59			15		50	
Viscosity, Saybolt Furol at 77°F (25°C), max.	AASHTO T 59			100	100		115
Viscosity, Saybolt Furol at 120°F (50°C), min.	AASHTO T 59	50	50			75	
Viscosity, Saybolt Furol at 120°F (50°C), max.	AASHTO T 59					300	
Demulsibility w/35 mL, 0.02N CaCl ₂ , % min.	AASHTO T 59		30				
Demulsibility w/50 mL, 0.10N CaCl ₂ , % min.	AASHTO T 59	75					
Oil Distillate by Distillation, mL/100 g Emul ⁽²⁾ max.	AASHTO T 59	4.0	3.0	4.0	4.0	7.0	3.0
Residue by Distillation, % min.	AASHTO T 59	65	65 ⁽⁴⁾	50	27	65	30
Residue by Distillation, % max.	AASHTO T 59				35		
Sieve Test, % max.	AASHTO T 59	0.10	0.10	0.30	0.10	0.10	0.10
Penetrating Ability, mm, min.	902.02(w)						6
Stone Coating Test, %	902.02(t)3a	90				90	
Settlement, % max.	AASHTO T 59	5		5			
Storage Stability, % max.	AASHTO T 59		1				
Tests on Residue							
Penetration (0.1 mm) at 77°F (25°C), 100g, 5 s, min. ⁽³⁾	AASHTO T 49	100	90				
Penetration (0.1 mm) at 77°F (25°C), 100g, 5 s, max. ⁽³⁾	AASHTO T 49	200	150	40	90		
Penetration (0.1 mm) at 77°F (25°C), 50g, 5 s, min. ⁽³⁾	AASHTO T 49					100	
Penetration (0.1 mm) at 77°F (25°C), 50g, 5 s, max. ⁽³⁾	AASHTO T 49					300	
Ductility at 77°F (25°C), mm, min.	AASHTO T 51	400					
Ash Content, % max.	AASHTO T 111	1.0	1.0	1.0	1.0	1.0	1.0
Float Test at 140°F (60°C), s, min. ⁽³⁾	AASHTO T 50	1200	1200			1200	
Force Ratio	AASHTO T 300		0.3				
Elastic Recovery, at 39°F (4°C)	AASHTO T 301		58				
Notes: (1) Broken samples or samples more than 14 days old will not be tested.							
(2) Oil distillate shall be in accordance with ASTM D396, table 1, grade No. 1.							
(3) The Engineer may waive the test.							
(4) Maximum temperature to be held for 15 minutes at 350 ±9°F (175 ±5°C).							

(c) Cutback Asphalts

Cutback asphalts shall be composed of an intimate homogeneous mixture of an asphalt base and a suitable distillate designed for medium, or slow curing. Cutback asphalts may also contain an additive as an aid in uniformly coating wet, damp, or dry aggregates used in patching mixtures or HMA pavements. These asphalts shall not contain more than 0.3% water as determined by ASTM D95, shall not separate when allowed to stand, and shall not foam when heated to permissible temperatures. When an additive is used, it shall be incorporated homogeneously in the asphalt at the point of manufacture. The temperature of the cutback asphalt shall not be higher than shown for that grade in 902.03. A type A certification in accordance with 916 shall be provided for cutback asphalt. The results of the following shall be shown on the certification.

1. Medium Curing Asphalts With and Without Additives

Medium curing asphalts with and without additives shall be in accordance with the following:

Characteristics	Grades			
	MC-70 MCA-70	MC-250 MCA-250	MC-800 MCA-800	MC-3000 MCA-3000
Flash Point (Open Tag.), °C ⁽⁴⁾	38+	66+	66+	66+
Kinematic Viscosity at 60°C (cSt) ⁽²⁾ ...	70 - 140	250 - 500	800 - 1600	3000 - 6000
Saybolt-Furol Viscosity at 50°C (s)...	60 - 120			
Saybolt-Furol Viscosity at 60°C (s)...		125 - 250		
Saybolt-Furol Viscosity at 83°C (s)...			100 - 200	300 - 600
Distillation ⁽¹⁾				
Distillate (% of total distillate to 360°C MC-70 @ 225°C):				
to 225°C.....	0 - 20	0 - 10		
to 260°C.....	20 - 60	15 - 55	35+	15+
to 316°C.....	65 - 90	60 - 87	45 - 80	15 - 75
Residue from distillation to 360°C (volume % by difference).....	55+	67+	75+	80+
Tests on Residue from Distillation ⁽¹⁾				
Penetration, 25°C, 100 g, 5 s, - (0.1 mm)				
(without additive).....	120 - 250	120 - 250	120 - 250	120 - 250
(with additive).....	120 - 300	120 - 300	120 - 300	120 - 300
Ductility, 25°C (10 mm) ⁽³⁾	100+	100+	100+	100+
Solubility in organic solvents, %.	99.5+	99.5+	99.5+	99.5+
Notes:	<p>(1) Test may be waived when approved.</p> <p>(2) Viscosity may be determined by either the Saybolt-Furol or Kinematic test. In case of dispute, the Kinematic viscosity test shall prevail.</p> <p>(3) If the ductility at 25°C is less than 100, the material will be acceptable if its ductility at 16°C is 100+.</p> <p>(4) Flash point by Cleveland Open Cup may be used for products having a flash point greater than 80°C.</p>			

2. Slow Curing Asphalts With and Without Additives

120 Slow curing asphalts with and without additives shall be in accordance with the following:

Characteristics	Grades			
	SC-70 SCA-70	SC-250 SCA-250	SC-800 SCA-800	SC-3000 SCA-3000
Flash Point (Cleveland Open Cup), °C	66+	79+	93+	107+
Kinematic Viscosity at 60°C (cSt) ⁽²⁾	70 - 140	250 - 500	800 - 1600	3000 - 6000
Saybolt-Furol Viscosity at 50°C (s)....	60 - 120	125 - 250	100 - 200	300 - 600
Saybolt-Furol Viscosity at 60°C (s)....				
Saybolt-Furol Viscosity at 83°C (s)....				
Distillation(1) Total Distillate to 360°C (% by volume).....	10 - 30	4 - 20	2 - 12	5
Float Test of Distillation Residue at 50°C (s).....	20 - 100	25 - 110	50 - 140	75 - 200
Ductility of Asphalt Residue at 25°C (10 mm) ⁽¹⁾	100+	100+	100+	100+
Solubility in organic solvents, % ⁽¹⁾	99.5+	99.5+	99.5+	99.5+
Notes: ⁽¹⁾ Test may be waived when approved. ⁽²⁾ Viscosity may be determined by either the Saybolt-Furol or Kinematic test. In case of dispute, the Kinematic viscosity test shall prevail.				

(d) Utility Asphalt

The asphalts shall be uniform in character and shall not foam when heated to 350°F. Utility asphalts shall be in accordance with the following:

Characteristics/Grades	UA-I	UA-II	UA-III
Softening Point (Ring & Ball), °C	46 - 63	63 - 85	79.5 - 96
Penetration of Original Samples ⁽¹⁾ (0.1 mm) at 4°C, 200 g, 60 s, min.....	10	10	10
at 25°C, 100 g, 5 s.....	50 - 100	25 - 45	15 - 35
at 46°C, 50 g, 5 s.....	100 min.	130 max.	90 max.
Ductility @ 25°C, 50 mm/min, 10 mm, min. ⁽¹⁾	30	10	2.5
Solubility in Organic Solvents, % min. ⁽¹⁾	99.0	99.0	99.0
Flash Point (Cleveland Open Cup), °C, min. ⁽¹⁾	225	225	225
Penetration of Residue from Thin Film Oven Test, 25°C, 100 g, 5 s, (0.1 mm) min. ⁽¹⁾	30	15	10
⁽¹⁾ Test will be performed when complete physical characteristics are needed or desired.			

130 A type A certification in accordance with 916 shall be provided for utility asphalt. The results of the above shall be shown on the certification.

(e) Asphalt for Coating Corrugated Metal Pipe

Asphalt for coating corrugated metal pipe shall be in accordance with the following:

Physical Properties	Min.	Max.
Softening Point (Ring & Ball), °C	93	110
Penetration of Original Samples (0.1 mm) at 4°C, 200 g, 60 s.....	20	
at 25°C, 100 g, 5 s.....	35 ⁽¹⁾	
Solubility in Organic Solvents, %	99.0	
Flash Point (Cleveland Open Cup), °C	232	
Flow Test, mm		6.4
Shock Test	3 of 4 specimens shall pass	
⁽¹⁾ May be 30 minimum provided all four shock test specimens pass.		

A type A certification in accordance with 916 shall be provided for asphalt coating to the pipe fabricator on corrugated metal pipe. The results of the above shall be shown on the certification.

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902.02 Sampling and Testing Asphalt Materials

The tests and AASHTO references are as follows:

- (a) Sampling Bituminous Materials AASHTO R 66

The following exceptions to AASHTO R 66 shall apply:

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1. Samples may be obtained at any time before material is incorporated into the work.
2. Samples for all grades of asphalt emulsion shall be a minimum of 1/2 gal. The size of samples of other liquid material may be 1 qt.
3. Samples of liquid materials shall be obtained at one of the following:

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- a. bulk storage tanks from sampling valves located in the tank or line and asphalt plant storage tanks from sampling valves located in the tank
- b. transports from sampling valves
- c. distributors from valves
- d. other storage or locations as approved
- e. sampling by other recognized devices may be approved
- f. sampling valves beyond the in-line blending location.

- (b) Water in petroleum products, except the solvent or carrier may be toluene ASTM D95
- 170 (c) Density, Specific Gravity, or API Gravity of Crude Petroleum and Liquid Products by Hydrometer Method ASTM D1298
- (d) Specific Gravity of Semi-Solid Bituminous Materials AASHTO T 228
- (e) Specific Gravity of Solid Pitch and Asphalt ASTM D71
- 180 (f) Flash Point (Open Cup)
1. When the flash point is higher than 175°F, “Flash Point by Cleveland Open Cup” AASHTO T 48
 2. When the flash point is 175°F, or lower, “Flash Point with Tag Open Cup” AASHTO T 79
- 190 (g) Softening Point of Bituminous Materials, Ring and Ball AASHTO T 53
- (h) Penetration of Bituminous Materials AASHTO T 49
- (i) Loss of Heating ASTM D6
- (j) Solubility in Organic Solvents, except the solvent may be 1,1,1,-Trichloroethane AASHTO T 44
- 200 (k) Inorganic Matter or Ash AASHTO T 59
- (l) Saybolt-Furol Viscosity AASHTO T 72
- (m) Ductility of Binder Material, except that the conditioning period of the specimens may be shortened, and that only one normal test will be required. Shortened conditioning period: The specimen shall be allowed to cool in air for at least 30 minutes. It shall then be trimmed and placed in the water bath for a period of 60 to 90 minutes before testing. In case of failure or dispute, three normal tests will be required and specimens shall be conditioned as in AASHTO T 51.
- 210

- (n) Distillation of Cutback Asphaltic Products, except the length of condenser tube may be 400 mm ±24 mm.....AASHTO T 78
- (o) Float Test for Bituminous Materials.....AASHTO T 50
- (p) Kinematic Viscosity of AsphaltsAASHTO T 201
- 220 (q) Absolute Viscosity of AsphaltsAASHTO T 202
- (r) Effect of Heat and Air on Asphalt Materials, Thin-Film Oven TestAASHTO T 179
- (s) Effect of Heat and Air on a Moving Film of Asphalt, Rolling Thin Film Oven TestAASHTO T 240
- (t) Testing Asphalt Emulsions.....AASHTO T 59

230 The following exceptions to AASHTO T 59 shall apply:

1. For the Residue by Distillation test, the specified aluminum alloy still shall be the referee still.
2. When tests on the residue are not required, the % of residue for emulsion grades RS-2 and AE-90 only, may be determined by the Residue by Evaporation test of AASHTO T 59. The % of residue shall be determined by the Residue of Distillation test in all cases of failure or dispute.
- 240 3. The stone coating test shall be performed as follows on a mixture of 465 ±1 g of reference stone and 35.0 ±0.1 g of asphalt emulsion:
 - a. For AE-90 the mixture of stone and asphalt shall be mixed vigorously for 5 minutes. At the end of the mixing period, the mix shall be rinsed by running sufficient tap water at the side of the container to completely immerse the mix. The tap water shall then be poured off and the rinsing step repeated as necessary until the rinse water pours off essentially clear. The stone shall remain a minimum of 90% coated.
 - 250 b. For AE-150 the mixture of stone and asphalt shall be mixed vigorously for 5 minutes and then allowed to stand for 3 h. At the end of this time, the mixture shall again be mixed vigorously for 5 minutes. At the end of the mixing period, the mix shall be rinsed by running sufficient tap water at the

260 side of the container to completely immerse the mix. The tap water shall then be poured off and the rinsing step repeated as necessary until the rinse water pours off essentially clear. The stone shall remain a minimum of 90% coated.

4. For the Demulsibility test, normally only one test will be required. In case of failure or dispute, the specified procedure in AASHTO T 59 will be followed.

270 5. For oil portion from Residue by Distillation, report the number of milliliters of oil per 100 g of emulsion.

(u) For coating test for cutback asphalts with additive, 20 g of 20 to 30 mesh Ottawa sand shall be placed in a clean 2 oz (60 mL) wide-mouthed jar and covered with 25 g of distilled water at room temperature. One gram of the liquid asphalt to be tested shall be placed gently upon the surface of the water so that it floats and does not contact the sand. The lid shall then be placed on the jar and tightened securely. If the liquid asphalt to be tested is grade 70 or 250, the jar and contents shall be shaken vigorously for 30 s. If the grade is 800 or 3,000, the jar and contents shall be immersed in a 115°F water bath for 5 minutes to bring the contents of the jar to a temperature of approximately 100°F. The jar shall then be shaken vigorously for 30 s. After shaking, the asphalt coating on the sand shall be observed under a constant, strong light. Complete coating of the sand is required.

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(v) Stripping tests for HMA mixtures using binder materials, with or without additives, shall be performed as follows:

290 1. **Test 1.** A sample of produced mixture, 500 g, minimum, shall be obtained for testing. The size of test specimen and the amount of distilled water shall be:

Approximate Size of Aggregate	Minimum Weight of Test Specimen	Amount of Distilled Water
Sand	100 g	400 mL
12	100 g	400 mL
11	150 g	600 mL
9	200 g	600 mL

Place the specimen in the boiling distilled water and stir with a glass rod at the rate of one revolution per second for 3 minutes. The aggregate shall retain a minimum of 90%

of its asphalt film compared with the remainder of the sample, upon completion of this procedure.

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- 2. **Test 2.** Approximately 500 g of produced mixture shall be heated to 250°F in a laboratory oven for 2 h; stirred and cooled to 200°F. Then a portion of the mix shall be placed in boiling distilled water, quantity of mix and quantity of boiling water shall be as specified in Test 1, and stirred with a glass rod at the rate of one revolution per second for 3 minutes. The aggregate shall retain a minimum of 90% of its asphalt film compared with the remainder of the sample, upon completion of this procedure.

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Note: The purpose of these tests is to determine the relative compatibility of the aggregate and asphalt, and to detect tendency of Asphalt Emulsions to re-emulsify. Test 2 may be performed as a method of determining whether compatibility can be achieved, Test 1 having given unsatisfactory results.

(w) Penetrating Ability of AE-PL.

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- 1. Apparatus and Equipment:

- a. Sand mixture:

- (1) Dry Ottawa Sand (AASHTO T 106)..... 90 parts
- (2) Dry Reference Limestone Dust, portion passing No. 50 (300 mm) sieve only.
Reference Limestone Dust used by the Department is Limestone Calcium Carbonate manufactured by France Stone Co. The Department will furnish approximately 5 lb of Reference Limestone Dust upon request..... 10 parts
- (3) Water 3 parts

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- b. Container, 6 oz ointment tin
- c. Ruler or other measuring device

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- d. Timing device readable in seconds
- e. Compacting Device. Rimac Spring Tester or other device suitable for compacting sand by applying a 20 psi load. The compacting device shall include an adapter consisting of

two metal discs slightly smaller in diameter than a 6 oz ointment tin separated by a spacer 1 to 2 in. The 2.54 in. diameter discs used in determining weight of coating in AASHTO T 65 or ASTM A90 are satisfactory.

- 350 f. Small, square ended spatula or putty knife
2. Procedure:
Thoroughly mix Standard Ottawa Sand, Reference Limestone Dust, and water. Weigh 190 ± 1 g of sand mixture into a 6 oz ointment tin. Level surface of sand with a spatula. Place the compacting adapter on the sand surface and slowly, over a period of about 5 s, compact the sand until the 20 psi load is achieved, which is approximately 100 lb on the Rimac Spring Tester. Remove the compacting device, avoiding disturbance to the sand surface. Quickly pour 12 g of the emulsion from a height of about 4 in. onto top of sand mixture. Start timer at start of pour. Stop timer when all emulsion penetrates into sand mixture. Delay 2 minutes then remove sand and mixture from one side of ointment tin, about 1/2 of mixture. Measure to determine average depth of penetration into sand mixture. Penetration time shall be 100 s or less; penetration depth shall be 1/4 in. or more.
- 360
- (x) Flow Test for Asphalt for Coating Corrugated Metal Pipe.....AASHTO M 190
- 370
- (y) Shock Test for Asphalt for Coating Corrugated Metal Pipe.....AASHTO M 190
- (z) Viscosity Determinations of Asphalt Binder Using Rotational Viscometer.....AASHTO T 316
- (aa) Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer.....AASHTO T 315
- 380
- (bb) Accelerated Aging of Asphalt Binder Using a Pressurized Aging VesselAASHTO R 28
- (cc) Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer.....AASHTO T 313

902.03 Application Temperatures

390 Binder materials for the several applications indicated in the specifications shall be applied at temperatures not to exceed those shown in the following:

903.01

Type and Grade of Material	Maximum Application Temperature, °F	
	Spray	Mix
MC-70, MCA-70.....	150	
MC-250, MCA-250.....	225	200
MC-800, MCA-800.....	250	225
MC-3000, MCA-3000.....	275	250
SC-70, SCA-70	200	
SC-250, SCA-250	225	225
SC-800-3000, SCA-800-3000.....	250	250
All Emulsions.....	160	180
All Penetration and Viscosity, Utility and Pipe Coating ...	350	325
PG Binders	(see Note)	(see Note)

Note: In accordance with manufacturer's recommendations.

SECTION 903 – CLASSIFICATION OF SOILS

903.01 Definitions

All of the soils shall be tested and classified in accordance with AASHTO M 145, and in accordance with the grain-size classification procedure as follows:

Soil Classification	Definition
Boulders	Retained on 3 in. (75 mm) sieve
Gravel	3 in. (75 mm) to No. 10 (2.0 mm) sieve
Coarse Sand	No. 10 (2.0 mm) to No. 40 (425 µm) sieve
Fine Sand	No. 40 (425 µm) to No. 200 (75 µm) sieve
Silt	0.075 to 0.002 mm
Clay	Smaller than 0.002 mm
Colloids	Smaller than 0.001 mm

903.02 Soils Having 0% to 19% Retained on No. 10 (2.00 mm) Sieve

These soils shall be classified as follows:

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Classification	Sand and Gravel, %	Silt, %	Clay, %
Sand	80 – 100	0 – 20	0 – 20
Sandy Loam	50 – 80	0 – 50	0 – 20
Loam	30 – 50	30 – 50	0 – 20
Silty Loam	0 – 50	50 – 80	0 – 20
Silt	0 – 20	80 – 100	0 – 20
Sandy Clay Loam	50 – 80	0 – 30	20 – 30
Clay Loam	20 – 50	20 – 50	20 – 30
Silty Clay Loam	0 – 30	50 – 80	20 – 30
Sandy Clay	50 – 70	0 – 20	30 – 50
Silty Clay	0 – 20	50 – 70	30 – 50
Clay	0 – 50	0 – 50	30 – 100

903.03 Soils Having 20% or More Retained on No 10 (2.00 mm) Sieve and More Than 20% Passing No. 200 (75 µm) Sieve

These soils shall be classified in accordance with 903.02, followed by a term describing the relative amount of gravel as follows:

20% to 35%: “with some gravel”

36% to 50%: “and gravel”

20 **903.04 Soils Having 20% or More Retained on No. 10 (2.00 mm) Sieve and Less Than 20% Passing No. 200 (75 µm) Sieve**

These soils shall be classified as follows:

Classification	Gravel, %	Sand, %	Silt, %	Clay, %
Gravel	85 – 100	0 – 15	0 – 15	0 – 15
Sandy Gravel	40 – 85	15 – 40	0 – 20	0 – 20
Gravelly Sand	20 – 40	40 – 80	0 – 20	0 – 20
Sand and Gravel	20 – 50	20 – 50	0 – 20	0 - 20

If the gradation of a given sample is not in exact accordance with the requirements for a given classification, it shall be placed in the classification to which it comes the closest.

903.05 Organic Soils

30 The following classification system shall be used for organic soils in accordance with AASHTO T 21 and AASHTO T 267.

Classification	Organic Content, %
With Organic Matter*	4 - 15
Organic Soil (A-8)*	16 - 30
Peat (A-8)	More than 30
* Soils classified in accordance with 903.02 shall also include this classification.	

903.06 Marly Soils

The following classification system shall be used for marly soils with calcium and magnesium carbonate content in accordance with ITM 507.

Classification	Percentage
With Trace Marl*	1 - 9
With Little Marl*	10 - 17
With Some Marl*	18 - 25
Marly Soil (A-8)	26 - 40
Marl (A-8)	More than 40
* Soils classified in accordance with 903.02 shall also include this classification.	

SECTION 904 – AGGREGATES

904.01 Aggregates

Aggregates shall consist of natural or manufactured materials produced from but not limited to limestone, dolomite, gravels, sandstones, steel furnace slag, SF, air-cooled blast furnace slag, ACBF, granulated blast furnace, GBF, wet bottom boiler slag, or other geologic rock types approved by the Engineer.

10 A source will not be considered for acceptance of material until a preliminary investigation has been made. As part of this investigation, samples will be obtained and tests conducted to determine the quality and classification of the aggregates in accordance with ITM 203.

Two types of samples are required for the preliminary investigation: ledge samples for crushed stone sources and production samples for crushed stone, natural sand and gravel, and slag sources.

20 Ledge samples will be obtained from bedrock units as they naturally occur in the proposed working face of the quarry. Ledges will be identified, at a minimum, by their differences in color, texture, and geological formation.

Production samples will be obtained from stockpiles of finished materials.

Aggregates, except those used for precast concrete units or fine aggregates used for snow and ice abrasive, shall be supplied by a Certified Aggregate Producer in accordance with 917. Structure backfill may be obtained from a non-CAPP source in accordance with 211.02. SF for SMA mixtures shall also require the following.

- 30 (a) Specific gravity quality control tests shall be completed at a frequency of one test per 2,000 t produced.
- (b) Target bulk specific gravity shall be established using the average of the first four tests.
- (c) Subsequent individual tests shall be within 0.050 of the target bulk specific gravity.
- 40 (d) Moving average of four consecutive tests shall be within 0.040 of the target bulk specific gravity.
- (e) Tests outside these ranges shall require the material to be isolated from the approved stockpile until action has been taken to eliminate the cause of the non-conformity. Any non-conforming test shall be followed immediately by a corrective action. Corrective actions shall include, but are not limited to,

investigation for assignable cause, correction of known assignable cause, and retesting.

- 50 (f) If it is determined that a new target is necessary, a request shall be made in writing to the District Testing Engineer to establish the new target.

Dolomite aggregates are defined as carbonate rock containing at least 10.3% elemental magnesium when tested in accordance with ITM 205.

Polish resistant aggregates are defined as those aggregates in accordance with ITM 214. Aggregates meeting these requirements will be maintained on the QPL of Polish Resistant Aggregate Sources.

- 60 Sandstone aggregates shall only be used in HMA surface or SMA surface mixtures. Sandstone aggregates are defined as a sedimentary rock composed of siliceous sandgrains containing quartz, chert, and quartzose rock fragments in a carbonate matrix or cemented with silica, calcite, or dolomite. The Department's Division of Materials and Tests will determine identification of sandstone.

- 70 Steel furnace slag, SF, may be used in aggregate shoulders, HMA surface or SMA surface mixtures, dumped riprap, and snow and ice abrasives. SF slag coarse aggregate may be used in HMA base and HMA intermediate mixtures if the deleterious content is less than 4.0% when tested in accordance with ITM 219. RAP with steel slag may be used in accordance with 401.06, 402.08, and 410.06.

Adjustments in weight shall be made to compensate for the difference in specific gravity of slag compared to natural aggregate when payment is on a weight basis. The following typical values for specific gravity will be used: natural aggregate both fine and coarse, 2.6; ACBF slag coarse aggregate, 2.3; ACBF slag fine aggregate, 2.6; GBF slag fine aggregate, 2.1; and SF slag both fine and coarse, 3.4. The contract quantity shall not be adjusted on any pay item less than 500 t.

- 80 When slag is furnished as an aggregate, the approximate quantity of tons to be supplied will be determined by multiplying the pay item quantity of tons by the specific gravity of slag divided by 2.6. The adjusted contract quantities will be determined by multiplying the accepted quantity of tons by 2.6 divided by the specific gravity of the slag.

At time of use, aggregates shall be free from lumps or crusts of hardened or frozen materials.

- 90 Composite stockpiling of natural sand fine aggregate from multiple sources into one stockpile will be allowed provided the fine aggregates are within a range of 0.030 for the bulk specific gravity (dry) and a range of 0.5% for the absorption. The range of bulk specific gravity (dry) and absorption values shall be the difference between the

average values for each of the fine aggregate sources within the stockpile as determined by the Department’s Division of Materials and Tests. A written request for the composite stockpiling shall be made to the Department’s Division of Materials and Tests.

904.02 Fine Aggregates

100 Fine aggregates are defined as 100% passing the 3/8 in. (9.5 mm) sieve and a minimum of 80% passing the No. 4 (4.75 mm) sieve. Characteristics of fine aggregates are as follows:

Characteristic	PCC	HMA	SMA
Physical			
Organic Impurities, AASHTO T 21 lighter than or equal to, Color Standard (Note 1)....	3		
Acid Insoluble, ITM 202.....		(Note 2)	
Soundness			
Freeze and Thaw, AASHTO T 103, Procedure A, % max. (Note 3).....	10.0	10.0	10.0
Brine Freeze and Thaw, ITM 209, % max. (Note 3)	12.0	12.0	12.0
Sodium Sulfate Soundness, AASHTO T 104, % max. (Note 3).....	10.0	10.0	10.0
Notes: 1. When subjected to the colorimetric test for organic impurities and a color darker than the standard is produced, it shall be tested for effect of organic impurities on strength of mortar in accordance with AASHTO T 71. If the relative strength at seven days is less than 95% it shall be rejected.			
2. The fine aggregate, including blended fine aggregate, used in HMA Surface 4.75 mm mixtures shall have a minimum acid-insoluble content of 40%, except when using ACBF or GBF slag sands, the minimum acid-insoluble content shall be 25%. Acid-insoluble requirements shall not apply to crushed gravel, limestone, or dolomite sands.			
3. AASHTO T 104 and ITM 209 may be run at the option of the Engineer, in-lieu of AASHTO T 103.			

(a) For Portland Cement Concrete

Fine aggregate for use in PCCP or bridge decks shall be natural sand. Fine aggregate for other PCC shall be natural sand or crushed limestone, dolomite, gravel, or ACBF.

110 Natural sand which has been used as foundry sand when tested in accordance with ITM 215, and complying with IDEM Class III or Class IV in accordance with 329 IAC 10-7-4 may be used in precast concrete units or precast concrete pipe. When foundry sand is used, the precast concrete manufacturer shall maintain a copy of the Waste Classification issued by IDEM and an indemnification statement shall accompany the precast items to each contract.

(b) For HMA Mixtures

120 Fine aggregates for use in HMA shall be natural sand or crushed limestone, dolomite, gravel, sandstone, SF, or ACBF. SF sand may be used in HMA surface mixtures. SF sand may only be used in HMA base and HMA intermediate mixtures if SF in accordance with 904.01 is used to produce the SF sand. The amount of crushed limestone sand shall not exceed 20% by volume of the total aggregate used in HMA surface mixtures with ESAL equal to or greater than 3,000,000, except limestone sands manufactured from aggregates on the QPL of Polish Resistant Aggregate Sources will not be limited. If soundness testing cannot be conducted, the aggregate shall come from a Category I source in accordance with ITM 203.

The fine aggregate angularity value of the total blended aggregate material from the fine and coarse aggregates, and recycled materials shall meet or exceed the minimum values for the appropriate ESAL category and position within the pavement structure as follows:

130

Fine Aggregate Angularity		
Traffic ESAL	Depth from Surface	
	≤ 4 in.	> 4 in.
< 3,000,000	40*	40
3,000,000 to < 10,000,000	45	40
≥ 10,000,000	45	40
* For 4.75 mm mixtures, the fine aggregate angularity shall be 45 for < 3,000,000 ESAL.		

Fine Aggregate Angularity, Method A.....AASHTO T 304

The fine aggregate angularity value shall not apply to OG mixtures.

(c) For SMA Mixtures

140 Fine aggregate for SMA shall be limestone, dolomite, crushed gravel, SF, or ACBF. Crushed gravels shall have a minimum fine aggregate angularity of 45 in accordance with AASHTO T 304, Method A. Fine aggregates shall be non-plastic in accordance with AASHTO T 90.

(d) For Pneumatically Placed Mortar

Fine aggregate shall be natural sand suitable for use with a pneumatic cement gun. Fine aggregate shall be size No. 15, or size PP in accordance with 904.02(h), or an approved gradation from a CAPP source.

(e) Mortar Sand

150 Fine aggregate for mortar shall consist of uniformly graded natural sand in accordance with gradation requirements of 904.02(h) for size No. 15 or an approved gradation from a CAPP source.

(f) Mineral Filler for SMA

Mineral filler shall consist of dust produced by crushing stone, portland cement, or other inert mineral matter having similar characteristics. Mineral filler shall be in accordance with the gradation requirements of 904.02(h) for size No. 16 or as approved by the Engineer. Mineral filler shall be in accordance with ITM 203 or from an ACBF slag source. The sieve analysis of mineral filler shall be conducted in accordance with AASHTO T 37 except as noted in 904.06. Mineral filler shall be non-plastic in accordance with AASHTO T 90.

160

(g) Snow and Ice Abrasives

Snow and ice abrasives shall be fine aggregates or cinders in accordance with the gradation requirements of 904.02(h) for size S&I.

When steel slag is used for snow and ice abrasives, and payment is on a tonnage basis, the pay quantity shall be adjusted in accordance with 904.01.

(h) Sizes of Fine Aggregates

Sizes (Percent Passing)						
Sieve Sizes	23	24	15	16	PP	S&I
3/8 in. (9.5 mm)	100	100				100
No. 4 (4.75 mm)	95 - 100	95 - 100			100	
No. 6 (3.35 mm)			100			
No. 8 (2.36 mm)	80 - 100	70 - 100	90 - 100		85 - 95	
No. 16 (1.18 mm)	50 - 85	40 - 80				
No. 30 (600 μm)	25 - 60	20 - 60	50 - 75	100	50 - 65	
No. 50 (300 μm)	5 - 30	7 - 40	15 - 40		15 - 25	0 - 30
No. 80 (180 μm)				95 - 100		
No. 100 (150 μm)	0 - 10	1 - 20	0 - 10		0 - 10	
No. 200 (75 μm)	0 - 3	0 - 6	0 - 3	65 - 100		0 - 7

170

(i) Sampling and Testing

Sampling and testing shall be conducted in accordance with the following AASHTO and ITMs.

180

- Acid Insoluble Content..... ITM 202
- Amount of Material Finer than
 - No. 200 (75 μm) Sieve* AASHTO T 11
- Brine Freeze and Thaw Soundness..... ITM 209
- Control Procedures for Classification
 - of Aggregates..... ITM 203
- Determining the Plastic Limit and
 - Plasticity Index of Soils..... AASHTO T 90
- Mortar Strength AASHTO T 71
- Organic Impurities..... AASHTO T 21
- Sampling Aggregates..... AASHTO T 2

	Sampling Stockpiled Aggregates.....	ITM 207
	Sieve Analysis of Aggregate*	AASHTO T 27
	Sieve Analysis of Mineral Filler*.....	AASHTO T 37
190	Soundness*.....	AASHTO T 103, AASHTO T 104
	Specific Gravity and Absorption, Fine Aggregate.....	AASHTO T 84
	* Except as noted in 904.06.	

904.03 Coarse Aggregates

Coarse aggregates are defined as having a minimum of 20% retained on the No. 4 (4.75 mm) sieve. Coarse aggregates shall not contain adherent fines that are detrimental to the end product as defined in ITM 211.

200 The coarse aggregate shall comply with the quality requirements and the additional requirements in accordance with 904.03(a). However, coarse aggregate may be rejected based on previous performance service records. Class AP is defined as the highest classification and Class F the lowest. Blending of material for compliance with gradation or crushed particle requirements may be approved when requested in writing. Blending of aggregate products to improve the quality classification of the finished product will not be allowed.

(a) Classification of Aggregates

1000

Characteristic Classes	AP	AS	A	B	C	D	E	F
Quality Requirements:								
Freeze and Thaw Beam Expansion, % max. (Note 1)060							
Los Angeles Abrasion, % max. (Note 2)	40.0	30.0	40.0	40.0	45.0	45.0	50.0	
Freeze and Thaw, AASHTO T 103, Procedure A, % max. (Note 3).....	12.0	12.0	12.0	12.0	16.0	16.0	20.0	25.0
Sodium Sulfate Soundness, % max. (Note 3)	12.0	12.0	12.0	12.0	16.0	16.0	20.0	25.0
Brine Freeze and Thaw Soundness, % max. (Note 3).....	30	30	30	30	40	40	50	60
Absorption, % max. (Note 4).....	5.0	5.0	5.0	5.0	5.0			
Additional Requirements:								
Deleterious, % max.								
Clay Lumps and Friable Particles	1.0	1.0	1.0	1.0	2.0	4.0		
Non-Durable (Note 5)	4.0	2.0	4.0	4.0	6.0	8.0		
Coke					(See Note 6)			
Iron.....					(See Note 6)			
Chert (Note 7)	3.0	3.0	3.0	5.0	8.0	10.0		
Weight per Cubic Foot for Slag, lb, min.	75.0		75.0	75.0	70.0	70.0	70.0	
Crushed Particles, % min. (Note 8)								
Compacted Aggregates.....			20.0	20.0	20.0	20.0		
Notes:								
1. Freeze and thaw beam expansion shall be tested and re-tested in accordance with ITM 210.								
2. Los Angeles abrasion requirements shall not apply to BF.								

3. Aggregates may, at the option of the Engineer, be accepted by the Sodium Sulfate Soundness or Brine Freeze and Thaw Soundness requirements.
4. Absorption requirements apply only to aggregates used in PCC and HMA mixtures except they shall not apply to BF. When crushed stone coarse aggregates from Category I sources consist of production from ledges whose absorptions differ by more than two percentage points, the absorption test will be performed every three months on each size of material proposed for use in PCC or HMA mixtures. Materials having absorption values between 5.0 and 6.0 that pass AP testing may be used in PCC. If variations in absorption preclude satisfactory production of PCC or HMA mixtures, independent stockpiles of materials will be sampled, tested, and approved prior to use.
5. Non-durable particles include soft particles as determined by ITM 206 and other particles which are structurally weak, such as soft sandstone, shale, limonite concretions, coal, weathered schist, cemented gravel, ocher, shells, wood, or other objectionable material. Determination of non-durable particles shall be made from the total weight (mass) of material retained on the 3/8 in. (9.5 mm) sieve. Scratch Hardness Test shall not apply to crushed stone coarse aggregate.
6. ACBF and SF coarse aggregate shall be free of objectionable amounts of coke, iron, and lime agglomerates.
7. The bulk specific gravity of chert shall be based on the saturated surface dry condition. The amount of chert less than 2.45 bulk specific gravity shall be determined on the total weight (mass) of material retained on the 3/8 in. (9.5 mm) sieve for sizes 2 through 8, 43, 53, and 73 and on the total weight (mass) of material retained on the No. 4 (4.75 mm) sieve for sizes 9, 11, 12, and 91.
8. Crushed particle requirements apply to gravel coarse aggregates used in compacted aggregates. Determination of crushed particles shall be made from the weight (mass) of material retained on the No. 4 (4.75 mm) sieve in accordance with ASTM D5821.

(b) Coarse Aggregate Angularity for HMA and SMA

The coarse aggregate angularity, CAA of the total blended aggregate, including recycled materials, shall meet or exceed the minimum values for the appropriate ESAL category and position within the pavement structure as follows.

Coarse Aggregate Angularity		
Traffic ESAL	Depth from Surface	
	≤ 4 in.	> 4 in.
< 3,000,000	75	50
3,000,000 to < 10,000,000	85/80*	60
≥ 10,000,000	95/90*	95/90*
* Denotes two faced crush requirements.		

For SMA mixtures, the total blended aggregate shall be 100% one face and 95% two face crushed.

220 Coarse Aggregate AngularityASTM D5821

Coarse aggregate angularity requirements do not apply to 4.75 mm HMA mixture designation.

(c) Flat and Elongated

The coarse aggregate shall contain 10% or less flat and elongated particles. A flat and elongated piece is defined as a particle having a ratio of length to thickness greater than 5. Determination of flat and elongated particles shall be made from the weight (mass) of material retained on the 3/8 in. (9.5 mm) sieve and each sieve size greater than the 3/8 in. (9.5 mm) sieve.

230 Flat and Elongated.....ASTM D4791

Flat and elongated requirements do not apply to 4.75 mm HMA mixture designation.

(d) Surface Aggregate Requirements

The surface mixture aggregates selection shall be based on the ESAL category as follows.

240 **1. HMA Coarse Aggregate**

- a. ESAL Category 2 and type B surface mixtures. All coarse aggregate types including ACBF slag, SF slag, sandstone, crushed dolomite, polish resistant aggregate, crushed stone and gravel may be used.
- b. ESAL Category 3 and type C surface mixtures. ACBF slag, SF slag, sandstone, crushed dolomite, polish resistant

250 aggregate or any combination thereof shall be used. Crushed stone or gravel shall not be used unless the aggregate is classified as a crushed dolomite or polish resistant aggregate.

- c. ESAL Category 4 and type D surface mixtures. High friction aggregates including ACBF slag, SF slag, sandstone or aggregates in accordance with ITM 221 shall be used and at a minimum shall comprise 50% by volume of the coarse aggregate.

260 Crushed dolomite and polish resistant aggregates may be used up to a maximum 50% by volume of the coarse aggregate material retained on the No. 4 (4.75 mm) sieve when blended with a high friction aggregate.

Crushed stone and gravel may be used up to a maximum 20% by volume of the coarse aggregate material retained on the No. 4 (4.75 mm) sieve when blended with a high friction aggregate.

270

2. SMA Coarse Aggregate

SF slag, sandstone, crushed dolomite and polish resistant aggregates in accordance with 904.03(a) may be used in SMA mixtures provided the mixtures are designed in accordance with ITM 220.

(e) Sizes of Coarse Aggregates

Sieve Sizes	Coarse Aggregate Sizes (Percent Passing)											
	Coarse Graded										Dense Graded	
	2	5	8	9	11, SC 11 ⁽⁵⁾	12, SC 12 ⁽⁵⁾	SC 16 ⁽⁵⁾	43 ⁽¹⁾	91	93PG ⁽⁶⁾	53 ⁽¹⁾	73 ⁽¹⁾
4 in. (100 mm)												
3 1/2 in. (90 mm)												
2 1/2 in. (63 mm)	100											
2 in. (50 mm)	80 - 100											
1 1/2 in. (37.5 mm)		100						100			100	
1 in. (25 mm)	0 - 25	85 - 98	100					70 - 90	100		80 - 100	100
3/4 in. (19 mm)	0 - 10	60 - 85	75 - 95	100				50 - 70			70 - 90	90 - 100
1/2 in. (12.5 mm)	0 - 7	30 - 60	40 - 70	60 - 85	100	100	100	35 - 50		98 - 100	55 - 80	60 - 90
3/8 in. (9.5 mm)		15 - 45	20 - 50	30 - 60	75 - 95	95 - 100	94 - 100			75 - 100		
No. 4 (4.75 mm)		0 - 15	0 - 15	0 - 15	10 - 30	50 - 80	15 - 45	20 - 40		10 - 60	35 - 60	35 - 60
No. 8 (2.36 mm)		0 - 10	0 - 10	0 - 10	0 - 10	0 - 35		15 - 35		0 - 15	25 - 50	
No. 16 (1.18 mm)							0 - 4					
No. 30 (600 μm)						0 - 4		5 - 20		0 - 5	12 - 30	12 - 30
No. 200 (75 μm) ⁽²⁾								0 - 6.0			5.0 - 10.0 ⁽⁴⁾	5.0 - 12.0
Decant (PCC) ⁽³⁾		0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5			0 - 1.5			
Decant (Non-PCC)	0 - 2.5	0 - 2.5	0 - 3.0	0 - 2.5	0 - 2.5	0 - 2.0			0 - 2.5	0 - 2.0		
Decant (SC)					0 - 1.5	0 - 1.5	0 - 1.5					

Notes: (1) The liquid limit shall not exceed 25 (35 if slag) and the plasticity index shall not exceed 5. The liquid limit shall be determined in accordance with AASHTO T 89 and the plasticity index in accordance with AASHTO T 90.

(2) Includes the total amount passing the No. 200 (75 μm) sieve as determined by AASHTO T 11 and AASHTO T 27.

(3) Decant may be 0 - 2.5 for stone and slag.

- (4) When slag is used for separation layers as defined in 302.01, the total amount passing the No. 200 (75 μ m) sieve shall be 10.0 to 12.0.
- (5) Seal coat (SC) aggregates shall be 85% one face and 80% two face crushed. The Flakiness Index in accordance with ITM 224 shall be a maximum of 25%.
- (6) Pea gravel shall be generally uncrushed gravel, with a maximum of 20% crushed particles, and shall meet the gradation requirements of 93PG. Determination of crushed particles shall be made from the weight (mass) of material retained on the No. 4 (4.75 mm) sieve in accordance with ASTM D5821.

904.04

280 **(f) Sampling and Testing**

Sampling and testing will be in accordance with the following AASHTO, ASTM, and ITMs.

	Amount of Material finer than No. 200 (75 µm) Sieve*.....	AASHTO T 11
	Brine Freeze and Thaw Soundness.....	ITM 209
	Clay Lumps and Friable Particles.....	AASHTO T 112
	Control Procedures for Classification of Aggregates	ITM 203
	Crushed Particles	ASTM D5821
290	Dolomite Aggregates.....	ITM 205
	Flat and Elongated Particles	ASTM D4791
	Freeze and Thaw Beam Expansion	ITM 210
	Lightweight Pieces in Aggregates*	AASHTO T 113
	Los Angeles Abrasion	AASHTO T 96
	Micro-Deval Abrasion.....	AASHTO T 327
	Polished Resistant Aggregates.....	ITM 214
	Sampling Aggregates*	AASHTO T 2
	Sampling Stockpiled Aggregates.....	ITM 207
	Scratch Hardness	ITM 206
300	Sieve Analysis*	AASHTO T 27
	Soundness*	AASHTO T 103, AASHTO T 104
	Specific Gravity and Absorption*	AASHTO T 85
	Unit Weight and Voids in Aggregates.....	AASHTO T 19

*Except as noted in 904.06

904.04 Riprap

Riprap shall consist of SF for dumped riprap only, sound stone, stone masonry, or other approved material, free from structural defects and of approved quality. Stone
310 containing shale, unsound sandstone, or other material that will disintegrate readily, shall not be used.

(a) Dumped Riprap

Dumped riprap shall be broken concrete, masonry, or stone removed from an old structure; broken pieces removed from concrete pavement, base, or monolithic brick pavement; or broken rock from class X, class Y, unclassified excavation, or solid rock excavation. Material provided from sources outside the right-of-way shall be coarse aggregate, Class F or higher.

320 **(b) Grouted Riprap**

Grouted riprap material shall be in accordance with dumped riprap or revetment riprap.

(c) Revetment, Class 1, and Class 2 Riprap

The material shall be coarse aggregate, Class F or higher. Gradation shall be in accordance with 904.04(f).

(d) Uniform Riprap

330 The material shall be coarse aggregate, Class F or higher in accordance with 904.03(a). Gradation shall be in accordance with 904.04(f). Either type A or type B may be utilized.

(e) Precast Concrete Riprap

340 Precast concrete riprap shall consist of unreinforced concrete units of the thickness specified and shall be in accordance with the details shown on the plans. The precast concrete units shall be in accordance with ASTM C139 except the fine aggregates shall be in accordance with 904.02(a) and the coarse aggregates, class A or higher, shall be in accordance with 904.03. The minimum compressive strength shall be 2,500 psi for an average of three units and 2,300 psi for individual units. The maximum water absorption shall be 12 lb/cu ft for an average of three units.

(f) Sizes of Riprap

Gradation Requirements					
Percent Smaller					
Size, in.	Revetment	Class 1	Class 2	Uniform A	Uniform B
30			100		
24		100	85 - 100		
18	100	85 - 100	60 - 80		
12	90 - 100	35 - 50	20 - 40		
8				100	
6	20 - 40	10 - 30	0 - 20	35 - 80	95 - 100
3	0 - 10	0 - 10	0 - 10		35 - 80
1				0 - 20	0 - 20
Depth of Riprap, min.	18 in.	24 in.	30 in.		

The maximum dimension of individual pieces shall not be greater than three times the minimum dimension. The riprap will be visually inspected for size, shape, and consistency.

904.05 Structure Backfill

350 The material shall be of acceptable quality, free from large or frozen lumps, wood, or other extraneous matter. It shall consist of suitable sand, gravel, crushed stone, ACBF, or GBF. Structure backfill shall be in accordance with one of the gradations shown in the table below, or coarse aggregate No. 5, No. 8, No. 9, No. 11, No. 12, No. 53, or No. 73 in accordance with the gradation requirements of 904.03(e). Coarse aggregate No. 5, No. 8, No. 9, No. 11, No. 12, No. 53, or No. 73 shall be crushed stone or ACBF, class D or higher.

Sieve Sizes	Nominal Sizes and % Passing					
	2 in. (50 mm)	1 1/2 in. (37.5 mm)	1 in. (25.0 mm)	1/2 in. (12.5 mm)	No. 4 (4.75 mm)	No. 30 (600 µm)
2 1/2 in. (63 mm)	100					
2 in. (50 mm)	90 - 100	100				
1 1/2 in. (37.5 mm)	70 - 100	90 - 100	100	100		
1 in. (25.0 mm)	55 - 95	70 - 100	85 - 100			
3/4 in. (19.0 mm)	45 - 90	55 - 95	70 - 100			
1/2 in. (12.5 mm)	35 - 85	40 - 90	55 - 95	85 - 100	100	100
No. 4 (4.75 mm)	20 - 65	20 - 70	25 - 75	45 - 85	90 - 100	
No. 8 (2.36 mm)	10 - 50	10 - 55	15 - 60	25 - 75	75 - 100	
No. 30 (600 µm)	3 - 35	3 - 35	3 - 35	5 - 45	15 - 70	70 - 100
No. 200 (75 µm)	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8

904.06 Exceptions to AASHTO Standard Methods

360

(a) Exceptions to AASHTO T 2

Stockpile sampling shall be in accordance with ITM 207, unless otherwise approved.

(b) Exceptions to AASHTO T 11, T 27, and T 37

370

1. When tests are performed in the field where ovens are not available, test samples may be dried in suitable containers over open flame or electric hot plates with sufficient stirring to prevent overheating, then cooled to constant weight.
2. The balance shall be a Class G2 general purpose balance in accordance with AASHTO M 231.

(c) Exceptions to AASHTO T 27 for Coarse Aggregates

The size of test samples for coarse aggregate shall be as follows:

380

Aggregate Size	Minimum Weight of Test Sample
No. 2.....	25 lb
No 5, 8, 43, 53, 73, and 91	13 - 18 lb
No. 9.....	9 - 13 lb
Structure Backfill	
2 in. (50 mm).....	25 lb
1 1/2 in. (37.5 mm) and 1 in. (25.0 mm).....	13 - 18 lb
1/2 in. (12.5 mm).....	9 - 13 lb
No. 4 (4.75 mm) and No. 30 (600 µm).....	10 oz

(d) Exceptions to AASHTO T 85

390 The in-water weight shall be determined following the 15 h soaking period prior to determining the SSD weight.

(e) Exceptions to AASHTO T 103 and T 104

1. Counting the number of individual particles coarser than the 3/4 in. (19.0 mm) sieve will not be required.
2. For testing ledge rock, the ledge samples shall be crushed to obtain test samples for the designated increments passing the 1 1/2 in. (37.5 mm) sieve and retained on the No. 4 (4.75 mm) sieve. The factors used to calculate the weighted average loss are 30%, 40%, and 30% of the 1 1/2 in. (37.5 mm) - 3/4 in. (19.0 mm), 3/4 in. (19.0 mm) - 3/8 in. (9.5 mm), and 3/8 in. (9.5 mm) - No. 4 (4.75 mm) increments, respectively.
3. In the case of ledge rock, modify sections 3.3 and 6.2 of AASHTO T 103 and AASHTO T 104 respectively. When the sample received is deficient in material of a component size of any test portion, that material will be supplemented with the available component size to provide the test portion.
4. Modify section 8 of AASHTO T 103 and section 10 of AASHTO T 104. For materials designated as a coarse aggregate, the weighted loss will be calculated considering the material retained on the No. 4 (4.75 mm) sieve as 100% of the sample, and only the total weighted loss reported. In AASHTO T 104 sections 10.1.3.2 and 10.1.3.3 shall not apply, and unless otherwise noted only new solution will be used.

420

SECTION 905 – MASONRY UNITS**905.01 Clay or Shale Brick**

Brick shall be in accordance with the following specifications.

(a) Sewer Brick

Sewer brick shall be in accordance with ASTM C32, grade SS.

(b) Manhole Brick

10 Manhole brick shall be in accordance with ASTM C32, grade MS.

(c) Building Brick

Building brick shall be in accordance with ASTM C62, grade SW.

905.02 Concrete Brick

Concrete brick intended for use in construction of manholes, catch basins, and similar structures, or as building bricks, shall be in accordance with ASTM C55.

905.03 Concrete Masonry Blocks

20 Concrete masonry blocks may be rectangular or segmented and, when specified, shall have ends shaped to provide interlock at vertical joints. Solid masonry units shall be in accordance with ASTM C139. Hollow load-bearing masonry units shall be in accordance with ASTM C90, normal weight.

905.04 Precast Concrete Curbing

Precast concrete curbing shall consist of precast portland cement concrete curb units constructed to the length, shapes, and other details shown on the plans. These units shall be reinforced with steel reinforcement when shown on the plans. Steel reinforcement shall be in accordance with 910.01.

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When required for driveways, crossings, closures, or for other reasons a depressed or modified section of curb is indicated, curbing with the required modification shall be furnished.

905.05 Detectable Warning Surfaces

The detectable warning surface in concrete curb ramps shall be constructed using materials from the QPL of Detectable Warning Surfaces, which is maintained by the Department's Division of Materials and Tests. A surface manufacturer wishing to add a product to the QPL shall comply with Procedure L of ITM 806.

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(a) Brick detectable warning surfaces shall consist of clay, shale, or similarly naturally occurring earthy substance, subjected to heat treatment at elevated temperatures to form bricks or pavers. The dimensions of the brick shall be 8 in. in length, 4 in. in width including any spacing lugs. The thickness of the brick shall be 2 in., excluding dome height and edge chamfers. The truncated domes on the surface shall be formed integral with the main body of the detectable warning surface and be present on the brick prior to heat treatment. The size and physical requirements of the bricks shall be in accordance with ASTM C902 for weather and traffic environment classifications Class SX, Type II, respectively. The truncated domes may be ground off to meet the cap thickness requirement for compressive strength testing.

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(b) Brick detectable warning surfaces shall be predominantly red-brown in color and shall be uniform throughout the brick. The color will be determined from the average of five color readings for detectable warning surfaces when measured at the top surface between the raised truncated domes and determined in accordance with ASTM E1349, CIE Illuminant D65, 10° Standard Observer,

60

using instrument geometry of 45°/0°, and the CIE L*a*b* color system. The tested bricks shall be within the limits as follows:

	Minimum	Maximum
L*	35.0	50.0
a*	6.0	36.0
b*	0.0	30.0

The value of a* shall not be less than 90% of the value of b*. The color difference of any installed brick after one year of exposure or of an individual detectable warning surface from the average color for any product or model from a manufacturer shall not be greater than 5.0 ΔE^* units. The color shall be uniform throughout the detectable warning surfaces.

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- (c) Cast iron detectable warning surfaces shall be manufactured from gray iron in accordance with AASHTO M 105, Class No. 30A as a minimum. The truncated domes shall be as shown on the plans. The tops of the domes and the space between domes shall have a non-slip textured surface. The minimum thickness of the casting shall be 0.20 in. The minimum thickness shall not be measured within the area of integral reinforcing ribs or bracing, domes or the textured surface.

80

- (d) The height range of the truncated domes shall be between 0.18 in. and 0.26 in. The design values shall be within the ranges identified in the Standard Drawings. No more than two truncated domes per surface may be out of tolerance for dimensions.

- (e) Detectable warning surfaces that are not classified as brick in accordance with 905.05(a) or cast iron in accordance with 905.05(c) will be considered. The detectable warning surfaces shall meet the color requirements of 905.05(b) and the truncated dome requirements of 905.05(d).

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905.06 Precast Concrete Units Not Otherwise Covered

These units shall be cast in substantial permanent steel forms. Structural concrete shall attain a minimum 28-day compressive strength of 3,000 psi as determined in accordance with AASHTO T 22. When air entrained concrete is specified, it shall have an air content of from 5% to 8% by volume. The precast units shall be cured in accordance with AASHTO M 170. Water absorption of individual cores taken from such units shall not exceed 9%. Additional reinforcement shall be provided as needed to handle the precast units.

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SECTION 906 – JOINT MATERIALS

906.01 Joint Fillers

Joint fillers shall be preformed materials intended to be used in PCCP or as otherwise specified. Joint fillers shall be in accordance with AASHTO M 213 or ASTM D8139. A type B certification in accordance with 916 shall be provided for joint fillers. The limits of the following shall be shown on the certification.

Property	Test Method
Compressive Strength	ASTM D8139
Recovery	ASTM D8139
Extrusion	ASTM D545
Heat Resistance	ASTM D8139
Asphalt Content	ASTM D545
Water Absorption	ASTM D545
Freeze Thaw Resistance	ASTM D8139
Density	ASTM D545

10 906.02 Joint Sealing Materials

(a) Joint Sealers

Joint sealers shall consist of materials which are intended to be used in sealing joints and cracks in pavements and structures.

1. Silicone Joint Sealants

a. Physical Requirements

Silicone joint sealants shall be in accordance with ASTM D5893.

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b. Field Evaluation

All silicone joint sealants complying with the physical requirements will be subjected to a field evaluation before approval for general use is granted. The Department will maintain a QPL of Joint Sealants, which comply with the physical requirements and field evaluation.

c. Specific Requirements for Installation of Silicone Joint Sealant

The sealant shall be stored in the original unopened container at or below 90°F. The sealant shall be placed when the ambient temperature is above 40°F. The equipment used shall be adequate for the placement of the sealant and shall meet the sealant manufacturer's recommendations. Air compressors used for the placement of this sealant shall be equipped with traps which remove moisture and oil from the air.

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The sealants which are self-leveling shall be identified as such on the QPL of Joint Sealants, and will not require tooling. Sealants not identified as self-leveling on the QPL shall be tooled or applied in such a manner which causes them to wet the joint

40 faces. Such sealants which are not formulated for self-leveling will not position properly in the joint under its own weight. A backer rod as set out herein shall be used to control sealant configuration and facilitate tooling. Applicable joint configurations shall be as shown on the plans. After a joint has been sealed, all surplus joint sealer on the pavement surfaces shall be promptly removed. Traffic shall not be allowed over sealed joints until the sealer is tack free.

The sealant shall be delivered in containers plainly marked with manufacturer's name or trademark.

2. Hot Poured Joint Sealant

50 The sealant shall be in accordance with ASTM D6690, Type II. The material shall be tested in accordance with ASTM D5329 except that after blotting, the surface of the blocks shall be blown dry with compressed air. A type A certification in accordance with 916 shall be provided for hot poured joint sealant. The results of the following shall be shown on the certification.

Property	Requirement
Cone Penetration at 25°C	90 maximum
Softening Point °C	80 minimum
Bond, non-immersed	Three 12.5 ±0.2 mm specimens pass 3 cycles at 50 % ext. at -29°C
Resilience, %	60 minimum
Asphalt Compatibility	Pass

The sealing compound shall be delivered in the manufacturer's original sealed container. Each container shall be legibly marked with the name of the manufacturer, the trade name of the sealer, the manufacturing batch number or lot, the pouring temperature, and the safe heating temperature.

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The sealant shall be used in accordance with the manufacturer's recommendations. A backer rod as set out herein shall be used to provide the joint configuration in accordance with the standard drawings.

3. Preformed Elastomeric Joint Seals

This joint shall be in accordance with ASTM D2628. A type A certification in accordance with 916 shall be provided for joint seals. The results of the following shall be shown on the certification.

906.02

Property	ASTM Test Method	Requirement
Tensile strength, minimum, psi (MPa)	D412	2000 (13.8)
Elongation at break, minimum, %	D412	250
Hardness, Type A durometer, points	D2240	55 ±5
Oven aging, 70 h at 212°F (100°C)	D573	
Tensile strength, loss, maximum, %		20
Elongation, loss, maximum, %		20
Hardness, Type A durometer, points change		0 to + 10
Oil Swell, ASTM Oil 3, 70 h at 212°F (100°C) Weight change, maximum, %	D471	45
Ozone resistance	D1149	
20 % strain, 300 ppm in air, 70 h at 104°F (40°C)		no cracks
Low-temperature stiffening, 7 days at 14°F (-10°C) Hardness, Type A durometer, points change	D2240	0 to + 15
Low-temperature recovery, 72 h at 14°F (-10°C) 50 % deflection, minimum, %	D2628	88
Low-temperature recovery, 22 h at - 20°F (-29°C), 50 % deflection, minimum, %	D2628	83
High-temperature recovery, 70 h at 212°F (100°C), 50 % deflection, minimum, %	D2628	85
Compression-deflection, at 80 % of nominal width, minimum, lbf/in. (N/m)	D2628	3.5 (613)

70

4. Polychloroprene Joint Membrane and Adhesive

Polychloroprene joint membrane shall be general purpose, heavy duty polychloroprene sheeting with nylon fabric reinforcement. The sheeting shall be in accordance with the following:

Property	Test Method	Requirement
Thickness	ASTM D751	0.094 in. ±0.01 in.
Breaking Strength, Grab Test, minimum	ASTM D751	700 lbf x 700 lbf (Longitudinal x transverse)
Adhesive Strip, 1 in. by 2 in.	ASTM D751	9 lbf minimum
Burst Strength	ASTM D751	1,400 psi minimum

A type B certification in accordance with 916 shall be provided for the polychloroprene joint membrane. The limits of the above shall be shown on the certification.

80

The adhesive used to attach the polychloroprene joint membrane to concrete shall be a black styrene-butadiene rubber base material compatible with both concrete and polychloroprene. The adhesive shall be in accordance with the following:

Property	Test Method	Minimum	Maximum
Viscosity, cps	ASTM D2196, RVF #6 sp @ 20 rpm	7,500	18,000
Solids, %	ASTM D1259	28	35
Weight per gal., lb	ASTM D1875	6.6	7.0

A type C certification in accordance with 916 shall be provided for the polychloroprene joint adhesive.

5. Hot Poured Joint Adhesive

- 90 Joint adhesive is a hot applied asphalt material that is used to seal the longitudinal construction joint formed between the adjacent HMA pavement courses.

Joint adhesive shall be in accordance with the following:

Test	Method	Test Result
Softening Point, °F (°C)	AASHTO T 53	> 170 (77)
Ductility @ 77°F (25°C), mm	AASHTO T 51	> 300
Ductility @ 39°F (4°C), mm	AASHTO T 51	> 300
Apparent Viscosity @ 400°F (204°C), cP	ASTM D2669	4,000 – 11,000
Asphalt Compatibility	ASTM D5329	Pass
Cone Penetration @ 77°F (25°C), mm	ASTM D5329	50.0 – 100.0
Flow @ 140°F (60°C), mm	ASTM D5329	< 5
Resilience @ 77°F (25°C), %	ASTM D5329	> 30
Tensile Adhesion @ 77°F (25°C), 1 in. specimen, %	ASTM D5329	> 500
Flexibility @ 0°F (-18°C)	ASTM D3111	Pass
Flash Point, °C (°F)	AASHTO T 48	> 219 (426)

A type A certification in accordance with 916 shall be provided for hot poured joint adhesive. The results of the above shall be shown on the certification.

(b) Backer Rod

- 100 The rod is to act as a bond breaker, to control the thickness of the bead, and to provide support for any required tooling of the sealant.

1. Requirements

When hot poured material is used, compatibility of the backer rod with the hot sealant shall be verified before use. The backer rod shall be a closed cell expanded polyethylene foam or an isomeric polymer foam rod. Diameter and placement shall be as shown on the plans.

2. Certification

- 110 A type C certification in accordance with 916 shall be provided for the backer rod.

906.03 Preformed Expansion Joint Filler

Preformed expansion joint filler, PEJF, shall be preformed materials intended to be used at bridge component interfaces that are not required to be watertight. PEJF shall be either extruded polystyrene, XPS, or expanded polystyrene, EPS in accordance with ASTM C578. The compressive resistance shall be less than 40 psi, as measured in accordance with ASTM D1621. Water absorption shall be less than 1%, as measured in accordance with ASTM C272. PEJF will be by accepted by visual inspection.

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906.04 Blank**906.05 Blank****906.06 Blank****906.07 Bridge Expansion Joints**

Type S and Type M joints, including anchor assemblies, shall be shop fabricated, delivered and installed as a continuous unit for lengths up to 46 ft. Joints longer than 130 46 ft shall be furnished in continuous units or in appropriate shorter sections as shown on the working drawings and approved by the Engineer. Joints used in stage construction shall be furnished in sections appropriate to accommodate the work. All steel joints furnished in sections shall be spliced with welds, with ends prepared for welding in the shop. All welds shall be in accordance with 711.32.

Type PCF joints shall be fabricated, delivered, and installed in lengths no less than 6 ft. Sections of joint shall be field spliced using silicone sealant in accordance with the manufacturer's recommendations. Joints shall be furnished with the fewest number of splices possible, and sections less than 6 ft in length shall not be used unless required 140 to complete the remaining length at the ends of a joint or construction phase.

The profile of the joint in the roadway area shall conform to the roadway cross section. Where changes in direction are required, such as at curbs or concrete rails, the sections shall be cut to the bevel required to produce the same cross section on each piece being joined. Slider plates shall be provided at curbs, walkways, and concrete rails as part of the completed joint assembly. The slider plate shall be the same material as the extrusion and shall be galvanized in accordance with ASTM A123.

All welds in contact with the elastomeric seals shall be ground smooth. Metal 150 surfaces in direct contact with the elastomeric seal shall be cleaned and treated in accordance with the manufacturer's recommendations to provide a high strength bond between the elastomeric seal and mating metal surfaces. The elastomeric seals shall be clean and free of foreign materials.

All exposed structural steel surfaces, except stainless steel or polytetrafluoroethylene coated, shall be shop painted in accordance with 619.

(a) Type SS

160 Structural steel shall be in accordance with ASTM A36, ASTM A588, ASTM A1011, ASTM A242, or Merchant Quality 1010, 1020.

Sealant and grouts shall be in accordance with the manufacturer's recommendation.

The elastomer shall be neoprene in accordance with ASTM D5973 except that the physical requirements in Table 1 for low temperature recovery, high temperature recovery, and compression-deflection properties will not apply.

170 The strip seal shall be furnished in one continuous length for the entire limits of the installed joint. Field splicing of the strip seal will not be allowed. Miter cut, vulcanized shop splices will be required in the strip seal. The shop vulcanization of the strip seal splice may be either a hot or cold process so long as the process produces a splice of equal or greater strength than the elastomer.

A type B certification in accordance with 916 shall be provided for the elastomer. The limits of the following shall be shown on the certification.

180 A type C certification in accordance with 916 shall be provided for the structural steel and polyurethane sealant.

(b) Type M

This joint shall consist of prefabricated multiple elastomeric seals, separator beams, and support bars. The structural design of the joint shall be in accordance with AASHTO LRFD Bridge Construction Specifications and shall be for the same design loading as the bridge structure at which it is to be installed, but not less than HS 20-44 truck loading and impact. The joint shall be designed to accommodate the movement shown on the plans.

190 The joint assembly shall be preset by the manufacturer in accordance with the approved working drawings, joint setting data and specifications. The assembly shall be properly secured for shipping and contain provision for final field adjustment at the time of installation. The manufacturer shall furnish a copy of the installation instructions prior to the placement of these joints.

Structural steel shall be in accordance with ASTM A36, ASTM A1011, ASTM A242, ASTM A588, or Merchant Quality 1010, 1020 in accordance with ASTM A576.

200 Sealant and grout shall be in accordance with the joint manufacturer's recommendation.

Elastomer shall be neoprene in accordance with ASTM D3542.

A type B certification in accordance with 916 shall be provided for the elastomer. The limits of the following shall be shown on the certification.

A type C certification in accordance with 916 shall be provided for the structural steel and polyurethane sealant.

210 Bearings above and below the support bar shall be a nylon or urethane compound with polytetrafluorethylene riding surfaces. All components of the system shall be accessible to periodic inspection and component replacement if necessary.

The elastomer seals shall be in accordance with the requirements as follows:

1. be held in place by compressive forces throughout the normal limits of joint movement;
2. be supplied and installed in one piece;
- 220 3. have corner locked edges for a watertight fit;
4. not be any part of the load bearing riding surface;
5. be installed using seal lubricant-adhesive or be mechanically clamped in position to produce a watertight seal;
6. have a shape which promotes self removal of foreign material during normal joint operation;
- 230 7. be recessed 1/2 in. below the riding surface throughout the normal limits of joint movement;
8. be held in position by the separator beams;
9. have a hollow box shape for joints utilizing urethane equilibrium control spacers or a strip seal configuration for joints using a mechanical linkage to maintain equidistant separator beam spacing. The joint shall have a maximum opening of 3 in. per seal.

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The separator beams shall be in accordance with the requirements as follows:

1. provide the riding surface across the joint;
2. have an extruded or machined shape suitable to hold the seals;

- 250
3. be stable against tipping, tilting, or lifting during application of traffic loads by use of a suitable shape and connection to the support bar;
 4. be supported individually on their own independent support bars;
 5. maintain equidistant spacing through use of suitable urethane equilibrium type control spacers to counter the compressive forces of the seals or through a positive horizontal mechanical linkage or proportioning bar.

The support bars shall be in accordance with the requirements as follows:

- 260
1. incorporate stainless steel sliding surfaces to minimize resistance to joint movements;
 2. be supported above, below, and laterally as required to prevent lifting, to transmit bearing loads, and to maintain positioning of the bar.

270 All support bar boxes and joint housings shall have top, bottom, and sides made of steel plate with 1/2 in. minimum thickness. Anchorages shall consist of looped No. 5 reinforcing bars welded to 1/2 in. steel plates spaced at 9 in. centers. Non-welded steel to steel contact will not be allowed.

(c) Type PCF

Pre-compressed foam joints, PCF, shall be furnished from the Department's list of approved PCF Bridge Joints. PCF joints may be added to the approved list by completing the requirements of ITM 806, Procedure C.

280 These products shall consist of a highway grade silicone faced self-expanding foam expansion joint seal, a field-applied epoxy adhesive, and a field-applied silicone sealant. The foam seal shall be able to accommodate the thermal movement range shown on the plans and shall have a movement capability of no less than +50% to -50% of the nominal material size. The silicone facing material shall accommodate a minimum elongation of 1,200%.

The foam seal shall be accordance with the following requirements:

Property	ASTM Test Method	Requirement
Temperature Service Range	C711	-40°F to 185°F
UV Resistance	G155 or C793	No changes or cracking at 2,000 h

906.08 High Density Bearing Strip

The strip shall be nontoxic multipolymer plastic in accordance with the following requirements:

Property	Test Method	Requirement
Compressive Strength	ASTM D695	8,000 to 9,000 psi
Coefficient of Linear Expansion	ASTM D696	7.62×10^{-4} mm/mm/°C to 1.27×10^{-3} mm/mm /°C

A type B certification in accordance with 916 shall be provided for the high-density bearing strip. The limits of the compressive strength test and measurement of the coefficient of linear expansion shall be shown on the certification for the high-density bearing strip.

SECTION 907 – CONCRETE, CLAY, AND PLASTIC DRAINAGE COMPONENTS

907.01 Non-Reinforced Concrete Pipe

This pipe shall be in accordance with AASHTO M 86 for the specified diameter and strength classes. When used for underdrain, each section of pipe shall not exceed 3 ft in length.

907.02 Reinforced Concrete Pipe

10 This pipe shall be in accordance with AASHTO M 170 for the specified diameters and strength classes. Precast concrete units shall be from a source listed on the QPL of Certified Precast Concrete Producers, in accordance with ITM 813. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

The pipe provided shall be in accordance with the class and D-load rating shown on the plans.

20 When the pipe listed below is specified or allowed, it shall be in accordance with the class noted.

- Extra Strength Reinforced Concrete Pipe..... Class IV
- Heavy Duty Reinforced Concrete Pipe..... Class V
- Reinforced Concrete Pipe..... Class III
- Reinforced Concrete Sewer Pipe..... Class II.

Precast reinforced concrete end sections shall be in accordance with the cited specifications to the extent to which they apply.

30 The manufacturer of the steel reinforcement shall furnish to the pipe manufacturer

a mill test report. The pipe manufacturer shall certify, on furnished forms that:

- (a) The placement of the steel reinforcement is in accordance with the Standard Specifications.
- (b) The area of steel reinforcement per linear foot of pipe is in accordance with or exceeds the specification requirements.
- 40 (c) Based on the steel reinforcement manufacturer's mill test report, the steel used in the pipe is in accordance with the specification requirements.
- (d) Copies of the steel reinforcement manufacturer's mill test reports shall be on file and available to review for five years.

907.03 Reinforced Concrete Horizontal Elliptical Pipe

This pipe shall be in accordance with AASHTO M 207. Precast concrete units shall be from a source listed in the Department's list of Certified Precast Concrete Producer, in accordance with ITM 813.

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907.04 Precast Concrete Manholes, Inlets, and Catch Basins

These units shall be in accordance with AASHTO M 199. References to diameter are applicable to corresponding dimensions in other than circular sections. Absorption tests will not be required for flat top or base slabs.

Precast concrete units shall be from a source listed in the Department's list of Certified Precast Concrete Producer, in accordance with ITM 813.

60 No more than three holes shall be cast or drilled in each section for the purpose of handling.

In addition to the requirements of AASHTO M 199, the manhole steps shall be permanently marked with the specific step designation, and the manufacturer's identification. This marking shall remain exposed after installation.

70 Steps shall be selected from the QPL of Manhole Steps. Requests for adding steps to the QPL shall be accompanied by: a certified test report demonstrating compliance with AASHTO M 199; instruction for proper installation; complete product description including the ancillary equipment required for installation; and a sample step. The Department may perform a laboratory evaluation of specific steps and may not add steps to the QPL which are not furnished with ancillary installation equipment.

907.05 Precast Reinforced Concrete Structure Sections

Precast reinforced concrete structure sections shall be from a source listed on the QPL of Certified Precast Concrete Producers, in accordance with ITM 813. A water-reducing admixture from the QPL of PCC Admixtures and Admixture Systems may be used.

80 Handling devices or holes will be allowed in each structure section. Holes for handling shall be filled with material in accordance with 901.07, 901.08, or with precast concrete plugs which shall be secured with portland cement mortar or other approved adhesive before backfilling. Drilled handling holes shall be filled with portland cement mortar. Prior to backfilling the structure, all holes shall be covered with joint wrap material with a minimum width of 9 in.

90 The section ends shall be of such design and shall be so formed that when the structure sections are erected, they shall make a continuous line of structure with a smooth interior free of irregularities. The ends of the structure sections shall be normal to the walls and centerline, except where beveled ends are specified. The surface of the structure sections shall be cast from a smooth steel form or troweled surface. Trapped air pockets causing surface defects shall be considered as part of a smooth steel form finish.

(a) Box

Box structure sections shall be in accordance with ASTM C1577 and the exceptions to ASTM C1577 listed in 714.04. Not more than four holes may be cast, drilled, or otherwise made in each box section for the purpose of handling or laying.

(b) Three-Sided

100 Three-sided structure sections shall be in accordance with ASTM C1504 and the exceptions to ASTM C1504 listed in 723.04. Not more than six holes shall be cast, drilled, or otherwise made in each section for the purpose of handling or laying.

907.06 Precast Reinforced Concrete Headwalls, Wingwalls, Footings and Spandrel Walls

Precast concrete units shall be from a source listed on the QPL of Certified Precast Concrete Producers, in accordance with ITM 813. A water-reducing admixture from the QPL of PCC Admixtures and Admixture Systems may be used.

110 Handling devices or holes will be allowed in each wingwall and spandrel wall section. Not more than four holes shall be cast or drilled in each section for the purpose of handling or setting. Weep holes shall be provided in all wingwalls.

Headwalls, wingwalls, and spandrel walls shall be free of fractures and shall be given a finish in accordance with 702.21.

120 The concrete compressive strength for headwalls, wingwalls, and spandrel walls shall have a minimum 28-day compressive strength of 4,000 psi, as determined by compressive strength testing of concrete cylinders. The concrete compressive strength for footings shall have a minimum 28-day compressive strength of 2,000 psi, as determined by compressive strength testing of concrete cylinders.

Structural steel used in bolted connections of headwalls or wingwalls to a box-structure section, or of wingwalls to a three-sided-structure section or spandrel wall,

shall be in accordance with 910.02(a), and zinc coated after fabrication in accordance with ASTM A153.

- 130 Bolts and studs shall be hot dipped in accordance with 910.02(g)1. Nuts shall be in accordance with ASTM A563, grade A, Hex style; unless specified otherwise. Washers shall be in accordance with ASTM F844, unless specified otherwise. Bolts, nuts and washers shall be hot dip zinc coated.

907.07 Joint Membrane System for Precast Reinforced Concrete Box Structure Sections

The Contractor may elect to use an approved self-adhering membrane system in lieu of the detail shown on the plans.

Joint membrane systems shall be in accordance with the following requirements.

Property	ASTM Test Method	Requirement
Thickness, minimum	D3767, Procedure A	59 mil
Tensile Strength, minimum	Grab Tensile Strength, D4632	650 N
Elongation, minimum	Grab Tensile Strength, D4632	20%
Bursting Strength, minimum	Mullen Burst, D3786	290 psi
Peel Strength, minimum	D903	850 N/m
Permeance, maximum	E96, Water Method	1.05 Perm

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The membrane system shall be supplied in roll widths of at least 12 in. The membrane shall be a composite sheet material composed of a non-woven fabric and a polymer membrane material. The membrane shall be protected by a release paper.

A type B certification in accordance with 916 shall be provided for the joint membrane system. The limits of the above shall be shown on the certification.

907.08 Clay Pipe

- 150 This pipe shall be in accordance with ASTM C700 for the specified diameters and strength classes for circular non-perforated pipe. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self centering feature. The pipe may be glazed or unglazed, unless otherwise specified.

907.09 Perforated Clay Pipe

This pipe shall be in accordance with ASTM C700 for the specified dimensions and strength classes. It may be glazed or unglazed, unless otherwise specified. Where vitrified clay culvert pipe is furnished, a pipe end section compatible to that as required for concrete or metal pipe shall be used.

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907.10 Drain Tile

This pipe shall be in accordance with AASHTO M 178 for concrete or ASTM C4 for clay for the specified material, diameters, and quality classes.

Precast concrete units shall be from a source listed on the Department's List of Certified Precast Concrete Producers, in accordance with ITM 813. Standard quality drain tile shall not be used. When specified, the pipe spigot shall have integral spacer lugs to provide for an annular opening and self-centering feature.

170 Clay drain tile furnished under this specification shall be covered by a type C certification in accordance with 916.

907.11 Pipe Joint Sealant

A type B certification in accordance with 916 shall be provided for the material for the sealing of joints of bell and spigot or tongue and groove concrete or clay pipe or culverts furnished under this specification. The material shall not contain asbestos fibers. The limits of the following shall be shown on the certification.

(a) Preformed Flexible Joint Sealants

180 Joint sealants shall be either bitumen or butyl rubber in accordance with ASTM C990. The results of the following tests shall be shown on the type B certification.

Property	Test Method
Hydrocarbon Blends	ASTM D4 (bitumen) or D297 (butyl)
Ash-Inert Mineral Matter	AASHTO T 111
Volatile Matter	ASTM D6
Specific Gravity @ 77°F	ASTM D71
Ductility @ 77°F	AASHTO T 51 or ASTM D113
Flash Point	ASTM D92
Fire Point	ASTM D92
Softening Point	ASTM D36
Compression Index @ 77°F and 32°F	ASTM C972
Cone Penetration @ 77°F and 32°F, 150 g, 5 s, mm/10	ASTM D217
Chemical Resistance	ASTM C990

(b) Bituminous Mastic Sealant

A cold applied, mineral filled, bituminous joint sealing compound that can be applied to the joints with a trowel when the air temperature is between 20° and 100°F.

The bituminous material shall adhere to the concrete or clay pipe so as to make a watertight seal and shall not flow, crack, or become brittle when exposed to the atmosphere.

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The mastic shall also be in accordance with the following. The results of the tests shall be shown on the type B certification.

Property	Minimum	Maximum
Grease cone penetration unworked, 77°F, 150 g, 5 s, ASTM D217, mm/10	125	275
Non-Volatile, 10 g, 220° - 230°F, 24 hr	75%	
Loss on Heating, 325°F, 5 hr, 50 g		20%
Inorganic Content (complete burn, 1200° to 1400°F)	15%	45%
Flash Point, ASTM D92 or D1310	100°F	
Fire Point, ASTM D92 or D1310	150°F	
High Temperature Resistance to Flow	No sag	
Cold Temperature Flexibility	No cracks	

The test for high temperature resistance to flow shall be as follows: trowel joint mastic approximately 1/2 in. thick on a porous concrete slab or piece of concrete block. Place in oven at 140°F for 10 h.

- 200 The test for cold temperature flexibility shall be as follows: trowel joint mastic approximately 1/4 in. on heavy kraft paper or very light gauge sheet metal. Condition in a freezer at 10°F for 3 h. Bend the sample over a 1 in. diameter pin or mandrel.

907.12 Joint Mortar

Pipe joint mortar shall consist of 1 part portland cement and 2 parts sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

907.13 Rubber Type Gaskets

- 210 B Ring gaskets for pipe shall be in accordance with ASTM C1619, class C. A type B certification in accordance with 916 shall be provided for the rubber type gaskets. The limits of the following shall be shown on the certification.

Property	Test Method
Tensile Strength and Elongation	ASTM D412
Hardness	ASTM D2240
Oven-age tensile reduction, of original	ASTM D573 and D412
Oven-age elongation reduction, of original	ASTM D573 and D412
Compression Set	ASTM D395
Immersion, water	ASTM D471
Ozone resistance	ASTM D1149
Splice Strength Classification	ASTM D2527

907.14 Blank

907.15 Blank

907.16 Thermoplastic Pipe Requirements

- 220 A QPL of thermoplastic pipe and liner pipe will be maintained by the Department. The list will specify the manufacturer and thermoplastic pipe designation. All of these

materials shall comply with the applicable AASHTO or ASTM requirements listed in the following table and will only be accepted from qualified manufacturers. The manufacturer is defined as the plant which produces the thermoplastic pipe. The manufacturer shall become qualified by establishing a history of satisfactory quality control of these materials as evidenced by the test results performed by the manufacturer's testing laboratory.

Summary of Thermoplastic Pipe Specification Requirements				
Pipe Material	Standard Specification	AASHTO	ASTM	Manufacturer Requirement
Corrugated Polyethylene Drainage Tubing	907.17(a)	M 252		ITM 806, Procedure O
Corrugated Polyethylene Pipe	907.17(b)	M 294*		ITM 806, Procedure O
Corrugated Polypropylene Pipe	907.19	M 330		ITM 806, Procedure O
Perforated PVC Semicircular Pipe	907.18		D3034	ITM 806, Procedure A
Profile Wall PVC Pipe	907.22	M 304		ITM 806, Procedure O
Profile Wall Polyethylene Pipe	907.20		F894	ITM 806, Procedure A
Schedule 40 PVC Pipe	907.24(b)		D1785 or D2665	916, Type C Cert.
Smooth Wall Polyethylene Pipe	907.21		F714	ITM 806, Procedure A
Smooth Wall PVC Pipe	907.23	M 278	F679	ITM 806, Procedure A
Type PSM PVC Pipe and Fittings	907.24(a)		D3034	ITM 806, Procedure A
* Pipe in accordance with AASHTO M 294 shall be manufactured with virgin materials.				

907.17 Corrugated Polyethylene Drainage Tubing and Pipe

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(a) Corrugated Polyethylene Tubing

Tubing and fittings shall be in accordance with AASHTO M 252. Perforations shall be required for tubing used as a longitudinal underdrain. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

(b) Corrugated Polyethylene Pipe

Pipe and fittings shall be in accordance with AASHTO M 294. Pipe shall be manufactured with virgin materials, and be marked with the code "V". Pipe shall not

240 be manufactured with recycled materials. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

907.18 Perforated PVC Semicircular Pipe

Perforated PVC semicircular pipe may be used as an alternate to 6 in. or less diameter pipe or tile. Pipe shall be in accordance with ASTM D3034, SDR 35. This semicircular pipe shall have a smooth top and a smooth, semicircular bottom, nominally 4 5/8 in. in diameter, with perforations uniformly distributed along the top of the bottom section in accordance with AASHTO M 252 perforation requirements. The top section shall extend a minimum of 1/2 in. beyond the top of the semicircular
 250 section. The top section shall be approximately 6 3/8 in. wide including the sloping overhangs on each side. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.19 Corrugated Polypropylene Pipe

Pipe and fittings shall be in accordance with AASHTO M 330. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

907.20 Profile Wall Polyethylene Pipe

260 Pipe and fittings shall be either closed profile or ribbed open profile in accordance with ASTM F894. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.21 Smooth Wall Polyethylene Pipe

Pipe shall be in accordance with ASTM F714 for nominal diameters of 39 in. or less. Fittings shall be in accordance with ASTM F1055. The pipe sizes shall be in accordance with ISO sizing system. The pipe dimension ratio shall be 26 or less. The resin used in manufacturing this type of pipe shall have a minimum cell classification of 335434C in accordance with ASTM D3350 or a minimum grade of PE4710
 270 in accordance with ASTM F714.

Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.22 Profile Wall PVC Pipe

Pipe and fittings shall be in accordance with AASHTO M 304. Perforations shall be required when used as a longitudinal underdrain or end bent drain pipe. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.
 280

907.23 Smooth Wall PVC Pipe

Pipe and fittings shall be in accordance with AASHTO M 278 for pipe sizes 4 in. through 15 in., and ASTM F679 for pipe sizes 18 in. through 27 in. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

907.24 Smooth Wall Pipe for Outlets

Pipe and pipe fittings shall be smooth wall, non-perforated plastic pipe. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure A.

(a) Type PSM PVC Pipe and Fittings

Pipe and fittings shall be in accordance with ASTM D3034, SDR 23.5.

(b) Schedule 40 PVC Pipe

Pipe shall be in accordance with ASTM D1785 or D2665 and shall have a minimum pipe stiffness of 150 psi at 5% deflection when determined in accordance with ASTM D2412. Material furnished under this specification shall reference ASTM D1785 or ASTM D2665 in the product print line. A type C certification in accordance with 916 shall be provided for the schedule 40 PVC pipe.

907.25 Thermoplastic Liner Pipe

Thermoplastic liner pipe shall be HDPE or PVC pipe with sufficient rigidity to withstand the installation operation and shall exhibit a minimum amount of distortion. The liner pipe shall be free from visible cracks, holes, foreign inclusions, or other defects. A type A certification in accordance with 916 shall be provided for the HDPE liner pipe. The results of the tests listed in ITM 804 shall be shown on the certification.

(a) Solid Wall HDPE Liner Pipe

Solid wall HDPE liner pipe shall be in accordance with ASTM F714. The maximum standard dimension ratio, SDR, as defined in ASTM F412 for the liner pipe shall be 32.5. The actual calculated minimum dimension ratio, DR, as defined in ASTM F412 for the liner pipe shall be 30.0. The resin used in the manufacture of the liner pipe shall have a minimum cell classification of 345464C in accordance with ASTM D3350 or a minimum grade of PE4710 in accordance with ASTM F714. A 12 in. section of the liner pipe shall show no evidence of splitting, cracking, or breaking when compressed between parallel plates to 40% of its outside diameter within 2 to 5 minutes. Thermoplastic liner pipe may be added to the QPL by completing the requirements of ITM 806, Procedure Q.

(b) Profile Wall HDPE Liner Pipe

Profile wall HDPE liner pipe shall be in accordance with ASTM F894. The minimum liner ring stiffness constant, RSC, shall be 160 for circular installations and 250 for deformed installations. Thermoplastic liner pipe may be added to the QPL by completing the requirements of ITM 806, Procedure A.

(c) Profile Wall PVC Liner Pipe

Profile wall PVC liner pipe shall be in accordance with ASTM F949. Thermoplastic liner pipe may be added to the QPL by completing the requirements of ITM 806, Procedure A.

907.26 Solvent Cements for PVC Pipe and Pipe Fittings

Solvent cement for PVC pipe and fittings shall be in accordance with ASTM D2564. A type C certification in accordance with 916 shall be provided for the solvent cements.

907.27 Elastomeric Seals

340 Elastomeric seals for joining plastic pipe shall be in accordance with ASTM F477. A type B certification in accordance with 916 shall be provided for the seals. The limits of the following shall be shown on the certification.

Test	ASTM
Tensile Strength	D412 or D1414
Ultimate Elongation	D412 or D1414
100% Modulus	D412 or D1414
Hardness (Durometer)	D2240 or D1414
Low-Temperature Hardness	D2240 or D1414
Compression Set	D395 Method B, or D1414
Accelerated Aging	D573
Immersion, water	D471
Ozone Resistance	D1149
Elastomer Compound Effect on Pipe	F477
Force Decay (Stress Relaxation)	F913

907.28 Reinforced Thermosetting Resin Pipe and Pipe Fittings

350 Reinforced thermosetting resin pipe and accompanying fittings shall be in accordance with ASTM D2996 for the specified sizes. The short-term rupture strength hoop tensile stress shall be a minimum of 30,000 psi. All pipes shall be pigmented resin throughout the wall thickness. The color of the pipe shall match color No. 26400 of SAE-AMS-STD-595. Painting, gel-coating, or exterior coating of the pipe to obtain the specified color shall not be done. Pipe shall be tested in accordance with ASTM G154 for 2,500 h of accelerated weathering following cycle 2 as defined in Appendix X2. After testing, the surface of the pipe shall show no fiber exposure, crazing, or checking, and may have only a slight chalking or color change. An adhesive recommended by the manufacturer shall be used for joining pipe and fittings. A type A certification in accordance with 916 shall be provided for reinforced thermosetting resin pipe/fittings. The results of the following shall be shown on the certification.

Test	ASTM
Wall Thickness and Diameter	D3567
Short-Term Hydrostatic Failure Strength	D1599
Stiffness Factor (for direct-bury only)	D2412, based on 5% deflection

360 A lot will be defined as the production quantity in a given calendar month for each pipe diameter, not to exceed 10,000 lft. The accelerated weathering test shall be performed once for each pipe material formulation that is provided. A new accelerated weathering test will be required if the pipe material formulation changes. Test results

shall be provided to the Engineer at the time of delivery and shall be from tests performed on the formulation representative of the pipe delivered.

SECTION 908 – METAL PIPE

908.01 Blank

908.02 Corrugated Steel Pipe and Pipe-Arches

Corrugated steel pipe and pipe-arches shall be type I, IA, IR, II, or IIA in accordance with AASHTO M 36.

10 Corrugated steel pipe, pipe-arches, and coupling bands shall be zinc coated steel or aluminum coated steel in accordance with AASHTO M 36, except as noted herein. They may be fabricated with circumferential corrugations and riveted lap joint construction or with helical corrugations or spiral ribs with continuous lock or welded seam extending from end to end of each length of pipe. Reforming the ends of helical corrugated pipe to form circumferential corrugations will be allowed to enable use of circumferential corrugated coupling bands.

20 The reforming shall be limited to the length required to accommodate the coupling bands and in such a manner that there is not appreciable slippage of the seam or a plane of weakness created.

Polymer precoated galvanized corrugated steel pipe type IA and pipe-arch type IIA have an outer shell of corrugated sheet with helical corrugations and an inner liner of smooth sheet attached to the shell with a helical lock seam.

Fittings, including stub-tee connections and saddle connectors specified in 715.06, shall be shop fabricated. Damage to the coating on fittings shall be repaired in accordance with AASHTO M 36.

30 If the pipe or pipe-arch invert is to be paved, it shall first be coated over half its circumference in accordance with 908.07. The paved invert shall then be constructed in accordance with 908.07.

Sheet metal used to fabricate pipe shall be the same brand from the same manufacturer in any one length of finished pipe.

40 The manufacturer shall furnish to the fabricator a certified mill report for materials shipped to the fabricator. This certified mill report shall list the kind of base metal, actual test results of the chemical analysis and mechanical tests of each heat, the thickness, the weight of coating, and shall certify that the material complies with specified requirements for the type of metal furnished.

The fabricator shall certify, on furnished forms that:

- (a) the fabricated structure has been manufactured in accordance with these Standard Specifications;
- (b) based on the sheet manufacturer's certified mill report, the materials used in fabricating the structure were tested and the test results are in accordance with the specified requirements; and
- 50 (c) copies of the sheet manufacturer's certified mill report shall be on file and available to review for five years.

908.03 Blank

908.04 Corrugated Aluminum Alloy Pipe and Pipe-Arches

Pipes, pipe-arches, and coupling bands shall be in accordance with AASHTO M 196. The pipe shall be type I, IA, II, or IIA. If the pipe invert is to be paved, it shall be in accordance with 908.07.

60

The sheet manufacturer's certified mill report and the fabricator's certification shall be in accordance with the applicable requirements of 908.02.

Where aluminum alloy pipe culvert is furnished, aluminum alloy end sections shall also be furnished. All component parts shall be aluminum alloy.

908.05 Blank

908.06 Metal End Sections

70

The end section's metal shall be in accordance with AASHTO M 36 or M 196, whichever is applicable. The sheet metal manufacturer's certified mill report and the fabricator's certification shall be in accordance with the applicable requirements of 908.02.

End sections consisting of multiple panels shall have lap seams which shall be tightly jointed with 3/8 in. galvanized rivets or bolts.

80

All steel pipe end sections shall have a toe plate anchor constructed of 0.138 in. thick galvanized steel. The toe plate anchor shall be match punched to fit holes in the skirt lip, and shall be supplied loose, and complete with 3/8 in. diameter galvanized bolts.

Straps for pipe end sections shall be either galvanized No. 6 reinforcing bars or zinc coated 3/8 in. diameter aircraft cable.

908.07 Fully Bituminous Coated Corrugated and Lined Steel Pipe and Pipe-Arches

The material, fabrication, the manufacturer's certified mill report, and fabricator's certification shall be in accordance with the applicable requirements of 908.02.

90

Coupling bands shall be fully bituminous coated.

After fabrication, the pipe or pipe-arch shall be fully bituminous coated.

Connecting or coupling bands shall be of the two-piece type when used with coated pipe of 36 in. diameter or larger.

100 The asphalt material for coating shall be in accordance with 902.01(e). Samples of the asphalt material will be obtained from the working tank prior to or during coating of the pipe, or from strippings off the pipe after coating. When applied to the pipe, the asphalt material shall be free from impurities. The metal shall be free from grease, dust, or moisture. Either process set out below may be used for application.

- (a) When the pipe is not preheated, the temperature of the asphalt at the time of immersion shall be 400°F ±5°F. The duration of the immersion in the asphalt shall be in accordance with the following:

Thickness, inches	0.052	0.064	0.079	0.109	0.138	0.168
Minimum Immersion Time for 1st Dip, minutes	2.0	2.5	3.0	5.0	6.5	8.0

- 110 (b) When the pipe is preheated it shall be brought to a temperature of 300°F and the asphalt shall be heated to a temperature of 380°F ±5°F before the pipe is dipped.

In either process, the pipe shall be dipped a second time or more if necessary, to give a minimum thickness of 0.05 in.

120 If paved invert is specified, the pipe or pipe-arch shall first be fully coated as required. Additional bituminous material shall be applied in the bottom section to form a smooth pavement. Except where the upper edges intersect the corrugations, the pavement shall have a minimum thickness of 1/8 in. above the crests of the corrugations. The pavement shall be applied to the lower quarter of the circumference.

The manufacturer of the asphalt material shall furnish to the pipe fabricator the type of certification specified in the Frequency Manual and in accordance with 916 for each shipment or lot of asphalt material. The pipe fabricator shall keep these certifications on file and available to review for five years. In addition, samples from the working tank will be obtained for verification of requirements.

908.08 Polymer Precoated Galvanized Corrugated Steel Culvert Pipe and Pipe-Arches

130 The pipe or pipe-arch and coupling bands shall be in accordance with AASHTO M 245 with additions in accordance with 908.02. The polymer precoated galvanized steel sheets shall be in accordance with AASHTO M 246, grade 10/10.

908.09 Structural Plate Pipe, Pipe-Arches, and Arches

(a) Steel

Steel structural plate pipe, pipe-arches, and arches shall be constructed from individually galvanized corrugated steel plates as described herein. For pipes and pipe-arches having a thickness less than 0.280 in., the bottom plates shall be of the next greater thickness than that specified for the top and side plates, not including corner plates for pipe-arches. The individual plates shall be in accordance with AASHTO M 167 and AASHTO LRFD Bridge Construction Specifications.

The materials and fabrication shall be as follows:

1. The minimum corner plate radius of the arc joining the top and bottom plates of pipe-arches shall be 18 in. for openings up to and including 131 sq ft and 31 in. for openings over 131 sq ft. The minimum radius of the arc shall be 31 in. for openings from 98 sq ft up to and including 214 sq ft.
2. Assembly bolts shall be high strength heavy hex in accordance with ASTM F3125, grade A 325, or ASTM A449. Nuts shall be heavy hex and in accordance with ASTM A563, grade C3. Washers shall be in accordance with ASTM F436. Assembly bolts, nuts, and washers shall be hot dip galvanized in accordance with ASTM F2329, or be mechanically galvanized in accordance with ASTM B695, Class 55.
3. The sheet manufacturer's certified mill report and the fabricator's certification shall be furnished in accordance with 908.02, except the documents shall be in accordance with the applicable requirements of AASHTO M 167.

(b) Aluminum Alloy

Aluminum alloy structural plate pipe, pipe-arches, and arches shall be in accordance with AASHTO M 219. The sheet manufacturer's certified mill report and the fabricator's certification shall be furnished in accordance with 908.02.

908.10 Cast Iron Soil Pipe

This pipe shall be in accordance with ASTM A74. Markings shall be in accordance with ASTM A74 or ANSI A 40.1.

908.11 Steel Pipe

This item shall be electric-fusion, arc-welded steel pipe in accordance with ASTM A139, grade B, or electric-resistance welded pipe in accordance with ASTM A53, type E, grade B, as applicable. A type C certification in accordance with 916 shall be provided for the steel pipe.

908.12

180 **908.12 Straps, Hook Bolts and Nuts Used in Anchors**

Straps shall be of the type and size shown on the plans. Reinforcing bars used for straps shall meet the applicable requirements of 910.01 and shall be galvanized in accordance with ASTM A767, class I. Aircraft cable used for straps shall be made of zinc coated steel wire, 3/8 in. nominal diameter, consisting of seven 19-wire flexible steel strands, with a minimum breaking strength of 14,000 lb. The cable shall be in accordance with Military Specification MIL-W-83420D.

190 Hook bolts and nuts shall be of the size shown on the plans, shall be in accordance with ASTM A307, and shall be galvanized in accordance with ASTM F2329. Threads shall be American Standard Coarse Thread Series Class 2 fit. Threads shall be cleaned after galvanizing to provide a free running fit. Maximum oversizing of the nut threads shall be 1/64 in.

908.13 Blank

908.14 Slotted Drain or Slotted Vane Drain Pipe

200 Slotted drains shall be manufactured from helically corrugated steel pipe in accordance with AASHTO M 36. At the end of the pipe there shall be two annular corrugations to allow the corrugated band to fully mesh with the pipe.

The grated assembly shall be made of structural steel in accordance with ASTM A36, Grade 36. The assembly shall be suitably welded to the pipe and galvanized after assembly in accordance with AASHTO M 111. The grate shall be of the size and spacing shown on the plans and shall be welded on both sides to each bearing bar with a 3/16 in. fillet weld.

The size and thickness of the corrugated steel slotted drain pipe shall be as shown on the plans.

210 Slotted vane drain pipe shall be smooth wall PVC in accordance with 907.23, and shall be of the diameter specified. The casting shall be in accordance with 910.05(b). The finish shall be standard black asphalt emulsion. Individual units shall have a minimum weight of 155 lb.

SECTION 909 – PAINT AND LIQUID EPOXY

909.01 General Requirements

All necessary facilities for inspection of materials and manufacture of coatings, paints, and ingredients shall be granted. Free access to all parts of the premises where any or all of these products are being prepared shall be allowed. Safety Data Sheets shall be provided.

10 Paints and coatings shall be furnished ready for use without modification and shall not settle, cake, curdle, liver, gel, or develop excessive change in viscosity between

time of manufacture and time of use. It shall remain capable of being readily dispersed with a paddle, or other approved methods, to a consistency appropriate for the intended use. Paints and coatings may be sampled and tested at any time prior to use. Paints and coatings that are part of an approved structural steel coating system shall be submitted in an unopened, full, and complete kit for testing. If, for any reason, re-sampling and re-testing following initial or prior approval is indicated, the latest test results shall prevail over all previous tests for material that has not been used. Previously approved paint or coating that are stored for future use may be re-sampled and re-tested.

- 20 Paints and coatings shall be delivered in new containers of such strength, durability, design, fabrication, and material that the paint shall be suitably protected in transit and in storage against any change in characteristics which would cause rejection on the basis of laboratory or field evaluation. Each container shall bear a label which shows the name and address of the manufacturer, kind of paint or coating, formula identification, date of manufacture, and lot or batch number. The container shall be so filled that the net weight of the material in the container shall be the product of the weight per gallon at 77°F and the stated number of gallons in the container.

- 30 All containers shall be labeled in accordance with the OSHA requirements for labeling of hazardous chemicals as described in the Hazardous Communications Standard.

909.02 For Metal

Paints for metal surfaces shall be in accordance with the requirements shown below.

(a) Zinc Primers

- 40 Both inorganic zinc primer and organic zinc primer for use on faying surfaces at all slip-critical structural bolted connections using ASTM F3125, grade A325 or grade A490, high strength heavy hex bolts in primary members shall meet class B slip coefficient in accordance with Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints as adopted by the Research Council on Structural Connections.

1. Multi-Component Inorganic Zinc Silicate Primer

- 50 Inorganic zinc primers shall be multi-component and of the self-cure type which, when mixed and applied in accordance with these specifications, shall cure without the use of a separate curing solution. Multi-component inorganic zinc silicate primers shall have a maximum of three components. The components of each primer shall be packaged in such proportions that when the full quantity of each component is mixed together, the specified mixed primer shall be yielded.

Inorganic zinc primers shall be in accordance with AASHTO M 300.

2. Organic Zinc Primer

Organic zinc primer shall be a self-curing type primer. It shall be in accordance

with SSPC Paint Specification No. 20, Type II. The organic zinc primer shall be compatible with inorganic zinc and finish coat paints already on the bridge. The color shall be able to produce a distinct contrast with blast cleaned metal surface and the finish coat. The cured organic zinc film shall be compatible with a top coating of waterborne finish coat paint.

The organic zinc primer shall also be in accordance with the following requirements.

	Viscosity, ASTM D562, Krebs Units	70 - 100
	Viscosity variation from the initially approved formulation, ASTM D562, Krebs Units, max.	±10
	Volatile organic compounds, ASTM D3960, max.	419 g/L
70	Weight/volume, ASTM D1475, 25°C, min.	2.040 kg/L
	Weight/volume variation from the initially approved formulation, max.	±0.048 kg/L
	Dry time, ASTM D1640, 6 mils wet film thickness on a tin-coated steel panel, max.:	
	Set-to-touch.....	1 h
	Dry hard	24 h
	Total solids of sample, ASTM D2369	70 – 100%
	Total solids variation from the initially approved formulation, ASTM D2369, %, max.	±2.0
80	Pigment by mass of total solids ^A , min.	83 %
	Metallic zinc in zinc dust, ASTM D521, min.	94 %
	Metallic zinc by mass of pigment, ASTM D521, min.	84 %
	Metallic zinc by mass of total solids ^B , min.	72 %

^A The pigment by mass of total solids shall be calculated as follows:

$$\text{Pigment by mass of total solids, \%} = \frac{A}{B} \times 100\%$$

where:

90 A = % pigment extracted from sample
 B = % total solids of mixed sample

^B The metallic zinc by mass of total solids shall be calculated as follows:

$$\text{Metallic zinc by mass of total solids, \%} = \frac{(C \times D)}{E}$$

where:

100 C = % metallic zinc in pigment
 D = % pigment extracted from sample
 E = % total solids of mixed sample

The infrared spectrum of the vehicle when extracted from the organic zinc primer, in accordance with ASTM D3168, shall match the infrared spectrum of the vehicle of the sample submitted for formulation approval.

110 The cured film shall not contain any toxic heavy metals above the limits of the regulatory levels of 40 CFR 261.24, Table 1. The cured paint shall not contain any other material which will require characterization as a hazardous waste for the disposal of the dried film.

3. Approval of Formulation

The manufacturer shall obtain approval of the formulation prior to furnishing the primers. Only zinc primers from the QPL of Coating Formulations shall be used. Zinc primers will be placed and maintained on the QPL of Coating Formulations in accordance with ITM 606.

(b) Epoxy Intermediate Paint

120 Epoxy intermediate paint shall be a two-component coating consisting of an epoxy resin and a curing agent, together with prime and filler pigments, colorants, gellant, leveling agents and solvents. When mixed, this coating shall be suitable for application over inorganic and organic zinc primers and shall be compatible with a polyurethane finish coat. The color of this coating shall contrast significantly from the other coatings within the coating system.

The mixed paint shall be in accordance with the following requirements.

	Volatile organic compounds, ASTM D3960, max.	336 g/L
	Volume solids, ASTM D2697, min.	60%
130	Set-to-touch, ASTM D1640, 6 mils wet film thickness, max.	4 h
	Weight/volume variation from the initially approved formulation, ASTM D1475, 25°C, max.	0.060 kg/L
	Total solids variation from the initially approved formulation, ASTM D2369, max.	3.0%

The coating shall be applied within the pot life recommended by the paint manufacturer with no evidence of gelation. The coating shall be in a free-flowing condition and easily sprayed.

140 The infrared spectrum of each component and of the mixed coating shall match the spectrums of the initially approved batch.

(c) Polyurethane Finish Coat

Polyurethane finish coat shall be a two-component polyester or acrylic aliphatic polyurethane suitable for use as a finish coat over epoxy intermediate paint.

The mixed paint shall be in accordance with the following requirements.

	Volatile organic compounds, ASTM D3960, max.	336 g/L
150	Volume solids, ASTM D2697, min.	60%
	Set-to-touch, ASTM D1640, 5 mils wet film thickness, min.	30 minutes
	Total solids ASTM D2369, min.	70%
	Specular gloss, 60°, ASTM D523, min.	75
	Viscosity, ASTM D562, Krebs Units, max.	100
	Contrast ratio, ASTM D2805, 5 ±0.5 mils wet film thickness, dried 24 h on opacity chart 2A or 2C, min.	0.95
	Dry hard, ASTM D1640, 5 mils wet film thickness, max.	24 h

160 The infrared spectrum of each component and of the mixed coating shall match the spectrum of the initially approved batch.

The color of the dried paint film shall match the color number of SAE-AMS-STD-595 as follows:

Color No.	Color
13538	Yellow
13711	Buff
14260	Green
15450	Light Blue
17038	Black
17886	White

(d) Waterborne Finish Paint

The waterborne finish coating shall be a single package, high build acrylic emulsion for use as a finish coat over inorganic and organic zinc primers. It shall be compatible with and adhere to the cured zinc primers.

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1. Vehicle Component

The vehicle shall consist of an acrylic emulsion together with the necessary antifoamers, cosolvents, coalescing agent, preservatives, and antifreeze in order to produce a coating in accordance with this specification.

2. Pigment Component

The active pigment shall consist of titanium dioxide in accordance with ASTM D476, type IV, and non-reactive color retentive tinting pigments. The pigment shall contain extenders and additives as required for proper application.

180

3. Mixed Paint Properties

The mixed paint shall be in accordance with the following requirements.

Viscosity, ASTM D562, Krebs Units	80 – 110
Weight/volume, ASTM D1475, variation from the initially approved formulation, 25°C, max.	0.024 kg/L

	Pigment grind, ASTM D1210, Hegman, min.	5
	Total solids, % by weight, ASTM D2369, min.	48
190	Dry time, ASTM D1640, 3 mils wet film thickness on a tin coated steel panel, max.:	
	Set-to-touch	1 h
	Dry hard.....	24 h
	Contrast ratio, ASTM D2805, 5 ±0.5 mils wet film thickness dried 24 h on opacity chart 2A or 2C, min.	0.97
	Specular gloss, 60°, 10 ±0.5 mils wet film thickness on a tin coated steel panel, dried 48 h, ASTM D523, max.	30
	pH, ASTM E70.....	7.0 – 9.5
	Volatile organic compounds, ASTM D3960, max.	180 g/L

200 The infrared spectrum of the vehicle when extracted from the mixed paint in accordance with ASTM D3168 shall match the infrared spectrum of the sample submitted for formulation approval.

The mixed paint shall be in accordance with the requirements of Sections 5.4 through 5.17 of SSPC Paint Specification No. 24.

210 The cured waterborne finish paint shall not contain any toxic heavy metals above the limits of the regulatory levels of 40 CFR 261.24, Table 1. The cured paint shall not contain any other material which will require characterization as a hazardous waste for the disposal of the dried film.

4. Color

The color of the dried paint film shall match the color number of SAE-AMS-STD-595 as follows:

Color No.	Color
23538	Yellow
23717	Buff
24227	Green
24466	Light Green
25526	Light Blue
27038	Black
27780	White

5. Approval of Formulation

220 The manufacturer shall obtain approval of the formulation prior to furnishing the waterborne finish paint. Only waterborne finish paint from the QPL of Coating Formulations shall be used. Waterborne finish paint formulations will be placed and maintained on the QPL of Coating Formulations in accordance with ITM 606.

(e) Finish Coat for Weathering Steel

The finish coat shall be an aliphatic polyurethane or a waterborne acrylic paint,

and the dried paint film shall match color No. 20045 of SAE-AMS-STD-595. It shall be suitable for use as a finish coat over epoxy intermediate paint. The mixed paint shall be in accordance with the following requirements.

For aliphatic polyurethane paint:

230

Weight/volume, ASTM D1475, 25°C, min.	1.200 kg/L
Total solids, % by weight, ASTM D2369, min.	60
Volatile Organic Compounds, ASTM D3960, max.	336 g/L
Specular gloss, 60°, ASTM D523, max.	25

For waterborne acrylic paint:

240

Weight/volume, ASTM D1475, 25°C, min.	1.200 kg/L
Total solids, % by weight, ASTM D2369, min.	48
Volatile Organic Compounds, ASTM D3960, max.	180 g/L
Specular gloss, 60°, ASTM D523, max.	25

909.03 Structural Steel Coating System

This coating system shall consist of an inorganic zinc primer, an epoxy intermediate paint, and a polyurethane finish coat for the painting of steel bridges and other structural steel. All of the coatings within any coating system shall be manufactured by the same manufacturer and shall be compatible with one another. All coatings shall be in accordance with 909.02.

250

(a) Toxicity

The cured film of each coating within the structural steel coating system shall not contain any toxic heavy metals above the limits of the regulatory levels of 40 CFR 261.24, Table 1 or contain any other material which will require characterization as a hazardous waste for the disposal of the dried film.

(b) Evaluation

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The coating system shall be evaluated by the NTPEP Structural Steel Coatings Program. The certified report from NTPEP shall include specific identification of the formulation or system being submitted for consideration. It shall also include all test results for the specific coating formulation or coating system. The certified report from NTPEP will be accepted as the certified test report required for approval. The coating system shall be in accordance with all of the applicable acceptance criteria contained within 909.02. In addition, the finish coat shall maintain a minimum of 60% specular gloss retention relative to the initial gloss and a maximum color change of 6 ΔE for Test No. 3, Cyclic Weathering Resistance.

(c) Approval of Structural Steel Coating System

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The manufacturer shall obtain approval of each structural steel coating system prior to furnishing any of these coatings. Only structural steel coating systems from the QPL of Structural Steel Coating Systems shall be used. Structural steel coating

systems will be placed and maintained on the QPL of Structural Steel Coating Systems in accordance with ITM 606.

909.04 Field Paint for Wood or Metal

The primers for field paint shall be formulated for minimal surface preparation, provide adhesion to the substrate and be compatible with the finish coat. The primers shall not contain lead, chromium, or other heavy metals which would require classification as a hazardous waste upon removal. The primers shall comply with the current IDEM VOC regulations and shall be used as follows:

280

- a. For unpainted galvanized steel and other ferrous metals, use one coat of a zinc dust-zinc oxide pigmented primer.
- b. For non-ferrous metals, use one coat of primer formulated for use on non-ferrous metals.

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The field paint finish coat shall be an exterior type coating. It shall be chalk resistant, gloss retentive, and suitable for application by brush, roller, or spray. This coating shall comply with the current IDEM VOC regulations and shall not contain lead, chromium, or other heavy metals which would require classification as a hazardous waste upon removal. The color of this coating shall be as specified.

909.05 White and Yellow Waterborne Traffic Paint

White and yellow waterborne traffic paints shall consist of an emulsion of pigmented binder.

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When glass beads are induced into the paint lines, the paint shall provide capillary action in the interstices and voids between the glass beads sufficient to cause the level of paint to raise approximately 2/3 the diameter of the glass beads. This capillary action shall not cause complete envelopment of the glass beads. The paint as furnished shall not contain glass beads. The paint shall be ground to a uniform consistency, and it shall enable satisfactory application by the pressure-spray type of painting equipment. The painting equipment shall use a pressurized bead application method that is designed to apply 4 to 6 in. reflectorized paint lines at paint temperature up to 150°F. The paint shall be capable of being applied at speeds of 10 to 15 mph.

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The paint shall not darken under the heating conditions of application, or show appreciable discoloration due to sunlight exposure and aging of the paint lines. The paint shall be furnished ready for use without thinning, screening, or other modifications and shall not settle, cake, curdle, liver, gel, or have an excessive change in viscosity in the container during a period of one year after manufacture. The paint shall be capable of being stirred to a uniform consistency. The paint shall be able to withstand variations of temperatures when stored outside in the containers as delivered, and in an environment above 40°F. All paint furnished under these specifications will be rejected if it contains skins, thickened or jelly-like layers, lumps, coarse particles, dirt, or other foreign materials which prevent the proper application

of the paint, or produces a non-uniform paint line. All paint which cannot be transferred by pumps on the paint equipment from the shipping containers and through the paint equipment due to excessive clogging of screens, filters, or paint guns will be
320 rejected.

The paint shall dry to a no-tracking condition in less than 60 s. The no tracking condition shall be determined by actual application of the paint on the pavement at a wet film thickness of 15 mils with glass beads at a rate of 6 lb/gal. The paint lines for the determination of no-tracking condition shall be applied with the specialized painting equipment operated so as to have the paint at application temperatures up to 140°F at the spray guns. This maximum no tracking time shall not be exceeded when the pavement temperature varies from 50 to 120°F, and with all relative humidity conditions providing that the pavement is dry. The no tracking time shall be
330 determined by passing over the paint line 60 s after the paint application, in a simulated passing maneuver at a constant speed of 30 to 40 mph with a passenger car. A paint line with no visual deposition of the paint to the pavement surface when viewed from a distance of approximately 50 ft from the point where the vehicle crossed the paint line shall be considered as showing a condition of no tracking and being in accordance with the requirement.

1. Composition Requirements

The exact composition of the waterborne traffic paint shall be left to the discretion of the manufacturer, provided that the finished product is in accordance with all of the
340 specification requirements.

The pigment portion of these paints shall be a combination of prime and extender pigments as required to produce either white or yellow waterborne traffic paint in accordance with the color and other requirements of the finished product. The yellow waterborne traffic paint pigment shall contain pigment yellow Color Index No. 65, or 74, or 75 or a combination of each. The white waterborne traffic paint pigment shall contain titanium dioxide in accordance with ASTM D476. The non-volatile portion of the vehicle shall be composed of a 100% acrylic polymer.

350 The cured film of waterborne traffic paint shall not contain any toxic heavy metals above the limits of the regulatory levels of 40 CFR 261.24, Table 1 or contain any other material which will require characterization as a hazardous waste for the disposal of the dried film.

2. Specific Requirements

	Min.	Max.
Volume solids, ASTM D2697, %	58.0	--
Total solids by mass, ASTM D2369, %	73.0	--
Pigment by mass, ASTM D3723, %	45.0	57.0
Vehicle solids by mass of the vehicle, %	44.0	--
Viscosity, ASTM D562, Krebs Units	75	95
Weight/volume, ASTM D1475, 25°C, kg/L	1.498	--
Weight/volume @ 25°C, variation from the manufacturer's initially approved batch, ASTM D1475, kg/L.	--	0.024
Dry time, ASTM D711, 15 mils wet film thickness, airflow of less than 50 cu ft/min, without glass beads	--	10 min
Reflectance Factor, Y, C.I.E. illuminant, C, 2° standard observer, ASTM E1349, 15 mils wet film thickness, air dried a minimum of 16 h, %		
White.....	84	--
Yellow.....	50	57
Color, yellow only, x - y C.I.E. Coordinates for the strong limits of FHWA color chart PR1, 15 mils wet film thickness, air dried a minimum of 16 h, measured on white background, C.I.E. illuminant, C, 2° standard observer, % deviation	Match the strong limits	±6.00
Coarse material retained on a No. 30 sieve, ASTM D185, %	--	0.05
Bleeding ratio, Federal Specifications TT-P-1952B, except asphalt saturated felt paper shall be in accordance with ASTM D226, Type I	0.97	--
Contrast ratio, ASTM D2805, 10 mils wet film thickness on opacity chart 2A or 2C, air dried a minimum of 16 h	0.96	--
Volatile organic compounds, ASTM D3960		
from May 1 thru September 30, g/L	--	105
from October 1 thru April 30, g/L	--	150
Abrasion resistance, Federal Specifications TT-P-1952B, L	190	--
Freeze-thaw stability, Federal Specifications TT-P-1952B, change in consistency, Krebs Units	--	10
Heat stability, Federal Specifications TT-P-1952B, change in consistency, Krebs Units	--	10
Scrub resistance, ASTM D2486, with abrasive medium and shims, cycles	300	--
Water resistance, Federal Specification TT-P-1952B	Film shall not soften, blister, wrinkle, or lose adhesion	
Flexibility, Federal Specifications TT-P-1952B	No cracking or flaking of film	
Infrared spectrum of the vehicle ASTM D3168	Shall match spectrum of manufacturer's previously submitted samples	

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Dilution test shall be capable of dilution with water at all levels without curdling or precipitation such that wet paint can be cleaned up with water only.

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909.10 Non-Epoxy PCC Sealers

370 Non-Epoxy PCC sealers shall be selected from the QPL of Non-Epoxy Portland Cement Concrete Sealers. A non-epoxy PCC sealer may be added to the QPL by completing the requirements in accordance with ITM 806, Procedure C.

(a) Properties

The non-epoxy PCC sealer shall be in accordance with NCHRP 244, Series IV, Southern Climate Weathering Test and possess the following properties.

Property	Requirement
Reduction of Chloride Ion Content	90% of the Control
Active Ingredients, minimum, Silane Based	40%

(b) Test Report

380 The testing shall be performed by a recognized laboratory in accordance with ITM 806.

The non-epoxy PCC sealers shall be delivered to the jobsite in unopened containers with the manufacturer's numbered seal intact.

909.11 Epoxy-Resin-Base System for Bonding Plastic Concrete to Hardened Concrete

390 Two-component, epoxy-resin bonding systems for use in bonding freshly mixed concrete to hardened concrete shall be in accordance with ASTM C881 for type II, grade 2, and the class consistent with the ambient temperature as follows. Class A for use below 40°F; class B for use between 40°F and 60°F; and class C for use above 60°F. A type C certification in accordance with 916 shall be provided for the epoxy-resin-base system.

909.12 Epoxy Resin Additives for Injection into Concrete

400 The epoxy resin adhesive shall be of low enough viscosity such that it flows to the next open port in the surface seal material. The adhesive shall be capable of penetrating crack widths down to 0.005 in. The adhesive shall be capable of bonding to dry or damp surfaces. The adhesive shall exhibit a slant shear strength exceeding the concrete strength when tested fully cured in accordance with AASHTO T 237.

The surface seal material shall have adequate strength to hold injection fittings in place and to resist injection pressures adequately to prevent leakage during injection.

A type C certification in accordance with 916 shall be provided for the epoxy resin adhesive.

SECTION 910 – METAL MATERIALS

910.01 Reinforcing Bars, Dowel Bars and WWR

(a) General

- Unless otherwise specified, bars for concrete reinforcement shall be deformed billet steel, grade 60. Tie bar assemblies used in lieu of bent tie bars shall be in accordance with the minimum total ultimate strength and minimum total yield strength requirements specified for bent tie bars; bend test and elongation will not be required.
- 10 Coiled reinforcing bars shall only be used for fabrication of spiral and ring reinforcement or for rectangular ties and stirrups. When approved by the Engineer, coiled reinforcing bars may also be used for supports in accordance with 703.06.

- Reinforcing bars and WWR shall be furnished by selecting materials made by a manufacturer or fabricator on the QPL of Uncoated Reinforcing Bar and WWR Manufacturers in accordance with ITM 301, except for WWR used for pneumatically placed mortar. WWR used for pneumatically placed mortar will be accepted by a type A certification in accordance with 916. When shipped to the project site, the reinforcing bars and WWR shall be accompanied by the type of certifications specified
- 20 in ITM 301 and in accordance with 916.

(b) Specific Requirements

1. Billet Steel Bars

Billet steel bars shall be in accordance with ASTM A615.

2. Threaded Tie Bar Assembly

- The threaded tie bar assembly shall be deformed billet steel, grade 60 or higher, in accordance with 910.01(b)1 and a coupling device. The minimum strength of the tie bar assembly shall be 125% of the designated yield strength of the bar from which it is manufactured. Where epoxy coated threaded tie bar assemblies are specified, an epoxy coating with a minimum film thickness of 6 mils shall be applied to the coupling device and epoxy coated reinforcing bars shall be provided in accordance with 910.01(b)9 with the exception that the epoxy coated bar is not required to be furnished from the QPL of Reinforcing Bar and WWR Epoxy Coaters.
- 30

3. Splicing Systems

Reinforcing bar splicing systems shall be selected from the QPL of Reinforcing

40 Bar Splicing Systems. A manufacturer may request to have a splicing system added to the QPL by submitting three randomly selected epoxy coated bars of each bar designation to be included as a splicing system on the list. The samples furnished shall be assembled. The splicing system will be tested for tensile strength in accordance with ASTM A370 and shall reach the specified ultimate tensile strength on all three samples for each bar size submitted. The manufacturer shall identify the grade or grades of reinforcing bar for which the system is being submitted. Splicing systems demonstrating consistent, repeatable, and passing test results will be added to the QPL. Qualified bar designations will be noted on the list.

4. Blank

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5. Deformed and Smooth Steel WWR

Deformed and smooth steel WWR shall be in accordance with ASTM A1064, except as follows:

- a. The wire used in manufacturing the WWR shall be drawn, not galvanized, unless otherwise specified.
- b. WWR shall be furnished in flat sheets.
- 60 c. When epoxy-coated WWR is specified, it shall receive a type 1 coating in accordance with ASTM A884. Repairing or patching of the coating shall be in accordance with ASTM A884 with the patching material in accordance with ASTM A775 Annex A2. The average coating thickness shall be 9 to 14 mils after cure. Epoxy coated WWR shall be furnished by selecting WWR coated from an applicator's plant on the QPL of Reinforcing Bar and WWR Epoxy Coaters and in accordance with ITM 301.
- 70 d. When galvanized WWR is specified, it shall be in accordance with ASTM A1060, including repair or renovation of the coating. It shall be coated after fabrication.
- e. The size and spacing of the WWR shall be provided as specified. If over-sized wire is proposed for substitution, the Contractor shall obtain written approval from the Engineer prior to delivery. The WWR shall be identified as the size provided, not the size originally ordered.

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7. Uncoated Seven-Wire Strand

Uncoated seven-wire strand shall be in accordance with ASTM A416. The strand shall have the minimum tensile strength and initial tension shown on the plans.

A type A certification in accordance with 916 shall be provided for uncoated seven-wire strand. In addition to the lot number, the results of the following shall be shown on the certification.

Property	Test Standard
Size	
Cross Sectional area	
Yield strength	ASTM A416
Breaking strength	ASTM A416
Strand composition	
Modulus of elasticity	ASTM A416
Load elongation curve	ASTM A416

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8. Steel Spiral Reinforcement

Steel spiral reinforcement shall be either:

- a. deformed billet steel, ASTM A615, grade 60; or
- b. cold drawn steel wire, ASTM A1064.

9. Epoxy Coated Reinforcing Bars

100 Epoxy coated reinforcing bars shall be furnished by selecting bars coated from an applicator's plant on the QPL of Reinforcing Bar and WWR Epoxy Coaters and in accordance with ITM 301. The epoxy coating material shall be selected from the QPL of Epoxy Coating Materials.

Epoxy coated reinforcing bars shall be in accordance with ASTM A775, except as follows.

- a. the bars shall be in accordance with 910.01(b)1;
- b. the coating color shall contrast with the color of iron oxide;
- c. tensile and bend tests shall be performed on the bars. If an examination of the bend test specimen suggests the need, the adhesion of the coating shall be checked by subjecting additional specimens to the 120° bend test. Hairline cracks without bond loss will be acceptable provided there are not more than two and the length of either crack does not exceed 1/4 in. The average coating thickness shall be 9 to 14 mils after cure. The thickness measurements shall be made in accordance with ASTM D7091. The coating thickness shall be an average based on 12 individual readings. No specific

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correction for the base preparation process shall be applied to the thickness measurements;

- d. epoxy coated reinforcing bars furnished by coaters on the QPL of Reinforcing Bar and WWR Epoxy Coaters shall be accompanied by the types of certifications specified in ITM 301 and in accordance with 916;
- e. repair and handling procedures shall be in accordance with 703.04. The patching material shall be in accordance with ASTM D3963.

Epoxy coated support devices for epoxy coated reinforcing bars shall be in accordance with ASTM A775, except as follows.

- a. the steel shall be in accordance with 910.01(b)1;
- b. the coating color shall contrast with the color of iron oxide;
- c. the coating thickness shall be 6 to 20 mils after cure. The thickness measurements shall be made in accordance with ASTM D7091.

10. Dowel Bars

Dowel bars shall be plain billet steel in accordance with ASTM A615, grade 40 or higher, except that the bend test and elongation requirements will not apply. The dowel bar area and weight for the nominal bar diameter shall be as follows.

Nominal Bar Diameter, in.	Cross Sectional Area, sq in.	Weight, lb/ft
1	0.79	2.670
1 1/4	1.23	4.172
1 1/2	1.77	6.008

Dowel bars shall be coated with an epoxy coating material selected from the QPL of Epoxy Coating Materials. The coating thickness after cure shall be a minimum of 7 mils. Dowel bars shall not have burring or other deformation restricting slippage in concrete. Dowel bar ends shall be saw cut. Chips from the cutting operation shall be removed from coated bars.

Dowel bars shall be furnished by selecting bars made by a coater and manufacturer on the QPL of Reinforcing Bar and WWR Epoxy Coaters and in accordance with ITM 301. When shipped to the project site, the dowel bars shall be accompanied by the types of certifications specified in ITM 301 and in accordance with 916.

(c) Inspection, Sampling, and Testing

All reinforcing bars may be inspected, sampled, and tested after delivery to the project.

910.02 Structural Steel**(a) Structural Steel**

170 Unless otherwise specified, structural steel shall be in accordance with ASTM A709, grade 36.

(b) Weathering Steel

Steel in accordance with ASTM A709 that has an atmospheric corrosion resistance index that meets or exceeds the index value shown in ASTM A709.

(c) High Strength Structural Steel

This steel, when specified, shall be in accordance with ASTM A709, grade HPS 100W; ASTM A709, grade 50; or ASTM A709, grade 50W.

180 The corrosion resistance of ASTM A709, grade 50W steel shall be at least four times that of structural carbon steel. The steel fabricator, when placing the order, shall state that the steel is for bridge use, and that the steel shall be used in the bare, unpainted condition.

All fasteners used in conjunction with ASTM A709, grade 50W steel shall be friction type high strength heavy hex bolts in accordance with ASTM F3125, grade A325 type 3. A certification in accordance with 916 and 910.02(g)2.d shall be provided for high-strength steel bolts. The results of the following shall be shown on the certification.

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Property	Test Method
Chemical Composition	ASTM F3125, Table 3
Hardness	ASTM F3125, Table 7
Tensile Properties	ASTM F3125, Table 5
Proof Load	ASTM F3125, Table 5
Zinc Coating (Hot Dip Process)	ASTM A153
Zinc Coating (Mechanically Deposited)	ASTM B695
Rotational Capacity Testing (Type 3 Bolt)	ASTM F3125

All plates and bars produced from ASTM A572 steel over 3/4 in. in thickness shall be “killed fine grain practice”.

(d) High Performance Steel

High performance steel, HPS, shall be in accordance with ASTM A709. In addition to the conditions listed in Section 6.7 of ASTM A709, high performance steel

200 may be furnished as hybrid/mixed design structural components using high performance steel plates in combination with high strength, low alloy steel plates and shapes, for welded or bolted applications in bridge construction.

The impact testing requirements for HPS in accordance with 10.1 and 10.2 of ASTM A709 shall meet temperature zone 2.

(e) Charpy V-Notch Toughness Tests

210 Structural steel, except members exempted below, shall meet the longitudinal Charpy V-Notch test requirement as specified in the following table for the type or types of steel specified or furnished. Sampling and testing procedures shall be in accordance with ASTM A673. The H frequency of heat testing shall be used. Charpy V-Notch test data shall be included on the mill test reports for structural steel specified in 711.08 and 916.

ASTM Designation	Thickness, in.	Foot-Pounds Joule @ 40°F
A709, grade 36		15
A709, grade 50*	Up to 4 in. mechanically fastened	15
	Up to 2 in. welded	15
A709, grade 50W*	Up to 4 in. mechanically fastened	15
	Up to 2 in. welded	15
	Over 2 in. to 4 in. welded	20

* If the yield point of the material exceeds 65,000 psi, the temperature for the CVN value for acceptability shall be reduced by 15°F for each increment of 10,000 psi above 65,000 psi.

This test requirement shall apply to all structural steel members and components except diaphragms, cross frames, stiffeners, lateral bracing, railroad ballast retainers and components, shoe assemblies, expansion joints, and compression members of trusses.

220 **(f) Mill Test Reports**

Mill test reports for structural steel shall be in accordance with 711.08 and 916 and shall include Charpy-Impact test data as set out in 910.02(e).

(g) High Strength Bolts, Nuts, and Washers

1. General Use

230 High strength heavy hex bolts shall be in accordance with ASTM F3125, grade A325. Type 3 bolts shall be provided if the structural steel is to remain unpainted. High strength heavy hex nuts shall be of the grade and finish specified in ASTM F3125 and ASTM A563. Washers shall be of the type specified in ASTM F3125 and ASTM F436. The bolts, nuts, and washers shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55.

2. Assembly of Structural Steel in Bridges

High strength bolts, nuts, and washers used in the assembly of structural steel in bridges, excluding shoes and bearing assemblies, shall be provided in accordance with 910.02(g)1 and the following additional requirements.

a. Bolts

240 The maximum tensile strength shall be 150,000 psi for bolts 1 in. or less in diameter. The maximum tensile strength shall be 120,000 psi for bolts greater than 1 in. in diameter. The maximum hardness shall be 33 Rc.

b. Nuts

The nuts shall be in accordance with ASTM A563, grade DH; or ASTM A194, grade 2H.

c. Tests

250 (1) Rotational Capacity

High strength fasteners shall be subjected to the rotational capacity test in accordance with ASTM F3125. The fastener shall complete two times the required number of turns from snug tight conditions in accordance with AASHTO LRFD Bridge Construction Specifications, in a Skidmore-Wilhelm calibrator or equivalent tension measuring device without stripping or failure. During this test, the maximum recorded tension shall be at least 1.15 times the required fastener tension indicated in AASHTO LRFD Bridge Construction Specifications. The measured torque required to produce the required fastener tension shall not exceed the value obtained by the following equation.

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$$\text{Torque} = 0.25 PD$$

where:

$$\begin{aligned} \text{Torque} &= \text{Measured Torque, (foot-pounds)} \\ P &= \text{Measured Bolt Tension, (pounds)} \\ D &= \text{Nominal Diameter (feet).} \end{aligned}$$

(2) Proof Loads

Proof load tests for bolts shall be conducted in accordance with ASTM F606, Section 3.2.3. Proof load test for nuts shall be conducted in accordance with ASTM F606, Section 4.2.

270 (3) Wedge Tension Test

The wedge tests of full size bolts shall be conducted in accordance with ASTM F606, Section 3.5.

d. Certification

The supplier shall provide a certification of compliance with all requirements for high strength bolts, nuts, and washers used in the assembly of structural steel in

bridges. The certification, in addition to complying with the applicable requirements of 916, shall include the lot number on the shipping package and indicate when or where all testing was performed.

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(h) Bolts other than High Strength Bolts

1. General

Bolts shall be unfinished, turned, or ribbed bolts in accordance with ASTM A307, grade A. Bolts shall have single, self-locking nuts or double nuts unless otherwise shown on the plans or in the special provisions. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

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Bolts, nuts, and washers utilized in the U channel steel post splice as shown on the plans shall be in accordance with ASTM A449, SAE J429-G7.9, or ASTM F3125, grade A325 and shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55.

2. Unfinished Bolts

Unfinished bolts shall be furnished unless other types are specified.

3. Turned Bolts

The surface of the body of turned bolts shall meet the ANSI roughness rating value of 125. Heads and nuts shall be hexagonal and standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed. Bolts furnished shall provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

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4. Ribbed Bolts

The body of ribbed bolts shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 5/64 in. greater than the nominal diameter specified for the bolts. Ribbed bolts shall be furnished with round heads conforming to requirements of ANSI B 18.5 unless otherwise specified. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to allow the bolts to turn in the holes during tightening. If for any reason the bolt twists before drawing tight, the hole shall be carefully reamed and an over-sized bolt used as a replacement.

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910.03 Permanent Metal Forms

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Metal bridge deck falsework and supports shall be fabricated from steel sheet, zinc-coated structural steel in one of the following grades: 33, 37, 40, 50 Class 1, 80

Class 1, or 50 Class 3, having a coating designation of G165, oiled but not chemically treated, all in accordance with ASTM A653.

A type A certification in accordance with 916 shall be provided for permanent metal forms. The results of the following shall be shown on the certification for each gauge.

Property	ASTM
Yield Strength, ksi	A653*
Tensile Strength, ksi	A653*
Elongation in 2 in., %	A653*
Weight of Zinc Coating	A653*
* The minimum mechanical requirements as stated in ASTM A653 for the respective grade shall be provided on the type A certification in addition to the test results.	

330 The materials will also be sampled at the work site as specified in the Frequency Manual. The sample will include a representative portion of a panel of each gauge, thickness, to be used and a representative portion of each type and size of hardware necessary to erect the panels, excluding the fasteners.

910.04 Steel Forgings and Steel Shafting

(a) Carbon Steel Forgings

340 Steel forgings shall be in accordance with ASTM A668 for carbon steel forgings for general industrial use. Class F forgings shall be furnished unless otherwise specified.

(b) Cold Finished Carbon Steel Shafting

Shafting shall be in accordance with ASTM A108 for cold finished carbon steel bars and shafting. Grade designation 1016-1030, inclusive, shall be furnished unless otherwise specified.

(c) Alloy Steel Forgings

350 Alloy steel forgings shall be in accordance with ASTM A668 for alloy steel forgings for general industrial use. Class G forgings shall be furnished unless otherwise specified.

(d) Certification

Steel forgings and steel shafting shall be covered by a mill certification reporting the test results of:

1. chemical analysis;
2. heat treatment, not required for shafting;
3. tensile strength, yield strength, and elongation.

360 Elongation is not required for shafting.

910.05 Castings

The casting design shall be proof loaded to 178 kN in accordance with AASHTO M 306. Castings shall be in accordance with the plan dimensions and to the following requirements for the designated materials. A certified inspection report shall be submitted by the manufacturer with each shipment of castings, except as otherwise provided herein. Inspection and testing shall be done by the manufacturer. The certified inspection report shall list the casting number, and the type of material, including the class of gray iron, and the grade of ductile iron. It shall state that inspection and testing has been performed, that all parts shipped meet the pertinent specification requirements, and that all component parts fit. The supporting test results, including proof load data, shall be retained and be available on request for a period of seven years. All castings shall have the manufacturer's identification and the date of manufacture cast on an exposed surface.

Acceptance of castings will be based on the certified inspection report, visual inspection, and check measurements.

(a) Steel Castings

Chromium alloy steel castings shall be in accordance with ASTM A743. Grade CA15 shall be furnished unless otherwise specified.

(b) Iron Castings

Iron casting shall be gray iron castings in accordance with ASTM A48, class No. 35B, unless otherwise specified. Tension tests will be required for all castings including drainage castings.

Castings shall be true to pattern in form and dimensions. A tolerance of $\pm 1/8$ in. in general dimensions as shown on the plans will be allowed with the exception that the tolerance in the dimensions of grates or covers and the openings into which they fit shall be limited to $\pm 1/16$ in. Each casting shall weigh at least 95% of the manufacturer's specified weight of the type specified and shall be cast to the dimensions shown on the plans. They shall be free from sponginess, cracks, blowholes, warping, sand inclusions, cold shots, cold shuts, chilled iron shrinks, or any defects which would affect the strength and value for the intended purpose. The castings shall completely fill the molds and shall not be removed until properly cooled. The casting date and a casting code number shall be cast on each casting.

All corners of the castings shall be filleted and outside corners and edges shall be rounded to a radius of not less than $1/8$ in. All contact surfaces between different castings shall present a firm and even bearing without rattling or rocking. The lid frame bearing surfaces on all round castings shall be machine milled to provide true bearings around the entire circumference. All other contact surfaces shall be ground.

All castings shall be cleaned of molding or core sand, rust, scale, and foreign material just prior to shipment. Iron castings shall be delivered unpainted.

(c) Ductile Iron Castings

410 These castings shall be in accordance with ASTM A536. Grade 65-45-12 shall be furnished unless otherwise specified. In addition, they shall be in accordance with all requirements of 910.05(b), except the first paragraph.

(d) Malleable Castings

These castings shall be in accordance with ASTM A47. Grade No. 32510 or 35018 shall be furnished unless otherwise specified. In addition, they shall be in accordance with all requirements of 910.05(b), except the first paragraph.

(e) Carbon Steel Castings

420 These castings shall be in accordance with ASTM A27. The grade shall be 60-30, 65-35, or 70-36.

Castings shall be true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, blowholes, and any defects in positions affecting their strength and value for the service intended.

430 Blowholes appearing on finished castings shall be located so that a straight line laid in any direction does not cut a total length of cavity greater than 1 in. in any 1 ft nor shall any single hole exceed 1 in. in any dimension or have an area greater than 1/2 sq in. Blowholes shall not be deep enough to affect the strength of the casting adversely.

Minor defects which do not impair strength may, with approval, be welded by an approved process. Defects shall be removed in solid metal by chipping, drilling, or other satisfactory methods and, after welding, the castings shall be annealed if required. Castings which have been welded without permission will be rejected. No sharp unfilleted angles or corners will be allowed.

910.06 Bronze and Copper Alloy440 **(a) Bronze Castings**

Bronze castings shall be in accordance with ASTM B22, alloys C91100 or C91300. A type A certification in accordance with 916 shall be provided for bronze casting. In addition to the number of casting or total weight, the results of the following shall be shown on the certification.

Property	Test Standard
Chemical composition	ASTM B22
Tensile strength	ASTM B22
Yield strength	ASTM B22
Elongation	ASTM B22
Brinell hardness	ASTM B22
Compression deformation limit	ASTM B22

(b) Copper Alloy Plates

Copper alloy plates shall be in accordance with ASTM B100. A type A certification in accordance with 916 shall be provided for copper alloy plates. In addition to the copper alloy UNS No. designation, the results of the following shall be shown on the certification.

Property	Test Standard
Chemical composition	ASTM B100
Dimensions	ASTM B100
Tensile strength	ASTM B100
Yield strength	ASTM B100
Elongation	ASTM B100
Permanent set under 100 ksi	ASTM B100
Brinell hardness	ASTM B100
Rockwell hardness	ASTM B100

910.07 Steel Components of MSE Retaining Walls**(a) Backing Mats, Clevis Connector, Connector Bar, and Wire-Facing****1. Backing Mats**

Backing mats shall be smooth steel welded wire reinforcement in accordance with 910.01(b)5. Galvanization, if required, shall be in accordance with ASTM A1060. The Engineer will test samples in accordance with ASTM A1064.

2. Clevis Connector

Clevis connectors, if used, shall be attached to the alignment templates using the bars provided with the forms. The vertical and horizontal alignment of the connectors shall be $\pm 1/8$ in. The holes inside the loops shall be free of all concrete and debris, loose or otherwise.

The clevis connector shall be fabricated of cold-drawn steel wire in accordance with ASTM A1064. Loops shall be galvanized in accordance with ASTM A641, class 5 or class C.

A type A certification in accordance with 916 shall be provided for clevis connector. The results of the following shall be shown on the certification.

Property	Test Standard
Tension	ASTM A1064
Bend	ASTM A1064
Coating adhesion	ASTM A123/A153
Coating thickness	ASTM A123/A153
Average weight of coating	ASTM A123/A153

3. Connector Bar

The connector bar, if used, shall be fabricated of cold-drawn steel wire in accordance with ASTM A1064, and galvanized, if so shown on the plans, in accordance with ASTM A641, class 5 or class C.

A type A certification in accordance with 916 shall be provided for connector bars. The results of the following shall be shown on the certification.

Property	Test Standard
Coating adhesion	ASTM A123
Coating thickness	ASTM A123
Average weight of coating	ASTM A123
Coating flexibility	ASTM A123

4. Wire-Facing

Wire-facing shall be smooth steel WWR in accordance with 910.01(b)5. Galvanization, if required, shall be in accordance with ASTM A1060. All wire-facing shall be handled, stored, and shipped so as to eliminate the danger of excessive bending stresses. The Engineer will test samples in accordance with ASTM A1064.

(b) Ground Reinforcement

The ground reinforcement shall be either a deformed steel strip or a welded-wire grid. The grid or strip used shall be consistent with that used in the pullout test and shall be consistent throughout the project.

The grid shall consist of not less than two longitudinal wires, perpendicular to the wall, welded to equally-spaced cross ribs capable of developing passive pressure with the fill. The deformed strip shall be of constant width. The strip thickness shall vary only from the undeformed section to the deformed section as required to produce the pullout resistance.

The face-panel edges shall be configured to conceal the joints. All horizontal and vertical joints shall be covered with a joint cover to prevent backfill leakage while passing water.

Ground-reinforcement units shall be hot rolled from bars to the required shape and dimensions. Physical and mechanical properties of the units shall be in accordance with ASTM A572, grade 65. Tie strips shall be shop fabricated with hot-rolled steel in accordance with the minimum requirements of ASTM A1011, grade 50. Galvanization for ground-reinforcing units and tie strips shall be in accordance with ASTM A123, coating grade 85, for strip-type reinforcements or ASTM A641, class 5 or class C, for bar mat or grid-type reinforcements.

All ground-reinforcement units and tie strips will be inspected to ensure that they are true to size and free from defects which can impair their strength and durability.

A type A certification in accordance with 916 shall be provided for ground reinforcement. The results of the following shall be shown on the certification.

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Property	Test Standard
Yield strength	ASTM A572/A1011
Coating thickness	ASTM A123/A641
Coating adhesion	ASTM A123/A641

(c) Fasteners

Fasteners shall consist of 1/2 in. diameter, bolts, nuts, and washers and shall otherwise be in accordance with 910.02(g)1 with the exception that the hardware shall be coated in accordance with ASTM F2329.

The supplier shall provide a certificate of compliance with all requirements for high strength bolts, nuts, and washers used in the assembly of MSE retaining walls. The certification, in addition to complying with the applicable requirements of 916, shall include the lot number and heat number on the shipping package and indicate when or where all testing was performed.

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(d) Alignment Pins

The rods used to align the face panels during construction shall be 3/4 in. diameter and 12 in. in length. The rods shall be mild steel, PVC, or fiberglass. A type C certification in accordance with 916 shall be provided for the alignment pins.

910.08 Steel Bin-Type Retaining Wall Units

Wall units shall consist of adjoining closed-face cells filled with structure backfill to form a gravity-type retaining structure. The cells shall be constructed of members in accordance with AASHTO M 218 that are bolted together.

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The necessary bolts and appurtenances shall be provided for complete assembly of the units into a continuous closed-face wall of connected bins.

Working drawings shall be submitted in accordance with 105.02.

The units shall present a uniform workmanlike appearance once assembled. The base metal shall be not less than 16 gauge.

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The steel sheets shall be galvanized on both sides in accordance with ASTM A123, coating grade 85. All sheets will be inspected to ensure that they are true to size and free from defects, which may impair their strength and durability.

A type A certification in accordance with 916 shall be provided for bin-wall sheets. The results of the following shall be shown on the certification.

Property	Test Standard
Yield strength	AASHTO M 218
Coating thickness	ASTM A123/A641
Coating adhesion	ASTM A123/A641

910.09 Guardrail

560 Guardrail of the same type shall be interchangeable regardless of the source. Guardrail materials shall be in accordance with the applicable AASHTO or ASTM requirements listed herein and will only be accepted from qualified manufacturers on the QPL of Guardrail Manufacturers. Qualification requirements for the manufacturers shall be in accordance with ITM 806, Procedure O.

570 Steel beam rail shall be galvanized, corrugated sheet steel beams in accordance with AASHTO M 180 as modified herein. The rails, including terminal sections, shall be either class A, base metal nominal thickness of 0.105 in., 12 gauge, or class B, base metal nominal thickness or 0.135 in., 10 gauge. They shall be type 2, zinc coated with 3.60 oz/sq ft minimum single spot and 4.00 oz/sq ft minimum triple spot. Tests for adherence of the coating may be made including the test specified in ASTM A123, when deemed necessary.

Where beam rail is set on a curve of 150 ft radius or less, the rail plate shall be shop curved with its traffic face concave or convex as required. The radii of curvature shall be in increments of 10 ft from a radius of 150 to 50 ft inclusive and in increments of 5 ft from a radius of 50 ft to and including 20 ft.

580 The steel channels specified on the plans shall be standard 5 in. channels weighing 6.7 lb/ft. The material shall be in accordance with ASTM A36. The channel shall be galvanized in accordance with ASTM A123 after fabrication. The weight of zinc coating per area of actual surface shall average not less than 2 oz/sq ft for any individual piece of channel.

590 Construction details for the rails and channels shall be as shown on the plans. Whenever field fabrication, as approved, requires cutting or drilling, the cut or drilled member shall be coated with a high zinc dust-zinc oxide paint in accordance with Federal Specification TT-P-641, type II, or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied.

910.10 Guardrail Posts

Guardrail posts shall be either steel or timber as specified and shall be in accordance with the following requirements.

(a) Steel Guardrail Posts

The dimensions of the steel guardrail posts shall be as shown on the plans. The material shall be in accordance with ASTM A36. The posts shall be galvanized in accordance with ASTM A123 after fabrication. However, the weight of zinc coating

910.11

600 per square foot of actual surface shall not average less than 2.0 oz for an individual post.

The weight of the W6 x 15 post, after fabrication and coating, shall not be less than 14.60 or more than 16.00 lb/ft.

610 Construction details shall be as shown on the plans. Whenever field fabrication, as approved, requires cutting or drilling, the cut or drilled member shall be coated with a high zinc dust-zinc oxide paint conforming to the requirements of Federal Specification TT-P-641, or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied.

(b) Timber Guardrail Posts

Timber guardrail posts shall be in accordance with 911.02(f). Dimensions and construction details shall be as shown on the plans.

910.11 Guardrail Accessories, Fittings, and Hardware

620 These items consist of brackets, splice plates and bars, post anchors, diaphragms, clamps and clamp bars, end caps, connections, anchor rod assemblies, deadmen, bolts, screws, nuts, washers and blockouts of the type, dimensions, and design shown on the plans. They shall be in accordance with the requirements set out below. Items of the same type shall be interchangeable regardless of the source.

(a) For Steel Beam Guardrail

630 1. Post brackets, bars, plates and shapes for bridge railing brackets, and plate washers shall be in accordance with ASTM A36. Post brackets, bars, and plates and shapes for bridge railing brackets shall be galvanized in accordance with 910.10(a). Plate washers shall be galvanized after fabrication in accordance with ASTM A153. The weight of the W6 x 15 post bracket shall be in accordance with 910.10.

2. Splice plates and rail portion of bridge railing brackets shall be class B, type 2, in accordance with the first paragraph of 910.09(a).

640 3. Bolts and nuts of the sizes specified on the plans shall be in accordance with ASTM A307. Cut washers and lock washers shall be standard round steel washers of the sizes specified on the plans. The diameter of cut washers shall be 1 3/4 in. for 5/8 in. bolts and 2 in. for 3/4 in. bolts with a thickness of 0.134 in. ±0.026 in. measured at the hole. The bolts, nuts, and washers shall be coated after fabrication by either hot dip galvanizing in accordance with ASTM F2329 or mechanically galvanizing in accordance with ASTM B695, Class 55.

- 650 4. Whenever approved field fabrication requires cutting or drilling, the cut or drilled members shall be coated with a high zinc dust-zinc oxide paint conforming to Federal Specification TT-P-641, type II, or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied.
5. Pipe spacers of the size specified on the plans shall be galvanized after fabrication in accordance with ASTM A153, class C. The weight of coating per square foot of actual surface shall average no less than 1.25 oz for the specimen tested and shall be no less than 1 oz for any individual specimen.
- 660 6. For breakaway cable terminal, and cable terminal anchor system, the rail element, standard bolts, nuts, and washers shall be in accordance with 910.09 and requirements 1 and 3 of 910.11(a).
- 670 7. For cable terminal anchor system, the anchor bracket, end plate, soil plate, bearing plate, strut and yoke shall be in accordance with AASHTO M 270, grade 250. They shall be zinc coated after fabrication in accordance with AASHTO M 111. The steel tube shall be in accordance with ASTM A500, grade B and zinc coated in accordance with AASHTO M 111. The post sleeve shall be in accordance with ASTM A53, grade B and zinc coated in accordance with AASHTO M 111. The stud shall be in accordance with ASTM A307, and zinc coated in accordance with AASHTO M 111. The threads shall be in accordance with ANSI B1.13M and shall be M24 by 3, class 6g pitch. The swaged fitting shall be in accordance with ASTM A576, grade 1035, zinc coated in accordance with AASHTO M 111, and shall be annealed for cold swaging. A lock pin hole to accommodate a 1/4 in. plated spring-steel pin shall be drilled through the head of the swaged fitting.
- 680 8. Timber blockouts shall be in accordance with 911.02(f). Alternate material blockouts shall be in accordance with 926.03.

690 High strength heavy hex bolts shall be in accordance with ASTM F3125, grade A325 or ASTM A449. High strength heavy hex nuts shall be in accordance with ASTM A563 Bolts, nuts, and washers shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. Foundation plates and bearing plates shall be in accordance with ASTM A36, and shall be galvanized after fabrication in accordance with ASTM A123, except the weight of zinc coating per square foot of actual surface shall average no less than 2.0

910.11

oz and shall be no less than 1.8 oz for any individual specimen. Welding shall be in accordance with AWS D1.1.

Terminal posts shall be fabricated from tubing meeting ASTM A500, grade B, or ASTM A501 and from plates meeting ASTM A36. Welding shall be in accordance with AWS D1.1. They shall be galvanized after fabrication in accordance with ASTM A123, except the weight of zinc coating per square yard of actual surface shall average no less than 2.0 oz. The average for any component part, including paddle plate, tubing, or base plate, shall be no less than 1.8 oz.

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The steel pipe in the type 5 anchor and the steel spacer tube in the transition type WGB shall be Schedule 40.

Tapered washers may be of steel or malleable iron, and galvanized in accordance with ASTM A153.

The wire rope used in the cable assemblies shall be in accordance with AASHTO M 30 and shall be 3/4 in. preformed, 6 by 19, wire strand core or independent wire rope core, IWRC, galvanized, right regular lay, manufactured of improved plow steel, with a minimum specified breaking strength of 42,800 lbf. The swaged fitting, stud, and nut shall develop the breaking strength of the wire rope. The fitting shall be galvanized in accordance with ASTM A123 before swaging. After galvanizing, the head and nut may be tapped 0.023 in. over the ANSI B1.1, class 2B tolerance.

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(b) For Steel Tube Guardrail

1. Channels and bars for connections, splice bars, and diaphragms shall be in accordance with ASTM A36.

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2. Cap screws shall be stainless steel in accordance with ASTM A276, type 304 or 430.

3. Rail end caps shall be malleable iron castings in accordance with ASTM A47, grade 35018, or steel castings in accordance with ASTM A27, grade 70-36.

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4. Cut washers and lock washers shall be standard round steel washers. The diameter of cut washers shall be 1 1/2 in. and 1/8 in. thick measured at the hole. Washers shall be coated after fabrication in accordance with requirement 3 of 910.11(a).

5. All materials other than cap screws and washers shall be galvanized after fabrication in accordance with ASTM A123.

6. When field fabrication, as approved, requires cutting or drilling, the cut or drilled members shall be coated with a high zinc

dust-zinc oxide paint conforming to the requirements of Federal Specification TT-P-641 type II or Military Specifications DOD-P-21035. When spray paint is used, two coats shall be applied.

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910.12 Blank

910.13 Steel Fence Posts

Tubular steel fence posts and line posts shall meet the following specifications and the requirements as shown on the plans.

(a) Line Posts

Line posts shall be in accordance with AASHTO M 281 and galvanized in accordance with AASHTO M 111, coating grade 65.

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Line posts for farm field fence shall be furnished with anchor plates. End, corner, pull, and gate posts for farm field type fence shall be furnished with braces and all fittings and details required to make a complete installation as shown on the plans.

(b) Tubular Steel Fence Posts

Two groups of tubular steel fence posts are included in these specifications. Tubular section posts shall have heavy malleable iron caps or pressed galvanized steel caps. Such caps shall be made to provide a drive fit over the outside of the section to exclude moisture. The weight per foot for tubular posts and braces shall be no less than 90% of the weight specified. Unless specified otherwise, the tubular steel fence post shall be group 1.

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1. Group 1

Tubular steel fence posts for group 1 shall be hot-dipped zinc-coated and shall be in accordance with ASTM F1083 except tests shall be conducted on sample posts selected as being representative of the posts furnished. The weight per foot will be acceptable provided it is at least 90% of the specified weight.

2. Group 2

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Tubular steel fence posts for group 2 shall have a minimum 50 ksi yield strength and be in accordance with AASHTO M 181, except that the inner pipe surface may be galvanized in lieu of a zinc rich coating or hot dipped aluminum coated, Type 2, meeting the chemical requirements of AASHTO M 274. The aluminum coated, Type 2, steel fence posts shall be manufactured by roll forming aluminum coated, Type 2, steel strip and electric resistance welding it into tubular form. The outside of the weld area shall be metallized with commercially pure aluminum to a thickness sufficient to provide resistance to corrosion equal to that of the remainder of the outside of the post. The aluminum coating weight (mass) shall be a minimum of 0.75 oz/sq ft average, and 0.70 oz/sq ft for an individual test specimen, as measured in accordance with ASTM A428. Specimens for determining weight of coating shall be obtained in accordance with ASTM F1083.

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(c) Fence Fastenings

When fastenings are necessary for attaching the farm field fence to the posts, they shall be either galvanized or aluminum coated No. 9 wire, or galvanized or aluminum coated clamps of the manufacturer's standard design. The coating weights shall be a minimum of 0.60 oz/sq ft and 0.30 oz/sq ft for galvanized and aluminum coated, respectively. A sufficient quantity of individual tie wires or clamps shall be furnished to provide for five attachments of the fencing to each line post and one tie wire for each strand of barbed or tension wire.

Line posts for chain link type fence shall be furnished with the necessary tie wires or fabric bands for fastening the fabric to the posts. These fastenings shall be made of aluminum strip or wire of approved gauge and design or of galvanized steel wire and may be in accordance with the manufacturer's standard design. If galvanized steel wire ties are furnished, the wire shall be no smaller than No. 9 gauge. A sufficient quantity of individual ties or bands shall be furnished to provide for attaching the fabric to each line post each 1 ft or as called for on the plans.

800 **910.14 Sign Posts****(a) Steel, Flanged, Channel Posts****1. General Requirements**

Posts shall be made from open hearth, basic oxygen, or electric furnace steel rolled from standard tee rails or new billets. The steel used in the posts shall conform to the physical properties of ASTM A499, grade 60, and to the chemical compositions of ASTM A1 for 91 lb/yd or larger steel rails.

810 Posts fabricated from other steels will be acceptable providing that the following criteria are met. A notarized copy of a dynamic crash test report shall be furnished substantiating that the posts manufactured from this material, when double mounted in a 7 ft span, conform to the breakaway requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, except that the maximum change in velocity shall not exceed 16 ft/s. For two posts in a 7 ft path, impact performance may be estimated by multiplying the vehicle energy loss observed in a single post crash test by 2. This estimated double post energy loss may then be used to calculate an estimated impact velocity change and momentum change for a double post sign design. The minimum yield strength shall be 60,000 psi and the minimum tensile strength shall be 90,000 psi.

820 The tensile strength shall be determined by either the standard Rockwell Hardness test, Brinell Hardness test, or by actual tensile test. The Rockwell Hardness shall be a minimum of B 91. The yield strength shall be determined by the manufacturer by actual test. Tensile and yield strengths and chemical composition shall be determined by the average from the three latest test results the manufacturer has available at the time of shipment. These test results need not be made on the materials from which the posts were made. However, the tests shall have been made within 90 days of shipment.

830 A type B certification in accordance with 916 shall be provided for the posts, except those used for temporary construction signs, temporary traffic signs, and temporary panel signs. The limits of the following shall be shown on the certification.

Property	Requirement
Dimensions	ASTM A499
Chemical composition	ASTM A1
Yield strength	Minimum 60,000 psi
Tensile strength	Minimum 90,000 psi
Elastic modulus value	910.14(a)3

840 Posts shall be of uniform flanged channel or U section such that the area of contact between the post and the sign is symmetrical about the vertical axis of both sign and post. The back of each post shall be formed in a manner to ensure a solid bearing surface over the entire length of the post when mounted back to back. The bearing surface on the back of the post shall be flat. The length shall be as specified with a tolerance of ± 1 in. Sign posts shall be punched with 58 holes which shall be 3/8 in. in diameter located on the center-line and spaced on 1 in. centers beginning 1 in. from the top. The remainder of the post shall be punched with 3/8 in. holes on 1 in. or 2 in. centers.

850 The finished posts shall be machine straightened and have a smooth uniform finish free from cracks, flaws, injurious seams, laps, blisters, and edges which are ragged, sharp, and imperfect, or other defects affecting their strength, durability, or appearance. The maximum variation in straightness shall be no more than 1/4 in. in any 5 ft of length, or exceed in inches 1/4 times the number of feet of length divided by 5. Bolt holes of the diameter specified shall be accurately spaced vertically and centered horizontally so that holes will register for back to back application. All holes and sheared ends shall be commercially free from burrs.

The steel sign posts shall be galvanized in accordance with ASTM A123.

860 Galvanizing shall be the final process after all fabrication and punching has been completed. Posts saw cut after galvanizing shall have the cut surface treated with a zinc-based solder in rod form which complies with ASTM A780. The cut surface shall not be treated until the fuse plate is installed and all bolts are tightened. The top of the fuse plate shall be 1 in. below the bottom of the sign.

Posts saw cut before galvanizing shall have temporary fasteners provided with sufficient strength to prevent warping or deforming of the post during the galvanization process. The surface under the temporary fasteners shall be treated with an approved zinc solder meeting the above mentioned specifications. The surface shall be treated before the fuse plate is installed. The break-away stubs shall be galvanized a minimum of 8 in. below the top of the concrete foundation.

870 Steel posts shall be wired or strapped securely in bundles of not more than 2,000 lb. They shall be nested in rows with the edges intermeshed so as to form a rectangular bundle and shall be fastened in such a manner that they do not slip or rub against each other and cause damage to the finish. Care shall be taken during shipment to prevent the bundles from rubbing against each other and causing damage. Excessive damage to the finish during shipment will be cause for rejection of the damaged posts.

2. Deflection Test Requirements

880 Posts will be tested as a simple beam with the flange in compression on non-restricting supports 24 in. apart. Test specimens shall be 28 in. $\pm 1/4$ in. long. A load of 1,500, 3,500, or 4,600 lb, depending on the type of post, shall be applied at the center of the span with a mandrel of not less than 1 in. in diameter. Application of the load shall be at a speed of not to exceed 0.03 in. per minute. Deflection of the post upon application of the total load shall not exceed 0.16 in. The load shall then be removed. Deflection of the post 1 minute after removal of the load shall not exceed 0.01 in.

3. Type of Posts

Posts shall conform to the following table and to deflection tests required in 910.14(a)2.

Type	Minimum Elastic Section Modulus	Loading
A	.200	1,500 lb
B	.400	3,500 lb
C	.560	4,600 lb
Abb*	.670	**
Bbb*	1.190	**
* Back to Back ** Back to Back post shall be tested singly for deflection prior to assembly. <u>Note:</u> The elastic section modulus values shall be included in the type B certification.		

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(b) Wide Flange Posts

900 Structural steel members for the support of signs shall be in accordance with ASTM A36 and ASTM A709, grade 36. These members shall be galvanized in accordance with ASTM A123. Base plates and stiffeners shall be in accordance with the requirements of ASTM A709, grade 36. Fuse and hinge plates shall be in accordance with the requirements of ASTM A36 and shall be galvanized in accordance with ASTM A123. All bolts and nuts shall be high strength heavy hex and be in accordance with ASTM F3125, grade A325, and ASTM A563. Washers shall be in accordance with ASTM F436. Direct Tension Indicator hardware shall be in accordance with ASTM F959.

All holes shall be drilled. All cutting shall preferably be saw cuts however flame cuts as specified in 711.13 may be allowed. Metal projecting beyond the plane of the

plate face will not be allowed.

(c) Structural Steel Posts

Steel members for the support of signs shall be standard shapes as specified and shall be in accordance with 910.02(a). These members shall be galvanized in accordance with ASTM A123. A type C certification in accordance with 916 shall be provided for the structural steel posts.

(d) Structural Aluminum Posts

These posts shall be standard shapes as specified and shall be aluminum in accordance with ASTM B221 alloy 6061-T6. A type C certification in accordance with 916 shall be provided for the structural aluminum posts.

(e) Square Steel Posts

A type B certification in accordance with 916 shall be provided for the square steel posts. The limits of the following shall be shown on the certification.

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1. Steel

Square steel posts shall be roll formed and in accordance with one of the following:

- a. ASTM A1011, hot rolled carbon sheet steel in either 0.105 in. or 0.075 in. with a minimum yield strength of 60,000 psi. The ultimate tensile strength shall not exceed 79,800 psi or have an elongation measured over 2 in. greater than 20%.
- 930 b. ASTM A1008, cold rolled high strength steel, 0.075 in. with a minimum yield strength of 60,000 psi. This shall apply to the 2 in. by 2 in. size posts only.
- c. ASTM A653, cold rolled high strength steel, 0.075 in. with minimum yield strength of 60,000 psi. The ultimate tensile strength shall not exceed 79,800 psi or have an elongation measured over 2 in. greater than 20%. This requirement shall apply to the 2 in. by 2 in. size posts only.

940 Yield strengths and chemical composition shall be determined from the three latest test results performed by the steel manufacturer. These test results may not be determined on materials from which the delivered posts were made. However, the tests shall have been performed within 90 days of shipment. The certification shall include the range of test results and the section modulus value in accordance with 910.14(a)3.

2. Fabrication

The posts shall be corner welded and scarfed as necessary to allow sections to telescope within each other. The finished posts shall be machine straightened and have a smooth uniform finish free from cracks, flaws, injurious seams, laps, blisters, and

950 edges which are ragged, sharp, and imperfect, or other defects affecting their strength, durability, or appearance. The maximum variation in straightness shall be no more than 1/4 in. in any 5 ft of length. Cut holes or knockout holes of 7/16 in. diameter shall be spaced on 1 in. centers, on the centerlines of all four sides in true alignment, and opposite to each other for back to back applications. All holes and sheared ends shall be free from burrs.

3. Protective Coating

The protective coating shall be applied using one of the following:

- 960 a. Before fabrication, both sides of the rolled sheet steel shall be galvanized in accordance with ASTM A653, coating designation G90.
- 970 b. After fabrication, a triple coating system on the outside of the posts consisting of galvanizing with zinc which is in accordance with ASTM B6 weighing 0.60 ±0.15 oz/sq ft followed by a chromatic conversion coating weighing 15 ±5 µg/sq in. and a clear organic exterior coating with a dry film thickness of 0.2 ±0.1 mil. The interior surface of the posts shall receive a double in-line application of a zinc rich organic coating with a total dry film thickness of 1.2 ±0.6 mil. The dried zinc rich organic coating film shall contain a minimum of 77% total zinc. Samples from the posts which use these protective coatings shall be exposed to salt fog testing in accordance with ASTM B117 for a total of 500 h. The samples shall be examined at both 100 and 500 h of salt fog testing and rated for corrosion. At 100 h the corrosion rating shall be a minimum of 9 and at 500 h the corrosion rating shall be a minimum of 6 when determined in accordance with ASTM D1654.
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(f) Portable Construction Sign Trailer

The portable construction sign trailer, not including the signs and lights, shall weigh no more than 300 lb and shall not be fabricated with heavier than 3 by 3 in. angles, 2 1/2 in. pipe, or 3 by 2 in. rectangular tubing. The rim size of the wheels shall not exceed 12 in. Axle assemblies with differential housings shall not be used.

910.15 Delineator Posts

Posts shall be in accordance with 910.14(a)1.

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Physical requirements for the finished delineator posts shall be:

- Width of flange face 2 to 2 3/8 in.
- Width of back 3/4 to 7/8 in.
- Depth from face of flange to back 7/8 to 1 1/8 in.
- Length..... 7.0 ft ±1 in.

Weight 1.0 to 1.5 lb/ft

1000 Delineator posts shall be punched with a minimum of twenty-four 1/4 in. holes on the centerline spaced on 1 in. centers beginning 1 in. from the top.

910.16 Copper Flashing

1010 Copper flashing shall be soft copper and shall be in accordance with ASTM B370, except the minimum copper content shall be 99.5%. The weight per square foot will be determined by weighing individual samples. If the first sample is not in accordance with the tolerances for 16 oz sheet, two additional samples shall be tested and both shall comply with the specified tolerances. The sample shall withstand being cold bent through an angle of 180° flat upon itself, without failure of the outside of the bent portion. A type C certification in accordance with 916 shall be provided for copper flashing.

910.17 Bronze or Copper Alloy Plates

Bronze or copper alloy to be used for self lubricating bearing plates shall conform to one of the following requirements based on the design unit loading set out on the plans.

Design Unit Loading not over	Shall Conform to ASTM
A. 3,000 psi	B22, Alloy C86300
B. 2,500 psi	B100, Alloy C51000
C. 2,000 psi	B22, Alloy C91100
D. 1,000 psi	B22, Alloy C90500*
* Up to 2.5% lead allowed.	

1020 The sliding surfaces of the plates shall be provided with cylindrical recesses with a depth necessary to provide proper containment of the lubricant. The recesses shall be arranged in a geometric pattern so that each successive row will overlap in the direction of motion. The total area of the recesses shall comprise no less than 25% and no more than 35% of the total area of the plate.

1030 The surface finish of bearing areas shall be in accordance with ANSI B46.1 #125. The lay of tool marks shall be in the direction of expansion or contraction of the structure. If the surface is ground, grinding knurls may be omni-directional. Flat bearing surfaces shall be flat to a tolerance of ±0.0005 in. Curved bearing surfaces shall be machined to a tolerance of ±0.0005 in. in each 1 in. of length perpendicular to the circular section. The radius of curved bearing surfaces shall have the following tolerances.

	Positive Tolerance	Negative Tolerance
Concave Surface	0.010 in.	0.000 in.
Convex Surface	0.000 in.	0.010 in.

The lubricant shall be of the solid type. It shall consist of graphite and metallic substances having lubricating properties with a lubricating binder. The lubricant shall be free of any material that causes abrasive or corrosive action on the metal surfaces. It shall withstand the atmospheric elements. The lubricant shall be compressed into the recesses of the bearing plate by hydraulic pressure to form a dense non-plastic lubricating insert.

- 1040 At the time of assembly in place, the steel surfaces which bear on the self-lubricating bearing plate shall be lubricated with additional lubricant furnished by the manufacturer. White lead, tallow, or other coating shall be removed before the application of the lubricant.

The coefficient of friction between the self-lubricating plate and the steel plates in contact with them shall not exceed 0.10 when subjected to twice the designed loading.

- 1050 A type C certification in accordance with 916 shall be provided for the bronze or copper alloy plates.

910.18 Fence, Fittings, and Gates

(a) Farm Field or Woven Wire Fence

This fence shall be in accordance with ASTM A116. The wire shall be No. 9 gauge (3.8 mm). The design shall be 1047-6-9. The coating shall be class 3. The method of securing the vertical stays to the horizontal wires may be either of those shown on the plans. Diagonal braces shall be in accordance with 910.18(b)3.

- 1060 A type C certification in accordance with 916 shall be provided for the fence, fittings, and gates.

(b) Steel Fabric Chain Link Fence

- 1070 This fence shall be in accordance with ASTM A392 for galvanized steel fabric or ASTM A491 for aluminum coated steel fabric. The height of the fabric shall be 48 in. unless otherwise specified. It shall be of No. 9 gauge (3.8 mm) wire woven in 2 in. mesh. The fabric shall be knuckled at the top and bottom selvages when the height is less than 72 in. Fabric of 72 in. in height or higher shall be knuckled at the top and shall have the twisted and barbed finish at the bottom. For galvanized fabric, coating shall be done after weaving and shall be class II, average of two or more specimens no less than 2.0 oz/sq ft and no less than 1.8 oz/sq ft for any individual specimen. For aluminum coated fabric, coating shall be class II, 0.40 oz/sq ft minimum.

The fabric shall be furnished with ties required for fastening it to the top and bottom tension wires. These fastenings may be of aluminum wire or strip of approved gauge and design, or of galvanized steel wire in accordance with the manufacturer's standard design. If galvanized steel wire ties are furnished, the wire shall be no smaller than No. 12 gauge (2.7 mm). Sufficient ties shall be furnished to provide for attaching

1080 to the top and bottom tension wires each 24 in. Fittings necessary to make complete installation shall be pressed or rolled steel, forged steel, cast steel, or malleable iron.

Steel fabric chain link fence shall be as shown on the plans and as set out above.

A type C certification in accordance with 916 shall be provided for the steel fabric chain link fence.

1. Tension Wire

1090 Tension wire intended for use on the top or bottom of steel chain link fence or on the bottom of farm field fence when specified shall be spring coil or crimped steel wire with an initial diameter of 0.177 ± 0.005 of an in., a minimum breaking load of 1,950 lb, and a coating of either zinc or aluminum. The minimum weight (mass) of coating shall be 0.80 oz/sq ft for galvanized wire and 0.40 oz/sq ft for aluminum coated steel wire. The weight of aluminum coating shall be determined in accordance with ASTM A428.

A type C certification in accordance with 916 shall be provided for the tension wire.

2. Stretcher Bars, Truss Rods, and Turnbuckles

1100 Stretcher bars shall be 3/16 by 3/4 in. flat bars. These bars, truss rods, turnbuckles, and necessary fittings shall be of good commercial quality steel, malleable iron, or wrought iron. They shall be galvanized in accordance with ASTM A153 after fabrication. The turnbuckles shall be made from drop forged malleable iron. They shall have a minimum take up of 4 in. The fittings may be pressed or rolled steel, forged steel, cast steel, or malleable iron.

3. Braces

1110 Braces shall be made of steel pipe with bolted steel couplings or connections. Steel pipe shall be in accordance with ASTM F1083. They shall be galvanized as set out therein. Fabrication or manipulation that causes minor damage to the galvanized coating shall be corrected by approved application of a high zinc dust-zinc oxide paint conforming to the requirements of Federal Specification TT-P-641 type II or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied. Damaged braces will be rejected.

4. Barbed Wire

1120 Barbed wire used at the top and bottom of farm field fence, or as otherwise specified, and in accordance with 603 shall be in accordance with applicable provisions of ASTM A121. It shall be composed of No. 12 1/2 gauge (2.5 mm) galvanized or aluminum coated steel wire with four round 14 gauge (2.0 mm) barbs at approximately 5 in. spacing. The galvanized coating shall be in accordance with class 3 in Table 2. The minimum aluminum coating shall be in accordance with class 60 for the line wire and class 20 for the barb wire. The weight of coating shall be determined in accordance with ASTM A428. The use of aluminum barbs, in accordance with

910.18

ASTM B211, alloy 5052-H38, nominal diameter No. 12 gauge, will be allowed.

1130 The use of barbed wire with No. 15 1/2 gauge (1.70 mm), high tensile strength line wires, and No. 16 1/2 gauge (1.47 mm) barbs will be allowed. The barbs shall be round with four points and spaced at approximately 5 in. intervals. The barbed wire shall be in accordance with ASTM A121. The galvanized coating shall be in accordance with class 3 in Table 2.

A type C certification in accordance with 916 shall be provided for the barbed wire.

5. Bridge Railing Pedestrian Fence

Fence posts and horizontal rails shall be in accordance with 910.13(b)1. The zinc-coating weight shall not be less than 2 oz/sq ft.

1140 Base plates shall be steel in accordance with ASTM A709, grade 36 or 50. Galvanization shall be in accordance with AASHTO M 111. The zinc-coating weight shall not be less than 2 oz/sq ft.

The chain link fabric shall be coated wire of 9 gauge, with a mesh size of 2 in. The zinc-coating weight of fabric shall not be less than 2 oz/sq ft. The zinc-coating weight of brace bands, fabric ties, fence post loop caps, fence post caps, horizontal rail end cups, tension bands, and tension bars shall not be less than 1.2 oz/sq ft.

1150 A type C certification in accordance with 916 shall be provided for the bridge railing pedestrian fence.

(c) Aluminum Fabric Chain Link Fence

This fence shall be in accordance with the applicable requirements of 910.18(b) except for composition of materials. Requirements for the various component parts of aluminum fence shall be as shown in Table 1.

Table 1

Item	ASTM Reference	Alloy	Additional Information
Fabric	B211	Al-clad 5056 or 6061-T94	
Barbed Wire - Line	B211	5062-0, H38, or 6061-T89	2-strand dia. 0.110 in. 4-pt barb. dia. 0.080 in. 5 in. space
Barbs	B211	5052-H38	
Tension Wire	B211	Al-clad 5056 or 6061-T94	Dia. 0.192 in.; Note 1
Hog Ring Fasteners	B211	6061-T94	Dia. 0.110 in.
Wire Ties	B211	1100-H18	Dia. 0.148 in.
Flat Band Ties	B211	3003-H14	1.2 in. wide; 0.06 in. thick
Stretcher Bars	B211	6063-T6	3/4 in. by 1/4 in.; square edges
Truss and Brace Rods	B211 or B221	6061-T6	Dia. 3/8 in.
Turn Buckles	B26 (cast parts), B211 (wrought)	356.0-T6 6061-T6	
Bands	B221	6063-T6	1/8 in. by 1 in. beveled edge
Bolts	B211 or B221	2024-T4	ASA B 18.2 hexagon threads class 2, 2A, or 2B
Nuts	B211 or B221	6061-T6	
Expansion Sleeves	B210	3003-H18	1.695 in. ID by 0.078 in.; wall drawn type. 6 in. long; self-centering
Post Tops, Rails and Brace Ends	B26 or B108	356.0T6	Fabricated in permanent molds or sand castings
Top and Brace Rails	B241 and B429	6063-T6	1 1/4 in. pipe; Note 2
Barbed Wire Extension Arms	B26 or B108	356.0T6	Fabricated as for post tops; sheet castings
Line Posts	B241 and B429	6063-T6	2 in. pipe; Note 2
Corner Posts	B241 and B429	6063-T6	2 1/2 in. pipe; Note 2
Note 1: Aluminum coated steel wire in accordance with 910.18(b) may be used.			
Note 2: ANSI schedule 40 pipe, plain ends.			

1160

(d) Gates

Gate posts sizes shall be as follows:

ANSI Nominal Pipe Size	Swing Gate Opening, (inclusive)	
	Single Gate	Double Gate
2 1/2 in.	Up to 6 ft	Up to 12 ft
3 1/2 in.	7 to 13 ft	13 to 26 ft
6 in.	14 to 18 ft	27 to 36 ft
8 in.	19 to 32 ft	37 to 64 ft

1. Steel Gates

Steel gate posts shall be standard weight, galvanized, steel pipe in accordance with ASTM F1083 and furnished with all necessary fittings. Post sizes shall be as set out above. The gate frames shall be of standard weight, galvanized, steel pipe in accordance with ASTM A53; of 1 1/2 in. (38.1 mm) nominal size; and shall have welded joint or riveted construction using galvanized pressed steel or malleable fittings. Areas welded after galvanizing shall be coated with a material conforming to the requirements of Federal Specification TT-P-641, type II or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied. Fabric coverings for gates shall be in accordance with 910.18(a) or 910.18(b). These gates shall be furnished with necessary fastenings, hinges, center stops, and locking devices galvanized after fabrication in accordance with ASTM A153.

2. Aluminum Gates

Aluminum gate post sizes shall be in accordance with 910.18(d). They shall be ANSI schedule 40 pipe and in accordance with ASTM B241 or B429, alloy 6063-T6. Gate frames shall consist of 1 1/2 in. schedule 40 pipe assembled by welding or with fittings. Pipe shall be in accordance with ASTM B241 or B429, alloy 6063-T6. Welding material and procedures shall be in accordance with the applicable AWS provisions. Formed sheet fittings shall be in accordance with ASTM B209, alloy 6061-T6. Gate hinges may be offset type wrought aluminum, ASTM B209, alloy 6061-T6, or galvanized malleable iron. Fabric shall be in accordance with 910.18(c).

910.19 Overhead Sign Structures

The complete structure with signs in place shall be able to withstand wind pressure in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. The structure shall be designed to resist fatigue of the material in accordance with the AASHTO specifications.

All prefabricated structural units shall be packed so that there is no injury or defacement during transportation to the point of destination.

All bolts, nuts, and washers for bridge bracket assemblies shall be stainless steel in accordance with ASTM F738M.

Strain poles for cable span signs shall be in accordance with 922.10(a). Each strain pole shall include three band-type attachments for span wire clamps. Such attachments shall be galvanized in accordance with ASTM A153. Cable shall be in accordance with 922.10(e)2. Each cable shall include three wire rope clips at each end. Anchor bolts shall be in accordance with 922.10(c)5. All sign mounting hardware except for the extruded aluminum bar shall be galvanized in accordance with ASTM A153.

Gratings for the walkway shall be of aluminum in accordance with ASTM B221, alloy 6061-T6 or 6063-T6. Cross bars and bent connecting bars shall be of aluminum

in accordance with ASTM B221, alloy 6061, 6063 or 3003 conforming to ASTM B210.

1210

A type C certification in accordance with 916 shall be provided for the overhead sign structure.

(a) Aluminum Trusses for Overhead Sign Structures, Box Truss and Dynamic Message Sign Structure Truss

Extruded tubes and other shapes shall be of aluminum in accordance with ASTM B221, B241, or B429, alloy 6061-T6. All other castings shall be of aluminum in accordance with ASTM B26, alloy 356.0-T6. Gusset, flange and stiffener plates shall be of aluminum in accordance with ASTM B209, alloy 6061-T6. Plates shall be free

1220 of sharp edges and irregularities.

Bolts, nuts, screws, and flat washers shall be passivated type 304 stainless steel. Bolts and screws shall be in accordance with ASTM A193, grade B8. Hexagon nuts and washers shall be in accordance with ASTM A194, grade 8. High strength bolts, nuts and washers for chord splice connections, with matching lock nuts having steel inserts, shall be in accordance with 910.02(g) and shall be galvanized in accordance with AASHTO M 232, class C or D.

1230 Neoprene pads shall be ultraviolet rated and shall conform to the requirements in 915.04.

Welding material and procedures shall be in accordance with 803 and applicable AWS provisions.

1240 Certified proof of the qualifications for a minimum of two welders shall be presented after the contract is awarded and before fabrication is started. This certification shall be from a commercial or public testing laboratory and qualifications shall be based on welding of aluminum alloy, 6061-T6 with consumable electrode type welding using aluminum alloy ER5356 filler material. Welders shall qualify by passing the requirements set out in 803.04.

Welding shall be checked by visual inspection. Poor welding workmanship shall be rejected.

Each complete structure shall be free from any misfits or structural deficiencies prior to shipment.

1250 **(b) Steel Overhead Sign Structures, Cantilever, Monotube, Tri-Chord, Bridge Attached, and End-Supports for Box Truss and Dynamic Message Sign Structure**

End-support members for box truss and dynamic message sign structure shall be fabricated from constant cross-section tubular steel or extruded steel shapes as indicated on the drawings. Sections used for end-support columns, diagonal and

horizontal members shall be constant cross-section tubular members in accordance with ASTM A53, type E or S, grade B, minimum yield strength of 35,000 psi. Constant cross-section tubular steel with greater yield strength may be used with written approval, however, structural dimensions shall remain as shown on the plans. Sections used for cross support beams shall be constant cross-section extruded W-shapes in accordance with ASTM A709, grade 36. Base plates shall be in accordance with
1260 ASTM A36. Base plates for columns shall develop the full strength of the columns. Structures shall be galvanized after fabrication in accordance with ASTM A123.

Support columns for the cantilever structure shall be fabricated from constant cross-section tubular steel as indicated on the drawings. Column sections shall be in accordance with ASTM A53, type E or S, grade B as shown on the plans. Members shall have minimum yield strength of 35,000 psi. Constant cross-section tubular steel with greater yield strength may be used, with written approval, however, structural dimensions shall remain as shown on the plans. Base plates shall be in accordance with
1270 ASTM A36. Base plates shall develop the full strength of the columns.

Cantilever arms shall be either double arms or quadri-chord trusses as shown on the plans.

Cantilever arms shall be fabricated from octagonal tubular member with 0.14 in./ft taper and in accordance with ASTM A595, grade A or B, or ASTM A572, grade 50. Quadri-chord arms shall be of constant cross-section tubular members in accordance with ASTM A53, type E or S, grade B as shown on the plans. Members shall have minimum yield strength of 35,000 psi. Steel with greater yield strength may be used, with written approval, however, structural dimensions shall remain as shown on the
1280 plans. Structures shall be galvanized after fabrication in accordance with ASTM A123. Plates shall be free of sharp edges and irregularities.

High strength bolts, nuts and washers for chord to column connections, with matching lock nuts having steel inserts, shall be in accordance with 910.02(g) and shall be galvanized in accordance with AASHTO M 232, class C or D.

Bolts, U-bolts, nuts, screws, and flat washers shall be passivated type 304 stainless steel. Bolts and screws shall be in accordance with ASTM A193, grade B8. Hexagon nuts and washers shall be in accordance with ASTM A194, grade 8.
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Bridge attached structures shall be fabricated from constant cross-section tubular steel in accordance with ASTM A53, type E or S, grade B with a minimum yield strength of 35,000 psi. Constant-cross section tubular steel with greater yield strength may be used, with written approval. However, structural dimensions shall remain as shown on the plans. Structures shall be galvanized after fabrication in accordance with ASTM A123.

Tri-chord truss structures shall be made of constant cross-section tubular members in accordance with ASTM A53, type E or S, grade B minimum yield strength of 35,000

1300 psi. Monotube structures shall be made of tapered tubular members in accordance with either ASTM A595, grade A or B, or ASTM A573, grade 50. Structures shall be galvanized after fabrication in accordance with ASTM A123.

The J hook shall consist of one 3/8-in. steel bar in accordance with ASTM A307. It shall be spot welded to the inside of the end-support member. The J hook shall be hot-dip galvanized prior to welding or in the final assembly with the support column.

1310 Anchor bolts, nuts, and washers shall be in accordance with ASTM F1554, grade 36. A hexagon nut, leveling nut, and flat washer shall be furnished with each anchor bolt. Top ends of anchor bolts and associated hardware as shown on the plans, shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55.

Base plate skirts shall be 10 gauge galvanized steel.

Welding material and procedures shall be in accordance with 711.32 and applicable AWS provisions.

1320 Welding shall be checked by visual inspection. Poor welding workmanship shall be rejected.

Each complete structure shall be free from any misfits or structural deficiencies prior to shipment.

1330 Strain poles shall be anchor bolt type complete with hand-holes and pole top or cap. They shall meet the requirements set out above for cantilever sign structures. Each pole is to include three band-type attachments for span wire clamps. The band shall be from material in accordance with ASTM A572, grade 50; ASTM A606; or approved equal. The bands shall not be of the U-bolt type. The poles shall have maximum deflections as shown below when loaded 18 in. from the top with a 100 lb load.

Pole Size	Deflection
15 in. by 30 in.	0.16 in.
14 in. by 26 in.	0.12 in.

The steel flanges at the center of the cross beam and at the ends of the horizontal arms shall be fastened to the tapered or straight sections by means of two circumferential welds. One of the circumferential welds shall weld the outside of the flange firmly to the tube. The flange connection shall develop fully the strength of the tubular sections being joined together by means of the flange connections.

1340 Gusset, flange, and base plates shall be in accordance with ASTM A36 and shall be galvanized after fabrication in accordance with ASTM A123. Base plates for upright poles shall develop the full strength of the poles. Castings for the vertical pole top and horizontal arm and cap shall be in accordance with ASTM A126 and shall be

910.20

galvanized with a minimum coating of 2 oz/sq ft. High strength heavy hex bolts and nuts, except anchor bolts, shall be in accordance with ASTM F3125, grade A325, Type 1, and ASTM A563. Two nuts for use in plumbing upright poles shall be furnished with each anchor bolt. Anchor bolts for overhead steel structures shall be in accordance with 910.19(a). Bolts, nuts, washers, and the top ends of anchor bolts shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. Welding shall be in accordance with 711.32.

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Beam clamp details and sign support assemblies shall be galvanized in accordance with ASTM A153. Clamps shall be fabricated of high strength, low alloy steel in accordance with ASTM A242, ASTM A606, or approved equal. Stainless steel U-bolts may be used in lieu of the clamps for the attachment of the sign hangers to the arms of double arm cantilevers. The U-bolts shall be in accordance with 910.19(a) for stainless steel hardware.

910.20 Steel Bridge Railing Components

1360 Materials for steel bridge railing components shall be in accordance with the following:

- (a) Railing and posts tubing shall be in accordance with ASTM A500, grade B.
- (b) Posts, connection plates, splice bars, base plates, and anchor channel bars shall be in accordance with ASTM A709, grade 36. High strength steel posts and connection plates shall be in accordance with ASTM A709, grade 50.
- 1370 (c) Steel bolts, nuts, and cap screws shall be in accordance with ASTM A307.
- (d) Railing end caps shall be steel castings in accordance with ASTM A27, grade 70-36.
- (e) Threaded rods, nuts, and washers shall be in accordance with ASTM A449, ASTM A563, and ASTM F436, respectively.
- 1380 (f) Steel washers shall be standard round cut or lock washers, as shown on the plans.
- (g) Cap screws shall be stainless steel in accordance with ASTM A276, type 304, 305, or 430.
- (h) Anchor bolts shall be galvanized and in accordance with 910.02(g)2. Threads may be cut or rolled.
- (i) Railing tubing, posts, connection plates, splice bars, base plates,

1390 anchor channel bars, and railing end caps shall be galvanized after fabrication in accordance with AASHTO M 111.

Bolts, nuts, cap screws, washers, and lock washers shall be galvanized after fabrication in accordance with AASHTO M 232.

- (j) A type A certification in accordance with 916 shall be provided for the anchor bolts. The results of the following shall be shown on the certification for the anchor bolts.

Property	ASTM Test Standard
Tensile strength	F3125 or A449
Proof load	F3125 or A449
Hardness	F3125 or A449
Coating thickness and weight	A153 class C or B695 class 55
Rotational capacity	F3125

1400 A type C certification in accordance with 916 shall be provided for the steel bridge railing components.

910.21 Steel Sheet Piling

Steel sheet piling shall be in accordance with ASTM A328, ASTM A1011, or ASTM A653.

910.22 Grating for Grated Box End Sections

(a) Type I Grated Box End Sections

1410 Steel pipe and steel tubing for grating shall be in accordance with ASTM A53, type E or S, grade B or ASTM A501, electric-resistance welded or seamless. Such pipe and tubing shall be galvanized in accordance with ASTM A123. All other related hardware shall be galvanized in accordance with ASTM A153.

1420 Pipe with a 4 in. outside diameter and in accordance with ASTM A513, type 5, may be used as an alternate to the 4 in. outside diameter pipe specified. The pipe used as an alternate shall have a minimum wall thickness of 5/16 in. and a minimum yield strength of 50,000 psi. Steel tube of 4 in. by 4 in. by 3/8 in. and in accordance with ASTM A500, grade B, will also be allowed as an alternate to the 4 in. outside diameter pipe specified.

(b) Type II Grated Box End Sections

Structural steel grates shall be ASTM A36 for end sections having widths less than or equal to 3 ft and shall be ASTM A572, grade 50 for widths greater than 3 ft.

A type B certification in accordance with 916 shall be provided for the pipe, tubing, tube, and grates. The limits of the following shall be shown on the certification.

Welding, as shown on the plans, shall be in accordance with 711.32 and AWS
1430 D1.1.

Test	ASTM
Tensile Strength, Yield Strength, Outside Diameter, Wall Thickness, Galvanization Coating Thickness	A53, type E or S, grade B
Tensile Strength, Yield Strength, Wall Thickness, Outside Diameter (Round) or Unit Weight (Square/Rectangular), Galvanization Coating Thickness	A501
Tensile Strength, Yield Strength, Bar Dimensions	A36
Tensile Strength, Yield Strength, Bar Dimensions	A572, grade 50
Wall Thickness, Outside Diameter, Yield Strength	A513, type 5
Tensile Strength, Yield Strength, Tube Dimensions, Wall Thickness	A500, grade B

SECTION 911 – WOOD MATERIALS

911.01 Untreated Lumber

(a) General

Untreated lumber is a saw mill product which may be further manufactured by sawing, resawing, passing lengthwise through a standard planing machine, drying, cross cutting to length, and machining but is not treated with preservatives.

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1. Boards

Yard lumber less than 2 in. thick and more than 1 in. wide is a board.

2. Dimension Lumber

Lumber from 2 in. to but not including 5 in. thick and 2 in. or more wide is dimension lumber.

3. Structural Lumber

20 Lumber that is 2 in. or more thick and 4 in. or more wide intended for use where working stresses are required is structural lumber. The grading of structural lumber is based on the strength and use of the entire piece. The grade of lumber shall be as shown on the plans or as otherwise specified.

4. Sawn Timbers

Solid sawn pieces with a nominal dimension of 5 in. or more in the least dimension is timber. Timbers may be classified as beams, stringers, posts, caps, sills, girders, or purlins. Timber for structural purposes shall be no less than 6 in. in width or thickness. Dimensions and grade of timber shall be as shown on the plans or as otherwise specified.

30 **5. Timbers, Round**

These timbers are used in the original round form, such as poles, posts, and mine timbers. Round timbers, such as posts and poles, shall be entirely peeled. All limbs and knots shall be trimmed flush. Unless otherwise approved or shown on the plans, no minus tolerances will be allowed on the specified diameter.

6. Yard Lumber

40 Lumber of all sizes and patterns intended for general building purposes is yard lumber. The grading of yard lumber is based on the intended use of the particular grade and is applied to each piece with reference to its size and length when graded without consideration to further manufacture.

7. Surfaced or Dressed Lumber

This is lumber that is dressed by running it through a planer.

8. Rough Sawn Lumber

This is lumber that has been sawn, edged, and trimmed, but not dressed.

(b) Species and Grade

50 Only Coastal Douglas-fir, red oak group, redwood, southern yellow pine, and white oak group will be allowed, except as set out elsewhere herein. Redwood lumber shall not be used in bridges where it is a permanent part of the structure.

Except as otherwise provided, all lumber furnished under these specifications shall be of the species and grades specified.

Softwood lumber shall be graded in accordance with grade rules which conform with the basic provisions of the American Softwood Lumber Standard PS 20. It shall be grade marked and shall be in accordance with the applicable grading rules or specifications of the following agencies for the species indicated.

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Coastal Douglas-fir – West Coast Lumber Inspection Bureau
 Southern Yellow Pine – Southern Pine Inspection Bureau
 Redwood – Redwood Inspection Service

Red and White Oak Group, Hardwood Lumber, shall be grade marked and shall be in accordance with the applicable grading rules of the National Hardwood Lumber Association.

70 If lumber is not to be graded as provided above, it may be green or seasoned, but shall be sound, free from excessive wane, unsound loose or hollow knots, knot holes, shakes, or other defects which would impair strength or durability for the use intended. Pin holes, shot holes, or occasional grub holes in oak are not classified as defects. If approved and if the proposed use of the material is stated on the purchase order, grade markings may not be required on native red or white oak groups furnished from local

sources or on emergency orders or small orders of Coastal Douglas-fir and southern yellow pine.

Lumber for temporary bridges or other temporary structures may be of any species and grade which meets approval.

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(c) Inspection

All lumber regardless of grade markings may be inspected for grades and quality at the point of origin or final destination. If, during inspection of a lot of lumber, it becomes apparent that the quantity of rejections exceed 20%, the entire lot may be rejected.

(d) Tolerances

Tolerances for rough sawn, or dressed lumber shall be in accordance with the National Lumber Grades Authority Grade Rule standards for each species.

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(e) Untreated Piling

Untreated piles shall be in accordance with ASTM D25 and the following. All piling shall be cut from white or red oak, dense southern yellow pine, fir, or cypress, preferred in the order listed. They may be of other species, subject to approval, which can withstand driving without showing excessive brooming or splitting.

The butts and tips shall be sawn square with the axis of the pile. Alternatively, the tips may be tapered to a point of not less than 16 sq in. with the tip so formed that the centerline of the pile passes through the tip.

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Unless otherwise specified, all piles shall be clean-peeled before driving. No strip of the inner bark remaining on the pile shall be more than 3/4 in. wide. There shall be at least 1 in. of bark free surface between two such strips. Not less than 80% of the surface shall be clean wood. All knots shall be trimmed flush with the body of the pile.

After peeling, piles shall have diameters as indicated below unless otherwise approved or required.

Length of Pile	Diameter, inches		
	Tip, min.	3 in. from Butt, min.	Butt, max.
Less than 20 ft	8	11	20
20 ft and less than 40 ft	8	12	20
40 ft and less than 60 ft	7	13	20
60 ft and more	6	13	20

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911.02 Treated Lumber

(a) General

Treated lumber shall be preservative-treated by pressure processes in accordance

with AWWA Standards T1 and U1 or AASHTO M 133. Other AWWA Standards applying to specific items are set out in 911.02(b), 911.02(c), 911.02(e), and 911.02(g). Lumber to be treated shall be in accordance with 911.01, except as modified in 911.02(b), 911.02(c), and 911.02(e). The lumber may be inspected at the treating plant. Preservatives shall be in accordance with 911.02(h). Wherever ammoniacal or alkaline copper quat azole or wherever copper preservative is utilized, only stainless steel or hot dipped galvanized fasteners and hardware shall be used. Galvanizing for fasteners shall be in accordance with ASTM A153. Galvanizing for hardware shall be in accordance with ASTM A653, coating designation G185. Fasteners and hardware in contact with one another shall be of the same base material and coating if applicable, and shall be used consistently throughout the treated wood article or structure.

(b) Bridge Lumber

This shall be southern yellow pine or Coastal Douglas-fir. There shall be no heartwood requirements and the amount of sapwood shall not be limited. Wane will not be allowed on any treated plank for flooring and may be excluded elsewhere when so specified. Lumber for bridges shall be treated with a preservative in accordance with applicable provisions of AWWA Standards T1 and U1, Commodity Specification A: Sawn Products, use category UC4B.

(c) Piling

Timber piling, before treatment, shall be in accordance with 911.01(e) except piles shall be southern yellow pine or Coastal Douglas-fir. The outer and inner bark shall be removed before treatment. Unless otherwise specified, piling shall be treated with a preservative in accordance with the applicable requirements of AWWA Standards T1 and U1, Commodity Specification E: Round Timber Piling, use category UC4C.

(d) Blank

(e) Sign Posts

Wood sign posts shall be cut from southern yellow pine, Coastal Douglas-fir, or other species as specified. Posts shall be surfaced four sides.

Dimensions shall be in accordance with the plans. There will be a length tolerance of ± 2 in. Both butt and top ends shall be sawn square. All outer and inner bark shall be removed. One way sweep, not exceeding 1 in. between the top and butt, will be acceptable. Short crooks will not be allowed.

The posts shall be sound timber. No splits, shakes, excessive cracks, loose decayed or hollow knots will be allowed. Occasional pin, shot, or grub holes in oak, or bird pecks in other timbers, will not be considered defects. All posts shall be entirely treated with preservatives in accordance with all applicable provisions of AWWA Standards T1 and U1, Commodity Specification A: Sawn Products, use category UC4A.

160 **(f) Sawn Timber Posts and Blockouts**

The requirements for posts and blockouts prior to treatment shall be in accordance with AASHTO M 168 and as modified below.

1. Species and Grades

Timber posts shall be of the species listed, and shall be in accordance with the grading requirements specified in Table A. Timber blockouts shall be of the species listed, and shall be in accordance with the grading requirements specified in Table B. Timber posts and blockouts shall have the cross section and length dimensions as shown on the plans.

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Table A

Special and Grading Requirements for Sawn Timber Guardrail Posts		
Species	Posts and Timbers Grade	Grading Rules Agencies ^a
Softwoods		
Coastal Douglas-fir	No. 1 or better	WWPA or WCLIB
Southern Pine	No. 1 or better	SPIB
^a WWPA (Western Wood Products Assoc.); WCLIB (West Coast Lumber Inspection Bureau); and SPIB (Southern Pine Inspection Bureau).		

Posts and blockouts shall be graded in accordance with grading rules based on principles and methods specified in ASTM D245. Where there is a conflict between AWPA and ASTM standards, AWPA will prevail. Where there is a conflict between either AWPA or ASTM standards and this specification, this specification will prevail.

All material shall show the approved grading agency stamp indicating mill origin, species, and grade.

180

Table B

Species and Grading Requirements for Sawn Timber Guardrail Blockouts		
Species	Posts and Timbers Grade	Grading Rules Agencies ^a
Softwoods		
Coastal Douglas-fir	No. 2 or better	WWPA or WCLIB
Southern Pine	No. 2 or better	SPIB
^a WWPA (Western Wood Products Assoc.); WCLIB (West Coast Lumber Inspection Bureau); and SPIB (Southern Pine Inspection Bureau).		

2. General Requirements

Posts and blockouts shall be in accordance with the following general requirements.

a. Decay

Posts and blockouts shall be free from decay before treatment.

190

b. Unsound Wood

Posts containing unsound wood will be rejected. Blockouts may contain small

spots of unsound wood provided they are well scattered.

c. Grounds for Rejection

Posts and blockouts shall be sound. No sapwood rot will be allowed. Ring shake will not be allowed. Grub holes in the butt, 1/2 in. or less in diameter, are not considered defects. Posts or blockouts containing ant holes will not be accepted. Any post or blockout which contains any defect which is detrimental to the post or blockout will be rejected.

200

d. Dimensional Tolerances

Posts and blockouts shall be sawn square to within -1/2 in. of the specified cross-sectional dimensions. A tolerance of ± 2 in. will be allowed on the specific length of the posts. A tolerance of -1/2 in. will be allowed on the specified length of the blockouts.

3. Pressure Treating Posts and Blockouts

Pressure treating posts and blockouts shall be in accordance with the following requirements and AWPA Standards T1 and U1, Commodity Specification A: Sawn Products, use category UC4B.

210

a. Machining

Posts and blockouts shall be sawn to their final shape and holes bored prior to treatment.

b. Inspection Before Treatment

The treater shall be responsible for ensuring that the material has the required approved grading agency stamp before treatment is commenced. The stamp or marking shall be applied on a wide face at the trimmed end. The stamp shall be applied such that it remains readable after treating. Material that has been air dried or kiln dried shall be inspected for moisture content in accordance with AWPA Standard M2.

220

c. Preservative Treatment

All posts and blockouts shall be treated with a preservative as specified herein.

d. Material for Preservative Treatments

The preservative used for treating posts and blockouts shall be in accordance with the appropriate AWPA or AASHTO Standards.

230

e. Treatment Methods

Timber for guardrail posts and blockouts shall be treated to be in accordance with AWPA Standard T1, and the requirements specified herein.

f. Sorting and Spacing

The material in a charge shall consist of the same species or consist of species within one group shown in table C. The material shall have similar moisture content and be of similar form and size. Blockouts and posts may be treated in the same charge.

Table C

Species Groupings for Treatment in Same Charge	
Group	Species
A	Southern Pine
B	Coastal Douglas-fir

240

g. Conditioning

Conditioning shall be in accordance with AWPAs Standard T1.

h. Inspection During Treatment

The treater shall determine that the preservatives used are in accordance with the requirements herein. The minimum frequency of the preservation analysis shall be each charge for the occasional single charge inspected. The minimum frequency for consecutive treatments from the same working tank shall be the first and at least one of every five additional charges, selected at random. Preservative samples shall be taken as appropriate so as to be representative of the solution in the treating cylinder.

250

i. Retentions

The minimum retentions shall be in accordance with AWPAs Standards T1 and U1.

j. Penetration

The penetration requirements shall be in accordance with AWPAs Standard T1, table B6.

260

k. Inspection After Treatment

Following treatment, the charge shall be physically inspected in accordance with AWPAs Standard M2, section 4. All treated material shall bear the quality mark of the inspection agency. All inspections shall be completed at no cost to the Department. All non-compliant material shall be removed from the remaining acceptable material before shipment.

l. Branding

All post and blockouts shall be clearly and permanently branded or marked on one of the wide faces. The brand shall be within 12 in. of the top of the post. The brand shall show the treater's identification, the plant designation, and the year of treatment. The month may also be included. The brand shall also show the species, the preservative type, and retention, all in accordance with AWPAs Standard M6.

270

m. Conformance

The treating plant supplying the material shall be responsible for and will be required to supply a certificate indicating the species, grade, preservative type, retention, year, and name of treater. The certificate shall also include all of the other information which is listed in AWPAs Standard M2, section 6.2.

280

n. Records

Copies of treating records, analysis records, and other records which may be necessary to determine accordance with specifications shall be made available to Department personnel or their designated representatives upon their request. Required information shall be that which is listed in AWWA Standard M2, section 6.2. These records shall be retained by the treating plant for five years from the date of material shipment.

o. Independent Inspections

The Department may inspect the material or call for a non-Departmental inspection to verify that it is in accordance with all specifications.

290

4. Field Treatment of Posts and Blockouts

Cuts, holes, or injuries to the surface of posts and blockouts which occur after pressure treatment shall be field-treated with copper naphthenate in accordance with AWWA Standard M4.

5. Rejection for Degrade After Treatment

Guardrail posts or blockouts developing the following degrade prior to installation will be rejected regardless of prior approvals.

300

- a. single checks greater than 3 in. deep or checks opposite each other totaling more than 3 in. deep, measured with a probe not more than 1/16 in. thick;
- b. single checks 1/4 in. wide or wider measured at the widest point, and extending more than 1/3 of the length of the post or blockout;
- c. single checks greater than 3/8 in. wide measured at the
- d. splits greater than 3 in. long which are in the plane of the bolt hole;
- e. crooks or bows exceeding 1 in. per 10 ft length; and all twists;
- f. combinations of checks, splits, or shakes which are otherwise in accordance with the specifications but which may cause the post or blockout to separate into several pieces.

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320

(g) Recreational Applications

Lumber and timber that will be used in facilities where human contact will occur, such as handrails, pedestrian facilities including decking and picnic tables, shall be

912.01

treated in accordance with AWWA Standards U1 or UC4A, or AASHTO M 133. A type C certification in accordance with 916 shall be provided for the lumber/timber.

(h) Preservatives

330 Preservatives shall be in accordance with current AWWA or AASHTO M 133 Standards as modified by EPA regulation.

Waterborne preservatives shall be in accordance with AASHTO M 133 or AWWA Standards.

SECTION 912 – CONCRETE CURING MATERIALS AND ADMIXTURES

912.01 Curing Materials

Curing materials shall be in accordance with the following requirements.

(a) Burlap Cloth made from Jute or Kenaf

10 This material shall be new, or reclaimed and thoroughly vacuum cleaned burlap. Burlap from sugar, salt, or fertilizer bags shall not be used. The burlap shall weigh no less than 10 oz/sq yd and shall be in strips of not less than 40 in. or more than 120 in. wide and no less than 2 ft longer than the width of the pavement being cured.

(b) Waterproof Paper Blankets

These blankets shall be in accordance with ASTM C171.

(c) White Polyethylene Sheeting, Film

The sheeting shall be in accordance with ASTM C171.

(d) White Burlap Polyethylene Sheet

20 These sheets shall be in accordance with ASTM C171.

(e) Liquid Membrane Forming Compounds

Materials shall be selected from the QPL of Liquid Membrane Forming Curing Compounds.

Storage of liquid membrane forming compounds shall be in accordance with the manufacturer's recommendations. Compounds shall be kept from freezing and shall not be applied when the ambient temperature is less than 40°F. Compounds that are more than one year past the date of manufacture shall not be used.

30 Products may be added to the QPL of Liquid Membrane Forming Curing Compounds by completing the requirements in ITM 806, Procedure F. Testing shall be performed by a recognized independent laboratory approved by NTPEP. In order to maintain approval, the manufacturer shall submit an annual recertification letter to the Department by January 1 of each year. The manufacturer shall also submit a type

A certification for a single batch every four months to the Department's Division of Materials and Tests.

1. Wax-Based, White Pigmented

40 These compounds shall meet or exceed requirements of ASTM C309, Type 2, Class A, when tested in accordance with ASTM C156.

2. Resin-Based, White Pigmented

These compounds shall be in accordance with ASTM C309, Type 2, Class B, 100% Poly-alpha-methylstyrene, PAMS, resin with the following exceptions:

PAMS Curing Compound Properties		
Physical Tests	Specification	Requirement
Total solids, % by weight of compound	ASTM D2369	≥ 42
Reflectivity, % in 72 h	ASTM E1347	≥ 65
Loss of water, kg/m ² in 24 h	ASTM C156	≤ 0.15
Loss of water, kg/m ² in 72 h	ASTM C156	≤ 0.40
Infrared Spectrum, vehicle	Match reference IR scan	100% poly-alpha-methylstyrene
V.O.C. Content, g/L	326 IAC 8-15	< 350
Long-Term Settling Test, ml/100 ml in 72 hrs	NTPEP	≤ 2.0

Samples of PAMS curing compound may be obtained randomly for verification at the point of incorporation into the work in accordance with 106.02. Verification testing will include:

50

1. Total Solids
2. Reflectance
3. Long-Term Settling Test

(f) Polyethylene Film

The sheeting shall be in accordance with ASTM C171.

912.02 Curing-Sealing Materials

60 Curing-sealing materials are single application curing and sealing products for portland cement concrete.

A QPL of PCC Curing-Sealing Materials will be maintained by the Department. The QPL will identify pre-qualified products, specify the manufacturer and product designation, and include application instructions.

In order to have a product added to the QPL of PCC Curing-Sealing Materials, a type A certification in accordance with 916 shall be provided for the curing-sealing

materials. Such certification shall state that the product is in accordance with the requirements of NCHRP 244 Series IV Southern Climate Weathering Test, and ASTM
70 C309, type 1.

- (a) The certification shall be in accordance with the applicable requirements of 916, and shall include a dated test report. The test report shall substantiate full compliance with the specifications and establish when the testing was started. Test reports older than seven years on January 1 of the approval year will not be accepted.
- (b) If irregularities are found in the results required for such certification, copies of the original data may be required prior to
80 reconsideration of the certification.
- (c) Tests shall be conducted by a state highway agency testing laboratory or a testing laboratory regularly inspected by CCRL. Proof of such inspection shall be furnished with the test report.

After a product has been qualified, it will be added to the QPL of PCC Curing Sealing Materials. The product will remain on the list until test results on file are seven years old, provided that there are no changes in raw materials, formulation, or procedures for manufacture. Results more than seven years old or products in which
90 there has been a change in raw materials, formulation, or procedures for manufacture shall be recertified in order to remain on the QPL.

A curing-sealing material that performs unsatisfactorily in the field will be removed from the QPL.

912.03 Admixtures for Use in Concrete

Admixtures for use in PCC shall be selected from the QPL of PCC Admixtures and Admixture Systems. An admixture may be added to the QPL by completing the requirements in ITM 806, Procedure D. Admixtures containing chloride added as an
100 ingredient of manufacture will not be acceptable.

(a) Air Entraining Admixtures

Air entraining admixtures are materials to be added to PCC mixtures at the mixer for the purpose of entraining air.

(b) Chemical Admixtures for Concrete

Chemical admixtures are materials to be added to PCC mixtures at the mixer for purposes indicated below.

110 1. Type A

Type A is a water reducing admixture that reduces the quantity of mixing water required to produce concrete of a given consistency.

2. Type B

Type B is a retarding admixture that retards the setting of concrete.

3. Type C

Type C is an accelerating admixture that accelerates the setting and early strength development of concrete.

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4. Type D

Type D is a water reducing and retarding admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and retards the setting of concrete.

5. Type E

Type E is a water reducing and accelerating admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and accelerates the setting and early strength development of concrete.

130

6. Type F

Type F is a high range water reducing admixture, HRWR, that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater.

7. Type G

Type G is a high range water reducing and retarding admixture, HRWRR, that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater, and retards the setting of concrete.

140

8. High Range Water Reducing Admixture System

HRWR admixture system is a combination of admixtures that act as a type F admixture within a concrete mixture. The system consists of chemical admixtures and an air entraining admixture. One of the components shall be a type F admixture. Components shall be in accordance with 912.03 for their respective types.

9. High Range Water Reducing and Retarding Admixture System

HRWRR admixture system is a combination of admixtures that act as a type G admixture within a concrete mixture. The system consists of chemical admixtures and an air entraining admixture. One of the components shall be a type F or a type G admixture. One of the components shall retard the setting of the concrete. Components shall be in accordance with 912.03 for their respective types.

150

(c) Test Report

Testing shall be performed by a recognized laboratory in accordance with ITM 806.

1. Air entraining admixtures shall be in accordance with AASHTO M 154.

160

2. Chemical admixtures shall be in accordance with AASHTO M 194 for their respective types.
3. Test reports shall not be more than five years old on January 1 of the approval year. New submittals of test reports more than five years old will be accepted, if all subsequent five year limited retest reports, are submitted. Subsequent limited retest results shall comply with the dating and age requirements specified above and shall include the following tests as a minimum requirement for compliance:

170

- a. infrared analysis, residue by oven drying, and specific gravity;
- b. water content and time of setting;
- c. flexural strength at 3, 7, and 28 days;
- d. relative durability.

912.04 Latex Modifiers

180 Latex modifiers are an admixture to be added to the concrete mixture at the continuous mixer. The latex shall be one of the latex modifiers on the QPL of Latex Modifiers.

The formulated latex admixture shall be a non-toxic, film forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture and shall be homogeneous and uniform in composition. A type B certification in accordance with 916 shall be provided for the latex modifiers. The limits of the following shall be shown on the certification.

190	Polymer TypeStyrene Butadiene StabilizersAnionic and Nonionic Surfactants Antifoaming Agent.....Polydimethylsiloxane Percent Solids, % by Mass46.0 minimum Mass Per Gallon8.4 lb at minimum pH (as shipped).....9.0 - 11.0 Freeze/Thaw Stability.....5 Cycles, -15° to 25°C Shelf Life.....2 Years, minimum Color.....White
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912.05 Foaming Agent

200 Foaming agents used in making preformed foam for cellular concrete grout shall be in accordance with ASTM C869. A type C certification in accordance with 916 shall be provided for the foaming agent.

912.06 Synthetic Fibers for Use in PCC

(a) General

Synthetic, non-metallic, fibers are used for concrete three-dimensional

reinforcement to promote post-crack control, and improve the long-term performance of PCC. Synthetic fibers shall be introduced into PCC mixtures at a minimum dosage rate of 4.0 lb/cu yd at the batching plant or a ready-mix truck.

(b) Acceptance

Synthetic fibers for use in PCC shall be selected from the QPL of Synthetic Fibers. Hybrid fibers which include a combination of macro and micro fibers will be accepted. Synthetic fibers may be added to the QPL by completing the requirements in ITM 806, Procedure F.

(c) Requirements

Synthetic fibers shall be Type III in accordance with ASTM C1116 and ASTM D7508 with the following exceptions:

1. Aspect Ratio – Length/Equivalent Diameter,

minimum	70
maximum.....	100
2. Length (macro fiber)..... 1.5 to 2.25 in.
3. Tensile Breaking Strength, min. 70,000 psi
4. Modulus of Elasticity, min. 800,000 psi

(d) Acceptance Testing of Hardened Fiber-Reinforced Concrete

Testing shall be in accordance with ASTM C1579 and ASTM C1609, using roller supports meeting the requirements of ASTM C1812.

Testing of fiber-reinforced concrete shall be performed by a recognized independent commercial laboratory, regularly inspected by the CCRL for PCC materials, to ensure that the properties of the fiber-reinforced concrete are in accordance with the following:

Required Hardened Fiber-Reinforced Concrete Properties		
Physical Test	Specification	Requirement
Equivalent Residual Flexural Strength ($f_{T,150}^{150}$ or f_c^3)*, min.	ASTM C1609	150 psi
Equivalent Flexural Strength Ratio ($R_{T,150}^{150}$ or R_c^3)*, min.	ASTM C1609	25%
Crack Reduction Ratio, (CRR), min. reduction	ASTM C1579	>85%
* The specimens shall be tested when the concrete ultimate flexural strength at peak stress (f_p) is a minimum of 650 psi. For 6 by 6 by 20 in. FRC beam the maximum required net deflection value of 1/150 of the 18 in. span length is 0.12 in.		

SECTION 913 – SOIL TREATMENT MATERIALS

913.01 Water

Water shall be clean and free of oil, algae, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials. Water shall be tested in accordance with the test methods listed in the table below. To be acceptable for use, the results of the water testing shall be in accordance with the results as follows:

10

Property	Test Method	Result
pH	ASTM D1293	6.0 to 8.0
Chloride Ions	ASTM D512	less than 300 ppm
Sulfate (SO ₄)	ASTM D516	less than 500 ppm
Total Solids	ASTM C1603	less than 1,500 ppm

A type A certification in accordance with 916 shall be provided for non-potable sources. The results of the tests listed in the table above shall be provided on the certification.

Water known to be of potable quality may be used without testing.

913.02 Calcium Chloride

Calcium chloride shall be in accordance with AASHTO M 144 and shall be:

20

- (a) Type S, grade N1, class A
- (b) Type S, grade N3, class A or B
- (c) Type L

913.03 Sodium Chloride

Sodium chloride shall be in accordance with AASHTO M 143. Rock salt shall be used for de-icing purposes. Either rock salt or evaporated salt may be used for stabilization.

30

913.04 Lime

Lime shall be a hydrated lime when used in masonry or a hydrated lime, quicklime, or lime by-product when used for soil modification.

(a) Hydrated Lime for Masonry

Hydrated lime used in masonry shall be in accordance with ASTM C207, Type N.

(b) Lime for Soil Modification

40 Hydrated lime, quicklime, or lime by-product used for soil modification shall be from the QPL of Soil Modifiers. A product will be considered for inclusion on the QPL by following ITM 806, Procedure P and shall meet the following requirements.

1. Hydrated Lime and Quicklime

Hydrated lime and quicklime shall be in accordance with AASHTO M 216.

2. Lime By-Products

Lime by-products shall be hydrated lime or quicklime by-products in accordance with ASTM C25 having the following requirements.

- 50 a. The lime by-products shall contain a minimum of 60% total calcium and magnesium oxides (non-volatile basis).
- b. Available calcium hydroxide plus magnesium oxide calculated as calcium hydroxide shall be a minimum of 30%.
- c. Soluble sulfate shall not be more than 5%.
- 60 d. Sieve analysis shall be performed in accordance with ASTM C110. The lime by-products gradation shall be as follows:

Sieve	% Retained (Max.)
No. 4 (4.75 mm)	5
No. 30 (600 μ m)	15
No. 100 (150 μ m)	30

913.05 Blank

913.06 Bentonite Grout

Bentonite grout shall be untreated, sodium bentonite, finely ground with not more than 5% retained on the No. 200 (75 μ m) sieve. It shall be free of lumps and materials that can prevent mixing into a fluid free of lumps of unmixed bentonite. Calcium bentonite will not be accepted.

70

The grout shall be proportioned at 2 lb of pure bentonite powder per gal. of potable water. Deviations from these proportions shall be subject to approval.

SECTION 914 – ROADSIDE DEVELOPMENT MATERIALS

914.01 Special Topsoil for Roadside Development

This topsoil shall consist of loose friable soil, free of refuse, stumps, large roots, rocks over 2 in. in diameter, brush, weeds, or other material which would be detrimental to the proper development of vegetative growth. It shall be capable of supporting normal vegetation as demonstrated by the growth of healthy vegetation on

it. It shall not be taken from a source known to contain any of the noxious weeds defined as such in the Indiana State Seed Law, IC 15-4-1.

10

Topsoil shall have a pH value of 6.2 to 7.4. Testing for pH value shall be performed in accordance with AASHTO T 289. Agricultural limestone may be added to topsoil in order to raise the pH to meet specification requirements. The addition of agriculture limestone shall be determined based on tests performed by a laboratory qualified by the Department. Topsoil shall not be incorporated into the work until it is approved.

914.02 Temporary Seed

- Temporary seed will be approved for use by visual inspection of the Engineer.
- 20 Temporary seed may be purchased from any commercial source provided the seed's package is clearly marked and labeled by the manufacturer as to its content and weight.

914.03 Fertilizer

Fertilizer shall be standard commercial fertilizer with an analysis of 12-12-12.

Tests will not be required, but fertilizer standards shall be governed by the rulings of the Indiana State Seed Commissioner.

914.04 Grass, Legume, and Forb Seed

- 30 Grass, legume, and Forb seed in the quantities and varieties required shall be furnished full-tagged and delivered in properly designated packages or bags as directed. Seeds shall be in accordance with the following requirements.

Native grass and forb seed shall be purchased from lots for which test results are provided. Testing will not be required for aquatic species. When normal germination testing is not practical for forb species, a tetrazolium test shall be conducted to determine seed viability.

- 40 Seeds shall contain none of the prohibited noxious weeds listed in 360 IAC 1-1-5 or any that are listed in the Acts of the General Assembly of the State. Restricted noxious weed seed listed in 360 IAC 1-1-6 shall not exceed 0.25% by weight in accordance with IC 15-15-1-32.

Clover shall be free from dodder with no tolerance allowed.

Requirements noted above are minimum and trade allowances will not be allowed.

- 50 Seed shall be purchased from sources of supply that have been accepted and reported by the State Seed Commissioner, Purdue University, West Lafayette, Indiana, and found to be satisfactory. Seed of native grasses shall be tested by the State Seed Commissioner or by an independent laboratory. Seed of forbs shall be tested by an independent laboratory. Test results by independent laboratories shall be signed by a

Registered Seed Technologist and shall be submitted to the State Seed Commissioner. This report is required before seed is installed.

Seed will be considered to be expired 15 months after the date it was tested. Expired seed shall not be installed.

- 60 Each bag or container of seed shall have a printed tag or label providing all of the information required by IC 15-15-1-32. Seed from bags with no labels, illegible labels, or with labels not giving all of the required information will not be accepted.

- The seed supplier shall provide certification in accordance with 916.02 and 916.03(g) that lists the seed lots used in the mixture and shall indicate that the seed mixture supplied meets the contract requirements for the specific contract that the particular seed mixture is supplied. Also, as part of the certification, the seed supplier shall provide a copy of the State Seed Commissioner's letter for the seed mixture that shows that each seed lot has been tested and found to be satisfactory. The specific test results for each seed lot shall also be attached to the certification.
- 70

Seed which meets the weed seed tolerance, but does not comply with the purity or germination requirements, or both, may be used provided the percentage of purity or the percentage of germination is not more than 10% below the minimum specified and that the result obtained from the following formulae does not exceed the maximum percent of weed seeds allowed.

$$M=W \times P \times G$$

- 80 where:

M = Maximum percent of weed seeds allowed

W = Actual percent of weed seeds

P = Purity Factor = $\frac{\text{Minimum Specified Purity}}{\text{Actual Purity}}$

- 90 G = Germination Factor = $\frac{\text{Minimum Specified Germination}}{\text{Actual Germination}}$

If such seeds are selected for use, the amount to be used shall be increased in accordance with the following formula except the amount used shall not be less than that specified.

$$\text{Amount to be used} = \text{Amount specified} \times P \times G$$

Percentages of Weed Seed Content		
	Variety	% (not more than)
Alkaligrass	<i>Puccinellia distans</i>	0.5
Alsike Clover	<i>Trifolium hybridum</i>	0.5
Chewings Fescue	<i>Festuca rubra</i> (var. <i>fallax</i>)	0.5
Creeping Red Fescue	<i>Festuca rubra</i> spp. <i>rubra</i>	0.5
Illinois Bundleflower	<i>Desmanthus illinoensis</i>	0.5
Kentucky Bluegrass	<i>Poa pratensis</i>	0.5
Ladino Clover	<i>Trifolium repens</i> (var. <i>latum</i>)	0.5
Lemons Alkali Grass	<i>Puccinellia airoides</i> (Lemons)	0.5
Orchard Grass	<i>Dactylis glomerata</i>	0.5
Perennial Rye Grass	<i>Lolium perenne</i>	0.5
Purple Prairie Clover	<i>Dalea purpurea</i>	0.5
Red Fescue	<i>Festuca rubra</i>	0.5
Red top	<i>Agrostis gigantea</i>	0.75
Rye, Agricultural	<i>Secale cereale</i>	0.5
Rye, Annual	<i>Lolium multiforum</i>	0.5
Smooth Brome Grass	<i>Bromus inermis</i>	0.95
Tall Fescue	<i>Festuca arundinacea</i>	0.5
White Dutch Clover	<i>Trifolium repens</i>	0.75

Percentages of Purity		
	Variety	% (not less than)
Alkaligrass	<i>Puccinellia distans</i>	90
Alsike Clover	<i>Trifolium hybridum</i>	97
Chewings Fescue	<i>Festuca rubra</i> (var. <i>fallax</i>)	97
Creeping Red Fescue	<i>Festuca rubra</i> spp. <i>rubra</i>	95
Illinois Bundleflower	<i>Desmanthus illinoensis</i>	98
Kentucky Bluegrass	<i>Poa pratensis</i>	85
Ladino Clover	<i>Trifolium repens</i> (var. <i>latum</i>)	98
Lemons Alkali Grass	<i>Puccinellia airoides</i> (Lemons)	85
Orchard Grass	<i>Dactylis glomerata</i>	85
Perennial Rye Grass	<i>Lolium perenne</i>	95
Purple Prairie Clover	<i>Dalea purpurea</i>	99
Red Fescue	<i>Festuca rubra</i>	95
Red top	<i>Agrostis gigantea</i>	90
Rye, Agricultural	<i>Secale cereale</i>	99
Rye, Annual	<i>Lolium multiforum</i>	95
Smooth Brome Grass	<i>Bromus inermis</i>	85
Tall Fescue	<i>Festuca arundinacea</i>	98
White Dutch Clover	<i>Trifolium repens</i>	97

Percentages Actual Germination		
Variety		% (not less than)
Alkaligrass	<i>Puccinellia distans</i>	80
Alsike Clover	<i>Trifolium hybridum</i>	85*
Chewings Fescue	<i>Festuca rubra</i> (var. <i>fallax</i>)	75
Creeping Red Fescue	<i>Festuca rubra</i> spp. <i>rubra</i>	80
Illinois Bundleflower	<i>Desmanthus illinoensis</i>	85
Kentucky Bluegrass	<i>Poa pratensis</i>	80
Ladino Clover	<i>Trifolium repens</i> (var. <i>latum</i>)	85*
Lemons Alkali Grass	<i>Puccinellia airoides</i> (Lemons)	80
Orchard Grass	<i>Dactylis glomerata</i>	80
Perennial Rye Grass	<i>Lolium perenne</i>	90
Purple Prairie Clover	<i>Dalea purpurea</i>	75
Red Fescue	<i>Festuca rubra</i>	85
Red top	<i>Agrostis gigantea</i>	80
Rye, Agricultural	<i>Secale cereale</i>	80
Rye, Annual	<i>Lolium multiforum</i>	90
Smooth Brome Grass	<i>Bromus inermis</i>	80
Tall Fescue	<i>Festuca arundinacea</i>	85
White Dutch Clover	<i>Trifolium repens</i>	90*
* including not more than 25% hard seeds.		

For all other seed indicated to be used but not shown in the charts above, that seed shall be placed at the indicated rate and be 100% pure live seed.

914.05 Mulch

(a) Mulch for Seeding

110 Mulch for seeding may consist of straw; excelsior mulch; wood cellulose fiber mulch; excelsior blanket; paper mat; or straw mat. All mulch shall be reasonably free from primary noxious weeds in accordance with 914.04.

1. Excelsior Mulch

Excelsior mulch shall consist of wood fibers cut from sound green timber. The average length of the fibers shall be 4 in. to 6 in. The cut shall be made in such a manner as to provide maximum strength of fiber, but at a slight angle to the natural grain of the wood so as to cause splintering of the fibers when weathering in order to provide adherence to each other and to the soil.

120

2. Wood Cellulose Fiber

Wood cellulose fiber mulch shall be made from wood chip particles manufactured particularly for discharging uniformly on the ground surface when disbursed by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed, and fertilizer when allowed, to form a homogeneous slurry. The mulch fibers shall intertwine physically to form a strong moisture holding mat on the ground surface. The mulch shall be heat processed so as to contain no germination

or growth inhibiting factors. It shall be non-toxic and colored green. The percent of moisture content shall be determined in accordance with 621.14(c), except material containing more than 15% will be rejected. The ash content shall not exceed 1.5%.

- 130 One hundred grams of oven dried material saturated in water, drained, and weighed shall hold a minimum of 1,000 grams of water.

3. Excelsior Blanket

- Excelsior blanket shall consist of a machine produced mat of wood excelsior with 80% of the fibers to be 6 in. or longer. The wood from which the excelsior is cut shall be properly cured to achieve curled and barbed fibers. The blanket shall have a consistent thickness, with the fibers evenly distributed over the entire area of the blanket. The excelsior blanket shall be covered on the top side with a 3 by 1 in. leno weave, twisted kraft paper yarn netting having a high wet strength, or a biodegradable
 140 extruded plastic mesh netting having an approximate minimum opening of 5/8 by 5/8 in. to an approximate maximum opening of 2 in. by 1 in. The netting shall be entwined with the excelsior mat for maximum strength and ease of handling. The minimum roll width shall be 4 ft. The mass of the material shall be not less than 0.7 lb/sq yd, constant mass, air dry. The rolls shall be packaged with suitable protection for outdoor storage on the project site in a manner which protects them from biodegradation prior to use.

4. Paper Mat

- Paper mat shall consist of a knitted construction of photodegradable, polypropylene yarn with uniform openings interwoven with strips of biodegradable
 150 paper. The rolls shall be packaged with suitable protection for outdoor storage at a construction site in a manner which protects them from biodegradation prior to use. The mass of the paper shall be a minimum of 0.125 lb/sq yd. Roll sizes shall have a minimum width of 5 ft.

5. Straw Mat

- Straw mat shall consist of a machine produced mat consisting of at least 90% of the total dry mass being clean straw from agricultural crops, with the exception that up to 30% of the total dry mass may be coconut fibers in lieu of an equal percentage of straw. Paper or paper related products shall not be allowed as component in the
 160 straw mat. The straw shall be evenly distributed throughout the mat to form a thickness of 1/2 in. \pm 1/8 in. The top side of the mat shall be covered with a photodegradable/biodegradable plastic mesh which shall be substantially adhered to the straw by a knitting process using photodegradable/biodegradable thread. The rolls shall be packaged with suitable protection for outdoor storage at a construction site in a manner which protects them from biodegradation prior to use. The average dry mass of the straw shall not be less than 0.7 lb/sq yd. The minimum roll width shall be 6 ft.

6. Compost Mulch

- Compost mulch shall consist of well-composted vegetable matter, leaves, yard
 170 trimmings, food scraps, composted manures, paper fiber, wood bark, class A bio-solids as defined in Title 40 of the Code of Federal Regulations at 40 CFR Part 503, or any combination thereof. Compost shall be produced using an aerobic composting process

in accordance with 40 CFR Part 503 regulations, including time and temperature data indicating effective weed seed pathogen, and insect larvae kill. Compost shall be well decomposed, stable, and weed free. Compost shall be refuse free by less than 1% by weight. Compost shall be free of any contaminants and materials toxic to plant growth. Inert materials shall not exceed 1% by dry weight, pH of 5.5 to 8.0. Carbon-nitrogen ratio shall not exceed 100. Moisture content shall not exceed 45% by dry weight. Variable particle size of the compost shall be a maximum dimension of 3 in. in length
 180 1/2 in. in width, and 1/2 in. in depth. Compost mulch shall not be used in storm water runoff channels or where concentrated flow is anticipated.

(b) Mulch for Plants

Mulch for plants shall consist of broken corncobs, wood chips, chopped bark, size No. 5 gravel, or crushed stone in accordance with 904.02(e), except 0% to 5% may pass the No. 200 (75 µm) sieve, or other approved materials. The particles of wood chips, chopped bark, and corncobs shall contain no more than 10% passing the 1/2 in. screen and 100% shall pass the 3 in. screen. Wood chips shall be from green, hardened, deciduous trees. Broken corncobs shall be no longer than 4 in.
 190

914.06 Leguminous Inoculants

The inoculants for treating leguminous seeds shall be standard pure culture of nitrogen fixing bacteria. They shall be no more than one year old at the time of use and shall be subject to approval. Directions of the manufacturer on containers of inoculants shall be followed when inoculating seed.

914.07 Sod

Sod shall consist of fibrous, well rooted, bluegrass, fescue, or other approved grass cut to a height of 2 to 3 in. Edges of sod shall be cut cleanly, either by hand or
 200 machine, to a uniform minimum thickness of 3/4 in. or more. The roots shall be exposed in the sod strip to allow the sod to be handled without undue tearing or breaking. The sod strip shall be of a uniform width of no less than 16 in. and no less than 2 ft in length. Sod shall be free from all primary noxious weeds in accordance with 914.04. Acceptance in the field before cutting shall not preclude rejection when delivered to the work if such contamination is found.

Nursery sod shall meet applicable requirements as set out above and shall be a variety or blend of Kentucky bluegrass or fescue. It shall comply with nursery inspections and plant quarantine regulations of the states of origin and destination as
 210 well as with Federal regulations governing interstate movement of nursery stock. A type C certification in accordance with 916 shall be provided for the sod.

914.08 Plant Materials

If the plant material is shown on the Schedule of Pay Items as plant, the Contractor shall submit its source of supply for each plant material for approval prior to delivery to the project site. This plant list shall include the name of the source of supply and the location where the plants were grown. A certification that the plants are available at this source, that the plants were grown at the prescribed location, and that there is a

220 firm commitment for their purchase at the time of certification shall be provided. These procedures shall be followed for approval of alternate sources when the originally approved source is unable to furnish plants at the time when needed. Plants shall be in accordance with the requirements set out herein. Unless otherwise specified, all plant material shall be acquired from zones 4, 5, or 6. However, plant material shall be acquired from zones no further than 1/2 zone south of the zone in which the project is located. Hardiness zones shall be determined from the Plant Hardiness Zone Map, Miscellaneous Publications No. 1475, Agricultural Research Service, United States Department of Agriculture, published by the U. S. Government Printing Office, Washington, D.C. The Contractor shall have a copy of this map.

230 If the plant material is shown on the Schedule of Pay Items as seedlings, the Contractor shall choose a source which is shown on the QPL of Seeding Sources. The QPL will specify the sources that are currently on an immediate use basis. If the source is not on the QPL, then the same procedure shall be followed as stated above for plants to obtain approval.

(a) Quality of Plant Material

240 All plants shall be first class and representative of the normal species or varieties, true to type, and standard form. Unless otherwise specified, all plants shall be nursery grown stock that had been transplanted or rootpruned two or more times according to the kind and size of plant. The root system shall be vigorous and well developed. The branch system shall be developed normally. All plants shall be free from disfiguring knots, sun-scald, injuries, abrasions of the bark, dead or dry wood, broken terminal growth, or other objectionable disfigurements.

(b) Plant Names

250 Plants shall be true to name, following standard botanical and common nomenclature as adopted by the American Joint Committee on Horticultural Nomenclature given in the current edition of Standardized Plant Names. All trees delivered shall be tagged legibly with the names and sizes of the trees.

All delivered shrubs shall be tagged legibly with the name and size of the shrub when "Tag Each" is indicated on the summary list. Otherwise, each bundle shall be tagged. If shrubs are separated individually when delivered, 20% of each species shall be tagged. A tag with the name and size of the shrub printed thereon shall be used for each species. A 1 in. band of non-toxic paint shall be applied to the stem of seedlings or "whips", prior to delivery, in lieu of tags. If tags are required, they shall remain attached to shrubs for the duration of the contract.

(c) Substitutions

260 Substitutions of plants in size and kind shall be made only after proper execution of a change order in accordance with 109.05 and then only when sufficient evidence has been shown that the specified stock could not be secured.

(d) Grading Standards

Grading of plants shall be in accordance with the American Association of Nursery Horticultural Standards of the current ASNS, ANSI Z 60.1 as revised herein and on the plans.

(e) Nursery Inspection and Plant Quarantine

270 All plants shall be free from plant diseases and insect pests. Shipments of plants shall be in accordance with nursery inspection and plant quarantine regulations of the states of origin and destination as well as with Federal regulations governing interstate movement of nursery stock. A valid copy of the certification of inspection shall accompany each package, box, bale, or carload shipped or otherwise delivered.

(f) Balled and Burlapped Plants

280 Balled and burlapped plants shall be dug so as to retain as many fibrous roots as possible and shall come from soil which forms a firm ball. The soil in the ball shall be the original and undisturbed soil in which the plant was grown and shall be free of noxious weeds and weed seeds. The plant shall be dug, wrapped, transported, and handled in such a manner that the soil in the ball will not be loosened enough to cause stripping of the small and fine feeding roots or cause the soil to drop away from such roots. Any indication of manufactured earth balls or mishandling of the plant will be cause for rejection. The shape and size of the ball shall be as specified in the ASNS as revised herein and shown on the plans.

(g) Container Grown Plants

290 Plants which are furnished in containers shall be well rooted and established in the container in which they were shipped. An established container grown plant shall be a plant transplanted into a container and grown in that container sufficiently long for the new fibrous roots to have developed so that the root mass retains its shape and holds together when removed from the container.

(h) Bare Rooted Plants

300 The minimum root system of bare rooted trees or shrubs shall be in accordance with the standards stated in the ASNS. Bare rooted plants shall be dug only when the air temperature exceeds 35°F. Particular attention shall be given to the fibrous roots. The maximum time lapse between loading for shipment and delivery to the work or approved storage site shall be four days unless other shipping arrangements are approved.

(i) Collected Plants

Collected plants, when specified in connection with any species or variety, shall not be nursery grown, but shall have been grown under natural conditions at the location from which they were procured. They may be balled and burlapped or bare roots as specified in the plant list on the plans. In either case, the collected material shall be in accordance with the applicable requirements given in the current issue of ASNS for quality, size, ball, and grade.

310 **(j) Forms, Shapes, and Condition of Plants**

Vines and groundcover plants shall be in accordance with grades and specifications shown in the ASNS unless otherwise specified.

Plants which have been cut back from larger grades to meet specifications will not be acceptable. Plants designated on the plans as street trees, specimen, extra heavy, clump, or of other like import shall be in accordance with the standards as given in the ASNS for the special type specified.

- 320 Trees shall have straight trunks, be well branched, and have symmetrical tops. There shall be no cuts of limbs over 3/4 in. in diameter which have not completely healed over. Each tree shall have the top and root characteristics of its variety and growth that are typical of such trees in this region. Deciduous trees, unless otherwise specified, shall have branching between 1/4 and 1/2 of the distance of their height from the ground. Street trees, if so specified, shall be of uniform branching height. Bush form, when specified, shall be branching at the base of the plant or within 12 in. of the base. Clumps, when specified, shall have three or more main leaders or trunks starting at the ground. At least two of these shall be of the caliber specified.

(k) Inspection

- 330 Plant materials shall be subject to inspection at any time during the life of the contract. Such inspection shall not be construed as final acceptance of the plants involved. Any stock which is not in accordance with these specifications will be rejected and shall be removed from the project.

Balled and burlapped plants may have the ball opened for inspection, at the option of the Department, to determine if the root system is sufficient to ensure plant growth. If after breaking open, the ball is found to be acceptable, payment for the destroyed plant will be made at 50% of the contract price for the plant involved.

- 340 Nursery stock may be inspected at the nursery before digging or shipping and sealed with Department seals. If not inspected and sealed at the nursery, it shall be done at a final collecting point at or adjacent to the project and prior to planting, unless otherwise specified in writing. Notification shall be made a minimum of three days in advance of delivery of unsealed plants. Large quantities of small plant material such as shrubs, seedlings, vines, and groundcovers shall be sealed in a satisfactory manner. Sealing of plants shall not be considered as final acceptance and shall not waive the responsibility to furnish, plant, and maintain material that complies with the specifications.

350 **(l) Shipment**

All precautions that are customary in good trade practice shall be taken to ensure the arrival of the plants in good condition. Plants shall be packed or covered in such a manner as to ensure adequate protection against damage while in transit. The roots of bare root plants shall be protected with wet straw or other suitable material to ensure the arrival at destination with the roots in a moist condition. When shipment is made

in an enclosed vehicle, the vehicle shall be adequately ventilated to prevent over heating of the plants in transit.

(m) Certification

360 Certifications from all plant supply sources shall be furnished certifying that all plants furnished are in accordance with 914.08. These certifications shall be submitted monthly and shall contain the information as indicated on the suggested form in ITM 804.

914.09 Miscellaneous Material

(a) Water

370 Water used in the planting or care of vegetation shall be free from oil, acids, alkalis, salts, or any substance injurious to plant life. Water from streams, lakes, ponds, or similar sources shall not be used unless approved.

(b) Stakes for Bracing and Anchoring

Wood stakes for bracing or supporting trees shall be of rough cypress, cedar, locust, oak, or other approved wood free from knots, rot, cross grain, or other defects that would impair the strength of the stake for which it is to be used. Wood stakes shall be a minimum of 2 in. by 2 in. square in cross section and of adequate length. The wood bracing stakes shall be painted or stained dark green. Delineator posts in accordance with 910.15 may be used except they shall be painted dark green.

380 An alternate staking and bracing method using a solid rubber support cord with metal hooks and stakes, and plastic stake disk system, may be used.

(c) Tree Wound Dressing

Dressing for treating tree wounds or cuts shall be either:

1. an approved black asphaltum base antiseptic paint;
2. an approved black paint consisting of Bordeaux Mixture, raw linseed oil, and lampblack; or
- 390 3. an approved black paint consisting of zinc oxide, raw linseed oil, and lampblack.

(d) Porous Material

Porous material for tree root protection may be gravel, crushed stone, slag, or other porous material varying in size from 1 to 3 in. and shall be approved before being used.

(e) Pipe

400 Pipe for underdrains shall be in accordance with 907 or 908. The size and type shall be as specified.

(f) Staples

Wire staples shall be made from No. 11 gauge (3 mm) or heavier wire, 1 or 2 in. wide at the throat and 6 in. from top to bottom after bending. Biodegradable staples shall be in accordance with ASTM D6400 and be 4 in. or longer with a head suitable for securing the fabric in place. The staples shall be packaged in cartons.

(g) Plastic Net

410 Plastic net shall consist of photodegradable, longchain synthetic polymer plastic yarn, either extruded oriented or woven into a net with the yarns fixed at each intersection such that they retain their relative positions with respect to each other. The plastic net shall have a square mesh opening of approximately 3/4 in. by 3/4 in. The plastic net shall have a minimum tensile strength of 20 lb over a 3 in. width in the machine direction and 15 lb over a 3 in. width in the transverse direction. The plastic net shall have a nominal mass of 2.8 ± 0.4 lb per 1,000 sq ft. The plastic net shall be furnished in rolls which can be easily handled and the rolls shall be packaged in a suitable protection for outdoor storage at a construction site, which protects the material from degradation prior to use. Roll sizes shall have a minimum width of 6 ft.

420

A type C certification in accordance with 916 shall be provided for the plastic net.

(h) Filter Sock

Filter socks for sediment control applications shall use a continuous tubular knitted mesh netting with 3/8 in. openings and constructed of 500 denier polypropylene. They shall be set in place using hardwood stakes of 1 by 2 in. or stakes of equivalent strength.

430 Where using socks with compost soil bark mixture as a filler, the Contractor shall use a continuous knitted mesh netting with 3/8 in. openings and constructed of 5 mil thickness of photodegradable HDPE.

Filler particle size shall not be greater than 3 by 1/2 by 1/2 in. and shall be capable of staying within the sock.

SECTION 915 – BRIDGE PILES AND BEARINGS**915.01 Steel Pipe Piles and Epoxy Coated Steel Pipe Piles****(a) General Requirements**

Steel pipe piles and epoxy coated steel pipe piles, as designated herein, shall consist of fluted steel, or rounded straight seamed, spiral seamed, or seamless steel pipes which, after being driven are filled with class A concrete. The steel pipe shall be uncoated unless an epoxy coating, in accordance with 915.01(d) is specified.

10

Pipe piles shall be of the diameter and minimum wall thickness shown on the

plans. All sections shall be one cylindrical integral piece except as otherwise required for end sections of the outside diameter specified. All pipe piles shall be of sufficient strength to withstand driving to the required penetration depth and nominal driving resistance.

If necessary to facilitate handling, pipe piles may be furnished in sections to be welded in the field to form the final integral lengths required.

- 20 The manufacturer shall provide a mill certification showing heat numbers and test results for the specified tests. Each pipe pile shall be stenciled to show the diameter, wall thickness, and heat numbers for the verification of the certifications. The certifications shall be delivered before the pipe piles are driven.

The end of pipe piles shall be equipped with conical pile tips or flat end plates. The welding used to attach the conical pile tips or flat end plates to the end of pipe piles shall be done by a welder qualified in accordance with 711.32.

1. End Plates

- 30 If end plates are used, they shall be flat, non-reinforced and a minimum thickness of 3/4 in. for pipe piles 12 in. outside diameter or smaller, and 1 in. thick for pipe piles greater than 12 in. outside diameter up to and including 14 in. For pipe piles larger than 14 in. outside diameter, the end plates shall be designed to complement the size of the pipe pile. End plates shall have a diameter approximately 1/2 in. greater than the outside diameter of the pipe pile and be fillet welded to the pipe pile, using two passes or beads.

2. Conical Pile Tips

- 40 Conical pile tips shall be of sufficient dimensions to ensure adequate joint and driving strength. The end of the pipe pile shall have full bearing on the face of the pile tip or against a shoulder inside the pile tip. Unless otherwise approved, the pile tip shall be conical with a 60 to 90° angle between faces. The pile tip shall be substantially of the same diameter as the end of the pipe pile and butt welded to the end of the lowest section.

(b) Fluted Steel Pipe Piles

- 50 Fluted steel pipe piles shall have a minimum tensile strength of 50,000 psi when tested in accordance with ASTM A370. Test specimens for determination of tensile strength shall be taken longitudinally adjacent to the crest of the flute. The diameter of fluted steel pipe piles shall be measured from crest to crest of flutes.

A sufficient taper will be allowed to enable no less than 6 in. telescoping at the joints. The lowest section shall taper approximately 1 in. in 4 ft from an 8 in. tip to the specified diameter of the upper end. Fluted steel pipe piles with a taper of 1 in. in 7 ft on the lowest section of long piles may be used provided a minimum of approximately 5 ft of the top of the pile below cutoff elevation is the full diameter as shown on the plans.

(c) Rounded Steel Pipe Piles

60 Rounded steel pipe piles, except for end finish, shall be in accordance with ASTM A252, grade 3. Welded pipe may be welded with straight or spiral seams.

(d) Epoxy Coating for Piles

Only powdered epoxy resin from the QPL of Epoxy Coating Materials shall be used for the epoxy coating of steel pipe piles and steel H piles.

The patching or repair material shall be compatible with the coating and shall be made available by the coating manufacturer. The material shall be suitable for repairs made to coated areas damaged during fabrication or handling.

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The coating color shall contrast with the color of iron oxide. All coated piles furnished for a structure shall be the same color. The patching or repair material shall also be the same color as the original coating material.

1. Prequalification of Organic Coatings for Steel Piles

The coating product shall be a 100% solids, heat curable, thermosetting, dry powdered epoxy coating. Coating manufacturers who request to have their product added to the QPL of Epoxy Coating Materials shall supply the information as follows.

80

a. Product Data Sheet

A product data sheet which shall specify the method of surface preparation, the thermal treatments before and after coating application, the coating application procedure, and the product name and description of the patching material shall be provided.

b. Fingerprint

The fingerprint shall include the method of test, such as infrared spectroscopy or thermal analysis, and a generic description of the product.

90

c. Materials Safety Data Sheet

Current materials safety data sheets shall be supplied for the product and the patching material.

d. Laboratory Report

A dated laboratory report shall be provided which substantiates full compliance with the following test requirements.

(1) Tensile Strength and Elongation

100 The tensile strength and elongation of the coating material shall be tested in accordance with ASTM D2370 with a rate of elongation of 10% to 20% per minute. The minimum tensile strength shall be 8,000 psi. The minimum elongation shall be 5%.

(2) Impact Resistance

The impact resistance of the coating shall be tested in accordance with ASTM G14 using a 0.03 mm minimum coating thickness of a 3.2 mm thick panel at 23°C. Three tests shall be performed. The minimum acceptable value shall be 9.0 N m. of impact with no visible breaks in the coating.

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(3) Abrasion Resistance

The abrasion resistance of the coating shall be tested in accordance with the Annex to ASTM A972.

(4) Salt Fog

The weathering resistance of the coating shall be tested by means of a salt spray cabinet following ASTM B117 for 1,000 h. The coating shall not blister or exhibit corrosion, discoloration, or loss of adhesion away from the scribed area.

2. Application

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The application of the epoxy coating shall be at an enclosed plant, equipped with environmental controls and automated blasting equipment. This equipment shall facilitate surface preparation and coating application in accordance with the manufacturer's recommendations and in accordance with additional requirements set out herein. The application process shall be performed by a continuous, balanced system where cleaning of the surface and application of the coating are performed at the same rate.

a. Surface Preparation

130

The pile surface shall be blast cleaned in conformance with SSPC-SP-10, Near White Metal Blast. The cleaning media shall produce an anchor pattern profile of 2 mils minimum. All raised slivers, scabs, laminations or bristles of steel remaining on the newly cleaned surface shall be removed by means of abrasive sanders. All traces of grit and dust from the blasting shall be removed.

b. Coating Application

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The coating shall be applied immediately to the cleaned surface and before visible oxidation of the surface occurs. The coating shall be applied in accordance with the manufacturer's recommendations. The recommendations shall address the equipment required for proper application, the number of coats of epoxy, cure time between coats, cure time before placing in service, and all other information needed by the Department to ensure proper performance of the material.

(1) Thickness

Thickness of the cured coating shall be measured on a representative number of piles from each production lot by the same method required by ASTM G12 for measurement of film thickness of pipeline coatings on steel. The minimum coating thickness for fusion bonded epoxy shall be 8.0 mils for individual measurements and 12 mils for the average.

150

(2) Cure

The coating film shall be cured and post cured in accordance with the manufacturer's recommendations. A representative proportion of each production lot shall be checked by the coating applicator using a method found most effective for measuring cure to ensure that the entire production lot is in a fully cured condition.

(3) Continuity of Coating

160 After cure, the epoxy coating shall be checked by the applicator for continuity of coating and shall be free from holes, voids, contamination, cracks, and damaged areas. There shall not be more than two holidays, which are pinholes not visually discernable, in any linear foot of the coated pile. A holiday detector in accordance with ASTM A972 shall be used in accordance with the manufacturer's instructions to check the coatings for holidays.

3. Certification

170 A type C certification in accordance with 916 shall be provided for the epoxy coating. In addition, a certificate of compliance prepared by the applicator shall be provided for each shipment of coated piles. The certificate of compliance shall state that the piles have been coated in accordance with the manufacturer's requirements; that thickness, continuity, and flexibility tests of the coating have been performed; and that the test results are in accordance with the requirements outlined herein. Test results shall be retained by the applicator and made available for inspection upon request for a period of seven years.

915.02 Steel H Piles and Epoxy Coated Steel H Piles

180 Steel H piles and epoxy coated steel H piles shall be of the shape and dimensions shown on the plans or as otherwise specified. The steel shall be in accordance with ASTM A572, grade 50. Steel H piling shall be handled in the same manner as required in 711.56. The piles shall be uncoated unless an epoxy coating, in accordance with 915.01(d), is specified.

The manufacturer shall provide a mill certification showing heat numbers and test results for the specified tests. Each H pile shall be stenciled to show the manufacturer's name, the specifications, size and mass of section, and heat numbers for verification of the certification. The certification shall be submitted at the time of delivery of the piles.

915.03 Pile Shoes

190 A type C certification in accordance with 916 shall be provided for the steel H pile shoes. Pile shoes shall be cast-in-one-piece steel in accordance with ASTM A148, grade 80-50 and shall be fastened to the piles by welding in accordance with the manufacturer's recommendations. They shall have sufficient flange and continuous web vertical back-ups to assure proper alignment and fitting to the pile. Either the pile shoe or the outside of each flange of the pile shall be beveled 45°. E70XX welding rods shall be used. All welds shall be made in the flat position and the welder shall be qualified in accordance with 711.32.

200 A type C certification in accordance with 916 shall be provided for the timber pile shoes. Pile shoes shall be cast-in-one-piece steel in accordance with ASTM A27, grade 65-35, class 2 or grade 70-36, class 2 and shall be fastened to the piles in accordance with the manufacturer's recommendations.

The soil or rock bearing surfaces of the shoes shall be sloped downward towards the web a minimum of 15° but not to exceed 45° to the horizontal under the flanges. The sloped surfaces of the shoes shall terminate so as to form a flat surface not exceeding 1/3 of the flange width. The surfaces may have individual or continuous cutting teeth.

915.04 Elastomeric Bearings

210 (a) Description

Elastomeric bearings as herein specified shall include plain bearings, consisting of elastomer only, and laminated bearings, consisting of layers of elastomer restrained at their interfaces by bonded laminates. The bearing type shall be as shown on the plans.

(b) Materials

1. Elastomer

220 Elastomeric bearing pads shall be made from elastomeric materials and shall be steel reinforced as shown on the plans. They shall be in accordance with Articles 18.1 and 18.2 of the AASHTO LRFD Bridge Construction Specifications and AASHTO M 251 with the exception that Table X1 is not applicable. The elastomer portion of the elastomeric compound shall be 100% virgin natural polyisoprene known as natural rubber, or 100% virgin polychloroprene known as neoprene. The cured compound shall be in accordance with Table A for natural rubber, or Table B for neoprene, depending on which type is furnished.

TABLE A
230 POLYISOPRENE, OR NATURAL RUBBER, QUALITY CONTROL TESTS

PHYSICAL PROPERTIES		
ASTM D2240	Hardness (Durometer type A)	55 ±5
ASTM D412	Tensile Strength, Min., ksi	2.25
	Ultimate Elongation, Min. %	425
HEAT RESISTANCE		
ASTM D573, 70 h, @ 158°F	Change in Durometer Hardness, Max. Points	10
	Change in Tensile Strength, Max. %	-25
	Change in Ultimate Elongation, Max. %	-25
COMPRESSION SET		
ASTM D395, Method B	22 h @ 158°F, Max. %	25
OZONE		
ASTM D1149	25 ppm ozone in air by volume, 20% strain, 100°F ±2°F, 48 h mounting procedure, D 518, Procedure A	No Cracks
LOW-TEMPERATURE BRITTLENESS		
ASTM D746, Procedure 9.1.2	Grades 0 and 2	
	Grade 3, Brittleness @ -40°F	No Failure
INSTANTANEOUS THERMAL STIFFENING		
ASTM D1043	Grades 0 and 2, Tested @ -32°C	Stiffness at test temperature shall not exceed four times the stiffness measured at 74°F.
	Grade 3, Tested @ -40°F	
LOW-TEMPERATURE CRYSTALLIZATION		
Quad Shear Test as Described	Grade 3, 14 Days @ -15°F	Stiffness at test time and temperature shall not exceed four times the stiffness measured at 74°F with no time delay. The stiffness shall be measured with a quad shear test rig in an enclosed freezer unit. The test specimens shall be taken from a randomly selected bearing. A ±25% strain cycle shall be used. A complete cycle of strain shall be applied within a period of 100 s. The first 0.75 cycle of strain shall be discarded. The stiffness shall be determined by the slope of the force deflection curve for the next 0.50 cycle of loading.

**TABLE B
POLYCHLOROPRENE, OR NEOPRENE, QUALITY CONTROL TESTS**

PHYSICAL PROPERTIES		
ASTM D2240	Hardness (Durometer type A)	55 ±5
ASTM D412	Tensile Strength, Min., ksi	2.25
	Ultimate Elongation, Min. %	375
HEAT RESISTANCE		
ASTM D573, 70 h, @ 212°F	Change in Durometer Hardness, Max. Points	15
	Change in Tensile Strength, Max. %	-15
	Change in Ultimate Elongation, Max. %	-40
COMPRESSION SET		
ASTM D395, Method B	22 h @ 212°F, Max. %	35
OZONE		
ASTM D1149	25 ppm ozone in air by volume, 20% strain, 100°F ±2°F, 48 h mounting procedure, D 518, Procedure A	No Cracks
LOW-TEMPERATURE BRITTLENESS		
ASTM D746, Procedure 9.1.2	Grade 3, Brittleness @ -40°F	No Failure
INSTANTANEOUS THERMAL STIFFENING		
ASTM D1043	Grade 3, Tested @ -40°F	Stiffness at test temperature shall not exceed four times the stiffness measured at 74°F.
LOW-TEMPERATURE CRYSTALLIZATION		
Quad Shear Test as Described	Grade 3, 14 Days @ -15°F	Stiffness at test time and temperature shall not exceed four times the stiffness measured at 74°F with no time delay. The stiffness shall be measured with a quad shear test rig in an enclosed freezer unit. The test specimens shall be taken from a randomly selected bearing. A ±25% strain cycle shall be used. A complete cycle of strain shall be applied within a period of 100 s. The first 0.75 cycle of strain shall be discarded. The stiffness shall be determined by the slope of the force deflection curve for the next 0.50 cycle of loading.

The bond strength, determined in accordance with ASTM D429, Method B, shall be at least 40 lb/in.

The adhesion failure, determined in accordance with ASTM D429, Method B, shall be at least R-80. The adhesion-failure requirement will be waived if the bond strength is at least 80 lb/in.

2. Structural Steel

Structural steel spacer plates, top and bottom load plates, and other steel components, including anchor bolts, exposed to the environment shall be galvanized in accordance with AASHTO M 111, zinc metallized with a coating of 7 mils in accordance with SSPC-CS 23.00, or painted with the structural steel coating system in accordance with 619.09(a). The finish coat for painted steel shall be in accordance with 909.02(d). The color shall be in accordance with SAE-AMS-STD-595, color No. 20045.

250

When stainless steel load plates are specified, the material shall be in accordance with ASTM A240, type 304.

3. Internal Steel Shims

Internal steel shims shall be rolled hot and cold steel and shall be in accordance with AISI 1015 through 1025, ASTM A1008, or ASTM A1011 grade 36 or higher. Shims shall be of the thickness specified with a tolerance of ± 0.015 in.

4. Threaded Stud

Threaded studs, where required, shall be in accordance with ASTM A307 and mechanically zinc coated in accordance with ASTM B695, class 50.

260

5. Side Retainer

Side retainers shall be made from plates or rolled mild steel in accordance with ASTM A36.

(c) Manufacturing Requirements

Plain bearings may be molded individually, cut from previously molded strips or slabs, or extruded and cut to length. Cut edges shall be at least as smooth as ANSI B 46.1 No. 250 finish. Unless otherwise shown on the plans, all components of a laminated bearing shall be molded together into an integral unit. Air bubbles within the elastomeric material shall be cause for rejection.

270

Laminated elastomeric bearings shall be individually molded to the required size. Corners and edges may be rounded with a radius at the corners not exceeding $3/8$ in. and a radius at the edges not exceeding $1/4$ in.

Steel shims shall be sandblasted and cleaned and protected against contaminants until fabrication is completed.

280

Bearings designed as a single unit shall be built as a single unit.

Each reinforced bearing shall be marked with indelible ink or flexible paint. The

marking shall consist of the orientation, the order number, lot number, bearing identification number, and elastomer type and grade number. Unless otherwise specified, the marking shall be on a face that is visible after erection of the bridge.

Where load plates are shown on the plans, the bearing shall be vulcanized to the steel load plate during the primary molding process.

290

(d) Appearance and Dimensions

The edges of the embedded steel laminates, including around holes, shall be covered with 1/8 to 1/4 in. of elastomer. All other dimension tolerances shall be in accordance with AASHTO M 251.

(e) Quality Assurance

The mechanical properties of the materials and of the finished bearing shall be in accordance with the AASHTO LRFD Bridge Construction Specifications, Article 18.2.5, and AASHTO M 251, with the exception that the tables in 915.04(b)1 shall be used.

300

1. Compressive strain of any layer of an elastomeric bearing shall not exceed 7% at 800 psi average unit pressure or at the design dead load plus live load pressure if so indicated on the plans.
2. The shear resistance of the bearing shall not exceed 40 psi for 55 durometer, table A compounds; or 75 psi for 55 durometer, table B compounds at 25% strain of the total effective rubber thickness after an extended four-day ambient temperature of -20°F.

310

(f) Certification

A type B certification in accordance with 916 shall be provided for the elastomeric bearings. The limits of the following shall be shown on the certification.

TEST	ASTM, or INDOT Standard Specifications
Ultimate Tensile Strength	D412
Ultimate Elongation	D412
Hardness (Durometer)	D2240
Tensile Strength and Elongation on Oven-aged Material	D573 and D412
Hardness on Oven-aged Material	D573 and D2240
Compression Set	D395, Method B
Ozone Resistance	D1149
Adhesion	D429, Method B
Brittleness	D746, Procedure 9.1.2
Compressive Strain	915.04(e)1
Shear Resistance	915.04(e)2

When steel components are incorporated into elastomeric bearings, a mill certification, galvanization certification, if applicable, and a Buy America Certification in accordance with 106.01(c) will be required.

320 In addition, one bearing pad from each type to be furnished for the structure will be required for laboratory testing. A type of bearing is defined by the length, width, and thickness of elastomer, and the number and thickness of internal shims. Bearings that differ by the dimensions of load plates vulcanized to similar elastomeric pads will also be considered different types. The material may be sampled prior to shipment to the project, provided suitable arrangements can be made through the Department's Division of Materials and Tests. Materials not previously sampled and approved for use shall be sampled after delivery to the project site. Samples shall be furnished at least 30 days before date of use.

330 **915.05 Bearing Assemblies with Polytetrafluoroethylene, PTFE, Sliding Surfaces**

A copy of the manufacturer's design manual shall be submitted for approval when directed.

All steel components shall be in accordance with ASTM A709, grade 36 unless otherwise shown on the plans. Where these assemblies are to be used in conjunction with a self-weathering steel bridges, the steel components shall be in accordance with ASTM A709, grade 50W. Stainless steel mating surfaces shall be 14 gauge minimum ASTM A240, type 304 sheets with a maximum surface roughness of 20 Rms.

340 The PTFE shall be 100% virgin unfilled polymer or 15% glass filled and etched on the bonding side. The properties of the PTFE shall be in accordance with the following:

Requirement	Test Method	Value
Tensile Strength, minimum	ASTM D638	2,500 psi
Elongation, %, minimum	ASTM D638	200
Specific Gravity	ASTM D792	2.1 to 2.3

PTFE, where required, shall be virgin material, etched on the bonding face and in accordance with ASTM D 4894. The PTFE shall be bonded to grit blasted steel in accordance with Federal Specification MMM-A-134, Type 1. The elastomeric pad shall be vulcanized to the steel load plate during the primary molding process. The stainless steel sliding plate shall be seal welded to the steel load plate.

350

All steel surfaces exposed to the environment shall be zinc metalized and shall be 7 mils thick in accordance with SSPC-CS 23.00, or painted in accordance with 619.09(a). The finish coat for painted steel shall be in accordance with 909.02(d). The color shall be in accordance with SAE-AMS-STD-595, color No. 20045.

A type B certification in accordance with 916 shall be provided for the bearing assemblies. The limits of the above shall be shown on the certification.

SECTION 916 – MATERIALS CERTIFICATIONS

916.01 General

Materials certifications will be required for certain materials in accordance with various sections of these specifications and other contract documents. Unless otherwise specified or directed, one copy of each certification shall be submitted prior to use of the material. All certifications shall be signed by a person having legal authority to bind the company preparing the certification.

- 10 The contract number, name of the Contractor, destination to which the material covered by the certification is consigned, and name and quantity of material represented shall be shown on all copies of the certification. Identifying information such as alloy, grade, type, class, or other similar designation shall also be shown when applicable.

Any material received on the project for which certification has been furnished may be sampled and tested. If the results of the tests are in disagreement with the certification, the test results shall prevail and further acceptance by certification from the manufacturer of the material concerned may be suspended.

20

916.02 Types of Certifications

Certifications shall be type A, type B, type C, type D, or as required under other types. When specified, the type of certification provided for a material shall be in accordance with the Frequency Manual except as otherwise specified. Specific information and test results required in type A, type B, and other types of certifications will be listed in the material specifications. Sample forms for type A, type B, type C, and type D certifications are shown in 916.03. Sample forms for other type certifications are shown in 916.03 or ITM 804.

30

(a) Type A

Type A certification shall be prepared by the manufacturer. It shall consist of a certified copy of a laboratory report which lists results of the specified tests and shall certify that the materials furnished comply with the specifications. The applicable specification shall be referred to in the certification. The tests may be conducted in the laboratory of the manufacturer or in another qualified laboratory. Such tests shall have been conducted on samples obtained from the lot or lots of material in the shipment.

(b) Type B

- 40 Type B certification shall be prepared by the manufacturer. It shall show the limits of test values for the specified tests and shall certify that the materials furnished comply with the specifications. The applicable specification shall be referred to in the

certification. The tests may be conducted in the laboratory of the manufacturer or in another qualified laboratory.

(c) Type C

Type C certification shall be prepared by the manufacturer and shall certify that the materials furnished are in accordance with the specifications. The applicable specification shall be referred to in the certification.

50

(d) Type D

Type D certification shall be prepared by the Contractor and shall certify that the materials furnished are in accordance with the specifications. The applicable specification shall be referred to in the certification. A type D certification shall be used for product identification. It may be required to certify that the material is in accordance with minimum trade standards.

(e) Other Types

60

Types of certifications other than type A, B, C, and D are specified for selected materials. The requirements for a certification, other are described in the respective material's specification. A sample is shown in ITM 804.

(f) Requirements for Small Quantities of Materials

Where circumstances warrant and previously approved material is not available, small quantities may be accepted either by a type D certification or by an affidavit from the supplier stating that the material offered is equal to that specified.

(g) Buy America Requirement

70

All steel and cast iron materials and products used in the contract shall be certified to be in accordance with 106.01(c).

916.03 Sample Forms

(a) For Buy America Requirement

BUY AMERICA CERTIFICATION

80

In accordance with Indiana Department of Transportation Specification 106.01(c), I hereby certify that all steel and cast iron materials and products were produced and manufactured in the United States of America or territories subject to its jurisdiction.

CONTRACT NUMBER _____

PROJECT NUMBER _____

CONTRACTOR'S NAME _____

MANUFACTURER'S NAME _____

90 B/L or INVOICE NUMBER _____

This is to certify that for the contract described above, the materials supplied are as follows:

** Material Name	Quantity
_____	_____
_____	_____

100 _____	_____
Date	Company of Manufacture

* _____
* Signature of Company Official/Title

_____	_____
Date	Contractor

Signature of Contractor Official/Title

110 * This Certification shall be prepared by the manufacturer of the material being supplied for this contract.

** Identifying information such as Alloy, Grade, Type, Class, or other similar designation shall also be shown when appropriate.

(b) Sample Type A Certification Form

INDIANA DEPARTMENT OF TRANSPORTATION

120 TYPE A CERTIFICATION OF COMPLIANCE

CONTRACT NUMBER _____

PROJECT NUMBER _____

CONTRACTOR'S NAME _____

MANUFACTURER'S NAME _____

130 B/L or INVOICE NUMBER _____

This is to certify that for the contract described above, the materials supplied are as follows:

916.03

** Material Name

Quantity

*** Conform to: _____

140

The materials listed above comply with the following Test Methods and are within the acceptable limits of said Test Methods:

TEST METHOD	LIMITS OF TEST VALUE	ACTUAL TEST RESULTS
_____	_____	_____
_____	_____	_____
_____	_____	_____

150

Date

Company of Manufacture

* Signature of Company Official/Title

* This Certification shall be prepared by the manufacturer of the material being supplied for this contract.

** Identifying information such as Alloy, Grade, Type, Class, or other similar designation shall also be shown when appropriate.

*** Applicable material specification reference shall be listed.

160

(c) Sample Type B Certification Form

INDIANA DEPARTMENT OF TRANSPORTATION

TYPE B CERTIFICATE OF COMPLIANCE

CONTRACT NUMBER _____

170 PROJECT NUMBER _____

CONTRACTOR'S NAME _____

MANUFACTURER'S NAME _____

B/L or INVOICE NUMBER _____

This is to certify that for the contract described above, the materials supplied are as follows:

180

** Material Name	Quantity
_____	_____
_____	_____

*** Conform to: _____

The materials listed above comply with the following Test Methods and are within the acceptable limits of said Test Methods.

190

TEST METHOD	LIMITS OF TEST VALUE
_____	_____
_____	_____
_____	_____

_____	_____
Date	Company of Manufacture

* _____
* Signature of Company Official/Title

200

- * This Certification shall be prepared by the manufacturer of the material being supplied for this contract.
- ** Identifying information such as Alloy, Grade, Type, Class, or other similar designation shall also be shown when appropriate.
- *** Applicable material specification reference shall be listed.

(d) Sample Type C Certification Form

210 CONTRACT NUMBER _____

PROJECT NUMBER _____

CONTRACTOR'S NAME _____

MANUFACTURER'S NAME _____

B/L or INVOICE NUMBER _____

220 This is to certify that for the contract described above, the materials supplied are as follows:

**Material Name	Quantity
_____	_____
_____	_____

*** Conform to: _____

230

_____ Date _____ Company of Manufacture

* Signature of Company Official/Title

* This Certification shall be prepared by the manufacturer of the material being supplied for this contract.

** Identifying information such as Alloy, Grade, Type, Class, or other similar designation shall also be shown when appropriate.

*** Applicable material specification reference shall be listed.

240

(e) Sample Type D Certification Form

CONTRACT NUMBER _____

PROJECT NUMBER _____

MANUFACTURER'S NAME _____

250 This is to certify that for the contract described above, the materials supplied are as follows:

**Material Name	Quantity
_____	_____
_____	_____

*** Is in accordance with: _____

260

_____ Date _____ Contractor

* Signature of Contractor Official/Title

* This Certification shall be prepared by the Contractor.

** Identifying information such as Alloy, Grade, Type, Class, or other similar designation shall also be shown when appropriate.

*** Applicable material specification reference shall be listed. Otherwise, a statement shall be provided that the material supplied is in accordance with minimum trade standards.

270

(f) Sample Asbestos Exclusion Letter

Prior to acceptance of work and final payment, the Contractor shall submit to the Engineer for each building or bridge, on the Contractor’s letterhead, a signed, dated copy of the following letter. The Engineer will be responsible for the distribution of the letter.

ASBESTOS EXCLUSION LETTER

280 _____
Date

work address of Engineer for Indiana Department of Transportation

ATT: _____
Name, Project Engineer/Supervisor

290 Re: Asbestos Exclusion
Location/Description _____
Contract Number _____
Bridge Structure Number _____
Contractor’s Name _____

Dear Engineer:

I hereby certify that to the best of my knowledge no asbestos containing material was used as a building material in this project.

300 Very truly yours,

Signature of Contractor official

Title of Contractor official

310 cc: District Bridge Inspection Engineer
Environment, Planning and Engineering Division Chief
Project File

(g) Sample Type Other Certification Form

SEED CERTIFICATION

This is to certify that the seed mixture supplied, _____, by
(name of seed mixture)

320 _____ (Manufacturer's Name) _____ (source code)

located in _____, _____
(City) (State)

manufactured at _____
(Location of Manufacturing Plant)

and has Case Review Number _____ meets INDOT Standard Specifications.

330 Attached are copies of the State Seed Commissioner’s Letter and test reports for each lot of seed used in the above-mentioned seed mixture.

Seed Species	Lot No.	Seed Expiration Date
<<All seed species contained in the seed mixture shall be listed in this space. >>		

I understand that State and/or Federal funds are involved in the work in which this material will be used and that any misrepresentation on my part constitutes fraud.

(Date) (Signature of Company Official)

340 This _____ pounds of seed mixture. _____ is being provided by
(name of seed mixture)

_____, for INDOT Contract No. _____
(Name of Contractor)

(Date) (Signature of Contractor)

350

SECTION 917 – QUALITY ASSURANCE AGGREGATE CERTIFICATION

917.01 General Requirements

An aggregate source will be authorized to ship products in the status of a Certified Aggregate Producer who is in accordance with the required standards of ITM 211. This will consist of a program which will require the aggregate source to make a commitment to product quality management. Approval to participate in the program will be based on the following criteria.

- 10 (a) existence of suitable materials in the deposit being mined;
- (b) facilities capable of consistently processing uniform materials in accordance with the specification requirements; and
- (c) a source Quality Control Plan which will ensure that the mineral aggregates have a 95% assurance of being in accordance with the Department's quality and uniformity requirements.

20 Specific details of the CAPP are contained in ITM 211. Additional details about the program are included in the CAPP Training Manual for Producer Technicians. A Certified Aggregate Producer shall operate in accordance with both of these publications.

917.02 Quality Control Plan

30 An aggregate source will not be included on the QPL of Certified Aggregate Producers until it has prepared a Quality Control Plan and the plan has been approved. The plan shall encompass all details of production starting with the extraction of the indigenous raw materials and concluding with material shipped from the plant. The Quality Control Plan shall be prepared in accordance with the requirements of ITM 211.

917.03 Source Approval Requirements

The Department's Division of Materials and Tests shall be notified in writing that the aggregate source wants to become a Certified Aggregate Producer. The aggregate source shall identify the specific products for which approval is sought. Such list shall include all of the products to be produced at the source regardless of whether the products are for Department or other uses.

40 An aggregate source may not be considered for entry into the certification program until the preliminary source investigation has been completed in accordance with ITM 203.

The following procedure will be used to establish an aggregate source as a Certified Aggregate Producer.

(a) Step 1

The source shall enter the coordinated testing phase of ITM 211. Coordinated

testing shall be performed in accordance with ITM 211. During this phase, the
 50 producer shall be required to develop a Quality Control Plan to establish demonstrated
 mean test values and standard deviations.

(b) Step 2

The aggregate source shall enter the trial phase. The producer shall also operate
 in accordance with ITM 211 and the Quality Control Plan. The Quality Control Plan
 shall be refined as may be necessary.

(c) Step 3

60 The aggregate source will be included on the QPL of Certified Aggregate
 Producers following satisfactory performance during the trial phase. Achieving such
 status shall be accompanied by the inherent responsibility to operate within the tenets
 of ITM 211. The Certified Aggregate Producer shall produce material at a compliance
 requirement of effectively 95% of the appropriate specifications. The Department will
 monitor such compliance through the use of periodic in-depth inspections of the
 production site. Continuing approval is contingent upon the effectiveness of the
 producer's Quality Control Plan as evidenced by the quality and uniformity of the
 products which are prepared in accordance with the appropriated specifications and
 ITM 211.

917.04 Removal from Certified Producer Status

70 The Department's Division of Materials and Tests will be responsible for the
 review and removal of an aggregate source from being an approved Certified
 Aggregate Producer. A Certified Aggregate Producer shall operate so as to avoid a
 need for the Department to exercise this action. However, removal from Certified
 Aggregate Producer status may be necessary for situations such as:

- (a) the statistical probability of the product compliance has fallen
 below 90%;
- 80 (b) the product has a 90% to 95% probability of compliance but the
 producer has failed to take corrective action to restore 95%
 probability;
- (c) the Certified Aggregate Producer has failed to take immediate
 corrective action relative to deficiencies in the performance of the
 approved Quality Control Plan;
- (d) evaluation of data has demonstrated an inability of the Certified
 Aggregate Producer to consistently be in accordance with
 Department requirements;
- 90 (e) the Certified Aggregate Producer has deliberately shipped
 aggregate material which is not in accordance with the
 specifications, or has falsified records; or

- (f) the production site has not been operated in accordance with the Summary of Production or Ledge Quality Results letter.

100 Notice of removal from Certified status will be in written form, will be issued by the Department's Division of Materials and Tests, and will identify the reasons for the removal. Effective immediately upon receipt of such notification, no further aggregate shipments shall be made on a certified basis.

917.05 Appeals

The producer shall have the right to appeal removal from Certified Producer status to the Engineer. The appeal shall be in written form, shall state the reason or reasons on which the appeal is based, and shall be received within 14 calendar days of receipt of the removal notice.

SECTION 918 – GEOSYNTHETIC MATERIALS

918.01 General Requirements

Geosynthetics are polymer based products used for separation, filtration, reinforcement, liquid containment, soil and aggregate confinement, and many other soil related purposes within many conventional civil engineering structures. When appropriate, the Department will require the use of geosynthetics meeting the categories and characteristics indicated below.

- 10 A manufacturer requesting that a geosynthetic be added to the QPL shall submit the required documents in accordance with ITM 806 to the Department's Division of Materials and Tests.

918.02 Geotextile

- 20 The geotextile shall be either non-woven or woven and consist of at least 85% long-chain synthetic polymers. The geotextile shall contain stabilizers or inhibitors added to the base polymer mix to make the filaments and yarns resistant to deterioration caused by ultraviolet radiation exposure. The geotextile shall be produced such that the yarns and fibers retain their relative positions. The non-woven geotextile shall be needle punched, heat bonded or resin bonded.

All damaged geotextile shall be replaced for the entire width of the roll. The Contractor shall furnish the product labeled that clearly indicates the manufacturer's or supplier's name, product identification, lot number, manufactured date, and roll dimensions. Geotextiles used for Department projects shall be NTPEP listed and shall be in accordance with AASHTO M 288 and the QPL of Geosynthetic Materials. Geotextiles will be placed and maintained on the QPL in accordance with ITM 806.

- 30 The geotextile shall meet the following requirements:

(a) Geotextile Properties for Riprap and Revetment Applications

Test	Method, ASTM	Requirements ⁽¹⁾				
		Type 1A	Type 1B	Type 2A	Type 2B	Type 3
Grab Tensile Strength, min.	D4632	200 lb	200 lb	250 lb	300 lb	250 lb
Grab Elongation	D4632	> 50%	< 50%	> 50%	< 50%	< 50%
CBR Puncture Strength, min.	D6241	500 lb	600 lb	625 lb	1,000 lb	875 lb
Trapezoid Tearing Strength, min.	D4533	80 lb	75 lb	100 lb	150 lb	60 lb
Deterioration in Tensile Strength due to UV Degradation 500 hrs, min.	D4355 D6637	70% strength retained	70% strength retained	70% strength retained	70% strength retained	90% strength retained
Apparent Opening Size, AOS	D4751	≤ No. 80 sieve, for soils ≥ 40% passing the No. 200 sieve	≤ No. 40 sieve, for soils < 40% passing the No. 200 sieve	≤ No. 100 sieve, for soils ≥ 40% passing the No. 200 sieve	≤ No. 40 sieve, for soils < 40% passing the No. 200 sieve	≤ No. 70 sieve
Permittivity	D4491	≥ 1.2 sec ⁻¹	≥ 2.1 sec ⁻¹	≥ 0.80 sec ⁻¹	≥ 0.90 sec ⁻¹	0.28 sec ⁻¹
Note: ⁽¹⁾ All values are minimum average roll values (MARV) as determined in accordance with ASTM D4354 in the weaker principal direction, except AOS size is based on maximum average roll value.						

(b) Geotextile Properties for Underdrains and Drainage Applications

Test	Method, ASTM	Requirements ^{(1) (2)}				
		Type 1A	Type 1B	Type 2A	Type 2B	Type 3
Grab Tensile Strength, min.	D4632	80 lb	200 lb	160 lb	200 lb	200 lb
Grab Elongation	D4632	> 50%	< 50%	> 50%	< 50%	< 50%
CBR Puncture Strength, min.	D6241	175 lb	600 lb	410 lb	750 lb	1,100 lb
Deterioration in Tensile Strength due to UV Degradation 500 hrs, min.	D4355 D6637	70% strength retained	70% strength retained	70% strength retained	70% strength retained	90% strength retained
Apparent Opening Size, AOS	D4751	≤ No. 50 sieve, for soils ≥ 40% passing the No. 200 sieve	≤ No. 40 sieve, for soils < 40% passing the No. 200 sieve	≤ No. 70 sieve, for soils ≥ 40% passing the No. 200 sieve	≤ No. 30 sieve, for soils < 40% passing the No. 200 sieve	≤ No. 40 sieve
Permittivity	D4491	≥ 1.2 sec ⁻¹	≥ 2.1 sec ⁻¹	≥ 0.8 sec ⁻¹	≥ 0.9 sec ⁻¹	0.90 sec ⁻¹
Notes:						
⁽¹⁾ All values are minimum average roll values (MARV) as determined in accordance with ASTM D4354 in the weaker principal direction, except AOS size is based on maximum average roll value.						
⁽²⁾ Type 3 value is a maximum average roll value (Max ARV) as determined in accordance with ASTM D4354.						

(c) Geotextile Properties for Pavement or Subgrade Stabilizations

40

Test	Method, ASTM	Requirements ⁽¹⁾			
		Type 1A	Type 1B	Type 2A	Type 2B
Grab Tensile Strength, min.	D4632	200 lb	300 lb	290 lb	400 lb
Wide Width Tensile , @ 5% Strain, min.	D4595	n/a	n/a	1,200 lb/ft	2,400 lb/ft
Grab Elongation	D4632	≤ 50%	< 50%	≤ 50%	< 50%
CBR Puncture Strength, min.	D6241	175 lb	600 lb	410 lb	750 lb
Trapezoid Tearing Strength, min.	D4533	75 lb	110 lb	n/a	n/a
Deterioration in Tensile Strength due to UV Degradation 500 hrs, min.	D4355 D6637	70% strength retained	70% strength retained	70% strength retained	70% strength retained
Apparent Opening Size, AOS, min.	D4751	No. 50 sieve	No. 40 sieve	No. 30 sieve	No. 30 sieve
Soil Retention, Pore Size, O ₅₀ /O ₉₅ , min.	D6767	n/a	n/a	290/380	100/350
Permittivity, min.	D4491	0.05 sec ⁻¹	0.050 sec ⁻¹	0.50 sec ⁻¹	0.40 sec ⁻¹
⁽¹⁾ All values are minimum average roll values (MARV) as determined in accordance with ASTM D4354 in the weaker principal direction, except AOS size is based on maximum average roll value.					

(d) Geotextile Properties for Silt Fence

Test	Method, ASTM	Requirements ⁽¹⁾	
		Wire Fence Supported	Self Supported
Grab Strength	D4632	90 lb	90 lb
Elongation @ 45 lb	D4632		50% max.
Apparent Opening Size ⁽²⁾	D4751	No. 20 sieve	No. 20 sieve
Permittivity ⁽²⁾	D4491	0.01 sec ⁻¹	0.01 sec ⁻¹
Ultraviolet Degradation at 500 hrs	D4355	70% strength retained	70% strength retained
<p>⁽¹⁾ The value in the weaker principal direction shall be used. All numerical values will represent the minimum average roll value. Test results from a sampled roll in a lot shall be in accordance with or shall exceed the minimum values shown in the above table. The stated values are for non-critical, non-severe conditions. Lots shall be sampled in accordance with ASTM D4354.</p> <p>⁽²⁾ The values reflect the minimum criteria currently used. Performance tests may be used to evaluate silt fence performance if deemed necessary by the Engineer.</p> <p>Note: All values are minimum average roll values (MARV) as determined in accordance with ASTM D4354.</p>			

918.03 Geomembrane

50 This material shall consist of a geomembrane fabricated from high density polyethylene, HDPE, consisting of strong, rot resistant, chemically stable long-chain synthetic polymer materials, dimensionally stable with distinct and measurable openings. The manufactures shall submit the tests for the intended use to the Department.

Geomembrane shall be selected from the QPL of Geosynthetic Materials. Geomembrane will be placed and maintained on the QPL in accordance with ITM 806.

The geomembrane shall meet the following requirements:

Test	Method	Requirement
Density @ 23°C, min.	ASTM D1505	0.88 g/cm ³
Sheet Thickness	ASTM D5199	0.75 mm
Tear Resistance	ASTM D1004	98 N
Resistance to Soil Burial	ASTM D6134	min. of 90% of original value retained
pH	AASHTO T 289	Durability between 3 to 12
Roll Width	Calibered	20 ft

60 **918.04 Geocell Confinement System**

Geocell confinement system is a lightweight, flexible mat that consists of high density polyethylene strips. The mat shall be perforated and the strips shall be ultrasonic bonded together to form a strong configuration. Cell seam strength shall be uniform over full depth.

Geocell shall be selected from the QPL of Geosynthetic Materials. Geocell will be placed and maintained on the QPL in accordance with ITM 806.

The geocell shall meet the following requirements:

70

Properties	Material/Test Method	Unit	Value
Sheet Thickness	ASTM D5199	mils	50
Environmental Stress Crack Reduction, min.	ASTM D1693	hours	3,500
Short-Term Seam Peel Strength for 4 in. depth	ASTM D6392	lb/ft	350
Percent Open Area	COE-02215	%	12.6
Nominal Expanded Cell Size	Calibered	in.	12.6 x 11.3
Note: Carbon Black shall be minimum 1.5% by weight in accordance with ASTM D5199.			

918.05 Geogrid

Geogrid shall be biaxial or multi axial of a regular network of connected polymer tensile elements with aperture geometry sufficient to enable significant mechanical interlock with the surrounding material. The material shall be polypropylene, ASTM

D4101 (97% minimum) and Carbon Black, ASTM D1603 (0.5% minimum). The geogrid structure shall be dimensionally stable and shall be able to retain its geometry under construction stresses. The geogrid structure shall have a resistance to damage during construction, ultraviolet degradation, and all forms of chemical and biological
80 degradation encountered in the soil being placed.

Geogrid shall be in accordance with the property requirements as specified in the Geosynthetic Research Institute, GRI, Standard Test Methods GG1, GG3, GG4, ASTM D5262, and ASTM D6637.

During periods of shipment and storage, the geogrid shall be protected from temperatures greater than 140°F, mud, dirt, dust, and debris. Each geogrid roll shall be labeled or tagged to provide product identification. The manufacturer's recommendations shall be followed with regard to protection from direct sunlight. At
90 the time of installation, the geogrid will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. All damaged portions of geogrid shall be replaced for the entire width of the roll. All of the geogrid shall be identified, stored, and handled in accordance with ASTM D4873. The Contractor shall furnish the product labels that clearly show the manufacturer's or supplier's name, product identification, lot number, manufactured date, roll dimension, and provide a document that the material is in accordance with manufacturer's or supplier's certificate.

Only geogrids selected from the QPL of Geosynthetic Materials shall be used.
100 Geogrids will be placed and maintained on the QPL in accordance with ITM 806, Procedure S.

The geogrid shall be in accordance with the property requirements for the type specified as follows:

(a) Type IA and Type IB

Property	Test Method	Unit	Type IA Value, Min.	Type IB Value, Min.
Aperture Area	Calibered	Sq. in.	1.3	1.3
Open Area	COE, CW02215	%	$> 50.0 \leq 80.0$	$> 50.0 \leq 80.0$
Junction Strength	ASTM D7737	lb/ft	-----	788
Tensile Modulus, machine direction	ASTM D6637 ^{1,2,3}	lb/ft	10,000	10,000
cross machine direction		lb/ft	10,000	10,000
Ultimate Strength, machine direction	ASTM D6637 ^{2,3}	lb/ft	800	800
cross machine direction		lb/ft	800	800
Ultraviolet Stability	ASTM D4355	-----	-----	70% at 500 hrs
¹ Secant modulus at 5% elongation. ² Results for machine direction, MD, and cross machine direction, CMD, are required. ³ Minimum average roll values shall be in accordance with ASTM D4759.				

(b) Type II

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Property	Test Method	Unit	Value, Min.
Open Area	COE, CW02215	%	> 50.0 ≤ 80.0
Tensile Modulus, machine direction	ASTM D6637 ^{1,2}	lb/ft	49,300
Ultraviolet Stability	ASTM D4355	70% at 500 hrs	
Creep Limited Strength, machine direction at 5% strain	ASTM D5262	lb/ft	1,090
¹ Secant modulus at 2% elongation.			
² Minimum average roll values shall be in accordance with ASTM D4759.			

(c) Type III

Geogrid material shall be of high-density polyethylene, HDPE; polypropylene, PP; or polyester, PET, polymers and have the following properties:

Property	Test Method	Unit	Value, Min.
Open Area	COE, CW02215	%	> 50.0 ≤ 80.0
Ultraviolet Stability	ASTM D4355	70% at 500 hrs	
Ultimate Strength, machine direction	ASTM D6637	lb/ft	1,500
Long-Term Design Strength, Allowable, LTDS, machine direction	GRI-GG4	lb/ft	1,000*
* Minimum Average Roll Value, MARV: Property value calculated as average minus two standard deviations.			

$$LTDS = \frac{T_{ult}}{(RF_{CR})(RF_{IR})(RF_D)}$$

where:

- T_{ult} = Ultimate strength
- RF_{CR} = Reduction factor for creep
- RF_{IR} = Reduction factor for installation damage
- RF_D = Reduction factor for durability

120 The minimum reduction factors are as follows:

$$RF_{CR} = 2.6 \text{ for HDPE, } 4.0 \text{ for PP, } 1.6 \text{ for PET}$$

$$RF_{IR} = 1.10$$

$$RF_D = 1.10$$

918.06 Fabric for Waterproofing

Fabric for waterproofing shall be treated cotton in accordance with ASTM D173, woven glass in accordance with ASTM D1668, or glass fiber mat in accordance with ASTM D2178. A type C certification in accordance with 916 shall be provided for the

130 fabric.

SECTION 919 – TRAFFIC SIGNS

919.01 Traffic Signs

Traffic signs shall be in accordance with the MUTCD.

Panel sign fabrication shall not utilize overlapping or butt splicing of reflective sheeting. Roll splices, as supplied on the roll of sheeting by the sheeting manufacturer, are allowed subject to the following conditions.

- 10 (a) a maximum of one roll splice per panel, and
 (b) a maximum of three roll splices per sign.

Exit panels are considered a part of the signs to which they are attached when fabricated under the same contract. If the exit panels are made for separate installation, only one roll splice is allowed on the entire sign.

- 20 Overlap splices on sheet signs will be allowed only because of insufficient sheeting width on signs whose smaller dimension exceeds 48 in. The overlap splice shall be installed in a shingle type manner using a horizontal lap. The lap width shall be a minimum of 1/4 in. Butt splices shall not be used. Roll splices are allowed on sheet signs but shall not exceed one splice per sign.

All signs shall be packed for shipment and handled during construction in accordance with the manufacturer's recommendations. All sign or sign face damaged prior to acceptance shall be replaced or repaired. Damaged sheet signs shall be replaced in their entirety. Damaged panel signs shall have the affected panels replaced or repaired in accordance with the manufacturer's recommendations.

- 30 Repaired areas on panel signs shall not be larger than 3 in. by 3 in. Repaired areas 1 in. by 1 in. or less shall be limited to a maximum of three per panel and a maximum of six per panel sign. Repaired areas larger than 1 in. by 1 in. shall be limited to one per panel and a maximum of three per panel sign. The maximum number of repaired areas shall be three on a panel or six on a panel sign. No more than 20% of the total number of panel signs may be patched. Panels with sheeting cracked at the bend around the panel edge shall be replaced.

A sign with the metal face damaged greater than superficial deformation shall be replaced.

- 40 Digital printed signs shall have transparent and opaque durable ink as recommended by the manufacturer. Digital printed colors shall have a warranty life of the base reflective sign sheeting. Digital applied colors shall present a smooth surface, free from the foreign material, bubbles, blemishes, streaks or spotted areas, and all messages and borders shall be clear and sharp. Digital printed signs shall meet the

daytime color and luminance, and night time color requirements of ASTM D4956. Overlapping of colors will not be allowed.

50 All digital printed signs shall be from an integrated system including reflective sheeting, durable inks, and clear overlay film all from the same manufacturer applied to aluminum substrate in accordance with 919.01(a)1. Only digital printers recommended by the manufacturer of the reflective sheeting shall be used.

Finished digital printed signs shall have a UV-protective clear overlay applied to the entire face of the signs. Overlay shall be part of an integrated component system as recommended by the reflective sheeting manufacturer. On temporary construction signs digitally printed with black ink only, the protective overlay film is optional.

(a) Backing Material

60 Fabrication, including cutting and punching of holes but excluding holes for demountable copy, shall be completed prior to surface treatment. Material shall be cut to size and shape and shall be free from buckles, warp, dents, cockles, burrs, and defects resulting from fabrication. The surface shall be a plane surface.

Metal sign base material shall be cleaned and prepared to receive the sheeting material in accordance with the sheeting manufacturer’s recommendation.

1. Sheet Signs

The backing material for permanent sheet signs shall be sheet aluminum in accordance with ASTM B209, alloy 5052H38, or alloy 6061-T6.

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The minimum thickness of the sheet shall be as shown for the appropriate sign width.

Width, in.	Thickness, in.
Up to 30	0.080
31 to 60	0.100
61 and Over	0.125

Backing material for temporary ground mounted signs shall be aluminum, steel, fiberglass, reinforced plastic, or plywood, unless otherwise approved.

2. Panel Signs

80 Extruded aluminum panels shall be in accordance with ASTM B221, alloy 6063-T6, and be 12 in. in width. Extruded aluminum panels shall be flat and straight within tolerances established by the aluminum industry. The weight for panels shall be 2.48 lb/ft.

Trim molding shall be of the same material and thickness as the panels to which it is attached.

Panel bolts, flat washers, and lock-nuts shall be in accordance with ASTM B211, alloy 2024-T4. Panel bolts shall be 3/8 in. by 3/4 in. standard hex head. Lock-nuts shall be standard hex head.

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3. Demountable Letters, Numbers, and Symbols

If demountable letters, numbers, or symbols are used, the backing material shall be 0.040 in. thick aluminum sheets in accordance with ASTM B209, alloy 3003-H14. Borders shall be 0.032 in. thick aluminum sheet in accordance with ASTM B209, alloy 6061-T6.

(b) Sheeting Material

Only sheeting materials from the QPL of Reflective Sheeting shall be used for Type IV through Type X sheeting. Type IV or higher sheeting shall be used for all sheet signs except as specified herein. For contracts let on or after September 1, 2020, Type VIII or higher reflective sheeting shall be used for sheet signs with a red background color and Type XI sheeting shall be used for all panel signs. Type XI highway sheeting shall be from the QPL of Reflective Sheeting or from a manufacturer that has complete test results from the NTPEP showing that the ASTM D4956 minimum requirements have been met. A type C certification in accordance with 916 shall be provided for Type XI sheeting. The sheeting type for the sign copy and border shall be the same type or higher than the sheeting type used for the background. Reflective sheeting materials will be placed and maintained on the QPL in accordance with ITM 806, Procedure H.

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A non-prorated manufacturer's written warranty, against delamination, blistering, discoloration, or 15% or greater loss of retro-reflectivity compared with the minimum initial ASTM D4956 value, shall be provided to, and in favor of, the Department by the reflective sheeting manufacturer. The warranty shall cover a period of 10 years.

1. Reflective Sheeting

Reflective sheeting used for signs, channelizing and delineation devices shall be in accordance with ASTM D4956.

For contracts let on or after September 1, 2019, type IV or higher white and fluorescent orange reflective sheeting shall be used for drums utilized on interstate routes and ramps.

For contracts let on or after September 1, 2020, Type IV or higher white and fluorescent orange reflective sheeting shall be used on all drums, tubular markers, vertical panels, and 42 in. cones.

Type V or higher reflective sheeting shall be used on delineators, except for barrier delineators which shall be Type III or higher.

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Reboundable reflective sheeting shall be used on plastic drums, flexible delineator posts, and other flexible channelizers.

The reflective sheeting shall include an adhesive backing Class 1 or Class 2 in accordance with ASTM D4956.

2. Non-reflective Sheeting

140 Non-reflective sheeting shall be in accordance with ASTM D4956 except that the sheeting shall not incorporate optical elements. The color shall be black in accordance with SAE-AMS-STD-595, color No. 17038.

3. Transparent Sheeting

Transparent sheeting shall be a material recommended by the background sheeting manufacturer.

(c) Letters, Numbers, and Symbols

Letters, numbers, and symbols may be demountable.

150 The reflective sheeting shall be of the same type as used on the background and mechanically applied to the properly prepared aluminum in a manner prescribed by the sheeting manufacturer.

Each demountable legend unit, supplemental panel, and border frame shall be supplied with mounting holes and shall be secured to the sign face with aluminum rivets with aluminum mandrels. Adhesives that, when removed, may damage the sign face, legend unit, or border shall not be used to hold the unit in place.

(d) Fasteners

160 1. Sheet Signs

The bolts, steel flat washers, and lock-nuts used to attach sheet signs to posts shall be stainless steel in accordance with ASTM A276, or type 304 carbon steel in accordance with ASTM A307, grade A. Carbon steel hardware shall be galvanized in accordance with ASTM F2329. Lock washers and hex nuts shall be used in lieu of the lock-nuts when carbon steel hardware is furnished.

170 The bolts shall be 5/16 in. by 3 in. hex head, full threaded. The steel flat washers shall be size no. 1/4, 0.738 in. outside diameter, 0.317 in. inside diameter, and 0.051 to 0.08 in. thick and in accordance with Military Specifications MS 15795-811. Nylon flat washers shall be 7/8 in. outside diameter, 0.317 in. inside diameter, and shall be 0.032 in. thick.

2. Panel Signs and Temporary Panel Signs

The aluminum post clips shall be in accordance with ASTM B26 or ASTM B108, alloy 356.0-T6 and as shown on the plans. Aluminum post clip bolts shall be as shown on the plans and in accordance with ASTM B211, alloy 2024-T4. Lock-nuts shall be in accordance with ASTM B211, alloy 2017-T4. Flat washers shall be in accordance with ASTM B209, alloy Alclad 2024-T4.

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3. Aluminum Rivets

Aluminum rivets shall be determined by character size and shape but shall not be more than 8 in. on center. All rivets shall be color matched to the legend or supplemental panel being installed.

(e) Basis for Use

A type C certification in accordance with 916 shall be provided for the traffic signs and components except those used for temporary construction signs, temporary traffic signs, and temporary panel signs.

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SECTION 920 – HIGHWAY ILLUMINATION MATERIALS**920.01 Highway Illumination Materials**

All luminaires, lamps, fuse kits, wire and cable, and major equipment shall be approved new material bearing the UL seal of approval or meet their standards.

Descriptive and technical literature shall be furnished for approval on all equipment prior to purchase and incorporation into the work.

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Warranties for all major equipment shall be in accordance with 807.02.

(a) Light Poles and Mast Arms, under 45 ft**1. General Requirements**

Conventional light poles shall be aluminum or steel and shall be in accordance with AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

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For conventional light poles, design wind velocity shall be 120 mph. The maximum horizontal deflection of the pole under maximum loading conditions shall not exceed a deflection angle of 1° 40" from the vertical axis of the pole for any 1 ft section of the pole along the entire length of the pole. Poles shall be designed for the Service I, Service II, Extreme I, and Strength I load combination states. The light pole shall be designed to support an ice load of 3 lb/sq ft applied to the full perimeter of all members. Vibration dampers shall be furnished as recommended by the manufacturer. The manufacturer may use drag coefficients based on actual wind tunnel tests; otherwise, they shall use the drag coefficients in Table 3.8.7-1. The pole shall also be designed for the Fatigue I load combination state should signs or other appurtenances be specified for mounting on the pole.

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Conventional light poles shall be designed to support a 53 lb luminaire with an effective projected area of 2.4 sq ft. When larger luminaires are specified, the light poles shall be designed to support the larger luminaires and this shall be shown on the light pole working drawings.

Conventional light poles shall have a 4 in. by 8 in. reinforced handhole centered 18 in. above the base of the pole, unless installed with a transformer base, and a cover attached with a minimum of two stainless steel hex head bolts. The pole shall have a removable pole cap and a wire support hook to support the vertical drop of the wire
 40 by a service drop clamp attached to the cable. A wiring hole with a 1 in. inside diameter grommet shall be provided where the mast arm is attached. Pole bases shall be designed for mounting on anchor bolts equally spaced on an 11 1/2 in. or 14 1/2 in. diameter anchor bolt circle. Anchor bolt covers shall be furnished.

Hardware shall be type 304 or 305 stainless steel in accordance with ASTM A276, except where otherwise specified.

For conventional light poles, a 1/2 in. by 13 UNC threaded grounding nut or other approved method shall be provided near the bottom of and shall be accessible through
 50 the handhole for attaching the ground wire. The ground wire shall be No. 6 AWG soft-drawn, solid copper in accordance with ASTM B3.

Mast arms less than 8 ft in length shall either be single member or truss type, except that mast arms for poles on bridge deck shall be truss type. Single member arms shall be a tapered tube, oval shaped, at the pole end with the long dimension in the vertical plane, welded to a pole plate and bolted, or clamped, to the shaft with a minimum of four 1/2 in. bolts. Mast arms 8 ft and over in length shall be truss type. The upper member shall be a tapered tube, oval shaped, at the pole with the long dimension in the horizontal plane. The lower member may be standard pipe. Both
 60 members shall be welded to a pole plate and bolted or clamped to the pole. A minimum of four 1/2 in. bolts at the upper member and a minimum of two 3/8 in. bolts at the lower member shall be used if a pole plate configuration is used to attach the mast arm to the pole. Mast arms that are clamped to the pole shall have a minimum of four 1/2 in. bolts per clamp. Mast arms shall provide an enclosed raceway for the wiring and shall be free of burrs and rough edges. Each arm shall be furnished with a 2 in. nominal pipe size slipfitter. The maximum rise of the truss style arm shall be as set out in the table and shall be measured vertically from the centerline of the free end of the truss to a plane through the centerline of the upper arm bracket after loading.

Mast Arm Length, ft	Maximum Rise, ft
9 or less	4
10 to 14	5
15 to 19	5.5
20 to 25	6
26 to 30	8

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Light poles shall be constructed to provide a nominal luminaire mounting height above the roadway pavement as shown on the drawings. The elevations of foundations above or below the edge of the pavement shall be controlled by existing roadside

conditions. The effective mounting height shall be determined by field measurement prior to placing an order for the poles.

A variation in the nominal mounting height of ± 1 ft is allowed so that the “Effective Mounting Height”, foundation to luminaire, of the light standards may be supplied for 40 ft nominal mounting height.

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Elevation of Foundation Top with Respect to the Near Road Edge, ft	Effective Mounting Height, Foundation to Luminaire, ft
+7.00 to +5.01	34
+5.00 to +3.01	36
+3.00 to +1.01	38
+1.00 to -1.00	40
-1.01 to -3.0	42
-3.01 to -5.00	44
-5.01 to -7.00	46

The effective mounting heights for other nominal mounting heights deviate from the table by the difference in nominal height and 40 ft..

2. Aluminum Light Poles

a. Round Seamless

The pole and mast arm shall be in accordance with ASTM B221, alloy 6063-T6, and of sufficient diameter and wall thickness to withstand the design loads. The pole shall be tapered full length or tapered in the middle with the top or bottom approximately 1/3 of the pole of constant cross section. The minimum wall thickness for poles on breakaway couplings and steel slip bases shall be 0.219 in. Poles on transformer bases or shoe anchor bases installed without breakaway devices are exempted from this minimum wall thickness requirement. An inner tube extension, or sleeve, fitted inside the main tube shaft, is permissible to increase the wall thickness of the shaft starting at the bottom of the shoe base and extending upward towards the top of the pole. The sleeve or tube extension shall be no less than 3 ft in length, fabricated from aluminum alloy 6063-T4 and heat treated to produce a T6 temper after placing in the shaft. The minimum wall thickness of the combination of shaft and sleeve shall be 0.219 in. Attaching plates or clamps for aluminum mast arms shall be in accordance with ASTM B241, alloys 6061-T6, 6063-T6, 356.0-T6, or 5052-H32. The bottom end of the shaft shall be welded to a one-piece cast aluminum shoe anchor base of 356.0-T6 aluminum alloy in accordance with ASTM B26 for sand castings or ASTM B108 for permanent mold castings or equal and provided with four slotted holes for anchor bolts and the shaft’s full length shall be heat treated to produce a T6 temper. The top of the shaft shall be provided with a removable aluminum pole cap. The shaft shall have no longitudinal welds. After fabrication, the shaft shall be cleaned to a satin finish and wrapped for protection during shipping and handling.

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b. Single Longitudinal Welded

The material for these light poles shall be round, tapered structural marine aluminum sheet in accordance with ASTM B209, alloy 5086-H34, and of sufficient diameter and wall thickness to withstand the design loads. The minimum wall thickness for poles on breakaway couplings and steel slip bases shall be 0.219 in. Poles on transformer bases or shoe anchor bases installed with no breakaway devices are exempted from the minimum wall thickness requirement. The anchor base shall be one-piece cast aluminum in accordance with ASTM B26, alloy 356.0-T6. The base casting for the formed and welded shaft shall be designed to be inserted a minimum of 12 in. into the shaft and bonded to the shaft with a weatherproof structural epoxy adhesive that fully develops the required strength as specified by the design criteria. After fabrication, the shaft shall be cleaned to a satin finish and wrapped for protection during shipping and handling.

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3. Galvanized Steel Light Poles

The pole and base plate shall be fabricated from steel in accordance with ASTM A572, A595, or A1011 with a minimum yield strength of 50,000 psi. Single member mast arms and the upper members of truss type mast arms shall be fabricated from steel in accordance with ASTM A572 or A595 with a minimum yield strength of 50,000 psi. The lower member of truss type arms may be fabricated from standard steel pipe in accordance with ASTM A53 with a minimum yield strength of 36,000 psi. After fabrication, the pole and mast arm shall be thoroughly cleaned and galvanized in accordance with ASTM A123.

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Steel poles shall be tapered 0.14 in./ft and shall be round, octagonal, or dodecagonal. The design load shall be used to determine the pole diameter and wall thickness. Design calculations stamped by an Indiana registered professional engineer shall be submitted with the working drawings. The pole shall have one longitudinal electrically welded joint. A steel base plate shall be welded to each pole and provided with four slotted holes for the anchor bolts.

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All welds on steel poles shall be performed at the factory. Base plate welds shall be 100% penetration. Circumferential welds shall be backed-up welds with 100% penetration. Longitudinal welds shall be a minimum of 60% penetration. The 100% penetration welds shall be ultrasonically inspected and all other welds shall be inspected by magnetic particle. Welding shall be performed in accordance with 711.32.

4. Timber Light Poles

Timber poles for highway light pole shall be in accordance with 922.10(b).

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5. Frangible Breakaway Bases

All light poles, except high mast towers, those protected by bridge end bents or retaining walls, and those placed along sidewalks, pedestrian pathways, and bicycle pathways shall be installed on breakaway devices. All breakaway devices on a contract shall be of the same type and manufacturer.

Breakaway devices shall be in accordance with AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals as modified in 920.01(a)1.

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A certification from the manufacturer shall be furnished with the shop drawings stating the breakaway devices conform to the breakaway criteria of the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

a. Cast Aluminum Transformer Base

The anchor bolts for transformer bases shall be in accordance with 920.01(a)7. The anchor bolt circle for transformer bases shall be 15 in. The bolt holes in the transformer base may be slotted. The pole shall be bolted to the transformer base with four 1 in. diameter galvanized steel bolts.

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An approved handhole in the transformer base may be substituted for the 4 in. by 8 in. handhole specified in 920.01(a)1.

b. Breakaway Coupling

Breakaway couplings may be used with aluminum poles with mounting heights up to 50 ft and with steel poles that weigh 600 lb or less. The couplings shall be furnished with necessary hardware including a two-piece cover. Couplings shall be installed in accordance with the manufacturer's instructions and recommended clearance between the top of the foundation and the bottom of the breakaway coupling.

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6. Anchor Bolts

Anchor bolts shall be 1 in. with 8NC rolled threads in accordance with ASTM A307. The minimum length of threads shall be 6 in. Mean diameter of rod stock shall be 0.918 in. ± 0.011 in. and out-of-round tolerance shall be ± 0.012 in. The top 10 in. of the bolt shall be galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. Anchor bolts shall be in accordance with 910.19(b). The bolts shall be a minimum of 36 in. in length for poles 8 in. outside diameter or less and 48 in. in length for poles 9 in. or 10 in. outside diameter. In addition to the minimum length, the bolt shall have a 4 in. right angle bend at the unthreaded end. The anchor bolts in bridge structures shall be as shown on the plans.

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(b) High Mast Towers 60 ft and Over

The high mast pole, base, anchor bolts, lowering device, installed fixtures, and associated appurtenances shall be designed to withstand a minimum wind speed of 120 mph using applicable design criteria in accordance with AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. Minimum design criteria for high mast tower heights from 60 ft to 120 ft shall be an effective projected area of 14.70 sq ft and a weight of 740 lb to account for 6 luminaires and a 6 place lowering ring. Criteria for high mast tower height from 125

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ft to 200 ft shall be an effective projected area of 26.70 sq ft and a weight of 1,065 lb to account for 12 luminaires and a 12 place lowering ring. If larger fixtures are used, the actual size and weight shall be used in the design of the pole.

The Contractor shall be responsible for the accuracy of the dimensions and the proper fit of all material and equipment furnished with the pole. The Contractor shall provide all applicable manufacturers' warranties for material and workmanship. External lowering devices shall be designed to attach to the pole as shown on the plans.

210 The pole shall include the mounting accommodations as shown on the plans.

1. High Mast Poles

The poles shall be tapered shafts having poly-sided or circular cross sections. The pole shaft sections shall be slip fitted and shall provide at least 1 in. radial clearance from all interior devices.

220 All tower shaft components shall be fabricated from high strength, low alloy, steel in accordance with AASHTO M 270; ASTM A595, grade A or B; ASTM A572, grade 55; ASTM A1011; ASTM A606, or ASTM A656, with a minimum yield strength of 50,000 psi.

Sections which are slip fitted shall have slip joints with a minimum overlap of 1.5 times the diameter of the bottom of the upper section at the slip joint. Towers having slip joint construction shall be match marked at the factory and shall be shipped disassembled for assembly at the work site. Slip joints shall be marked to ensure that the 1.5 times diameter insertion is provided.

230 All steel used in the base plate and shaft shall meet an impact property of 15 ft·lb at 40°F in the longitudinal direction using the Charpy V-Notch test. This shall be an average of three tests per mill heat with no test below 10 ft·lb. A copy of the certified mill test reports for this steel and the Charpy V-Notch test results shall be submitted. Sufficient information shall be furnished to demonstrate that this material is traceable to the mill heat number shown on the test report.

All tower shaft hardware including hardware for the handhole door, and the latch mechanism shall be stainless steel in accordance with ASTM A276, type 304 or 305, except where otherwise specified.

240 After fabrication, the pole shall be cleaned and galvanized. Galvanized steel towers, including the handhole, handhole door, base plate, mounting plate, and all other elements welded to the shaft shall be hot-dip galvanized in accordance with AASHTO M 111 or ASTM A123.

2. Welding

The welding symbols and all information regarding location, type, size, welding sequence, and welding procedure specifications shall be shown on the working drawings.

250 Welds shall be smooth and cleaned of flux and spatter in accordance with AWS procedure. Minimum preheats for welds shall be 100°F for seams, and 225°F for circumferential welds.

260 All welds shall be performed at the factory. Circumferential welds shall be backed-up welds with 100% penetration. Longitudinal welds shall have a minimum of 60% penetration except within 2 ft of either side of the circumferential joint, the welds shall be backed-up and of 100% penetration. Base plate welds shall be 100% penetration. Circumferential welds and 100% penetration longitudinal welds shall be 100% ultrasonically inspected. The 60% penetration longitudinal welds shall be 100% ultrasonically or radiographically inspected for soundness. Welding shall be performed in accordance with 711.32. Weld filler shall provide Charpy V Notch equal to or greater than 20 ft·lb at 0°F.

a. Inspection

The manufacturer shall provide quality control, QC, inspection. The inspector shall be an AWS CWI, in accordance with AWS D1.1. The NDT inspector shall be an independent non-destructive-testing inspector, certified as level II in RT, UT, or MT, or all as applicable. Copies of the inspection reports and NDT reports shall be provided to the Engineer.

270 The method for testing full penetration and partial penetration welds by the independent welding inspector shall be the same as specified above.

b. Blank

3. Handholes

280 Openings for handholes shall be reinforced to maintain the design strength of the pole. The handhole shall have a weatherproof gasket made of neoprene or silicone rubber. The gasket shall be formed for a forced fit around the handhole or be attached by mechanical means. The door and hinges shall be the same type steel as the poles. The hinge pins and other securing hardware shall be stainless steel and tamperproof. The door shall be fabricated to allow for a padlock, which is not included in the hardware. The hasp used for padlocking shall be fabricated from stainless steel. Provisions shall be made to bolt the door securely shut. The door shall include a bugproof and weatherproof aperture with a minimum opening of 4 sq in. Nylon or non-corrosive screens, or other approved methods of bug proofing shall be furnished. Two bonding plates shall be furnished which are accessible through the pole handhole for connecting the ground wires. A connection shall be furnished for an additional ground wire on the outside of the pole near the base plate.

4. Luminaire Ring Assembly

290 The ring shall be fabricated from ASTM A666, type 304 stainless steel and shall have a removable raceway cover. The ring shall be fabricated as an enclosed wire

raceway to provide for the symmetrical mounting of the luminaires. All structural connections shall be made with bolts and nuts.

The luminaire ring shall be supported by means of stainless steel aircraft cables of seven strands with 19 wires per strand with a minimum breaking strength of 3,700 lb.

- 300 Luminaire rings shall be provided with either 6 or 12 - 2 in. diameter pipe fittings for luminaire attachment. The number of luminaires and their positions on the ring will be shown on the plans. Counterweights that provide an even weight distribution shall be installed on pipe fittings where luminaires are not shown.

5. Head Frame Assembly

- 310 The head frame shall be made of ASTM A666, type 304 stainless steel. All required pulleys, rollers, or sheaves and shafts shall be constructed from non-corrosive metallic materials. No component shall be used in the lowering device in excess of its rating or in violation of the component manufacturer's recommendation. This requirement shall be applicable, but not limited to, the compatibility of the cables and sheaves. There shall be three supports for the suspension cables. A roller system or one compatible sheave for the power cable shall be located mid-point between two of the suspension supports. To prevent the cables from riding out of the grooves, cable guides shall be provided. The suspension cable sheaves shall have a minimum pitch diameter of 3 1/2 in. and the power cable sheave or individual rollers in a roller assembly shall have a minimum pitch diameter of 18 1/2 in. and shall be grooved to fit the power cable.

- 320 All components at the top of the pole shall be protected from the weather by a dome fabricated from steel in accordance with 920.01(b)1, fiberglass, or spun aluminum.

- 330 The dome shall be secured to the head frame assembly with at least eight fasteners around the perimeter of the dome. The dome shall be reinforced at the points of attachment and it shall be fitted to the head frame assembly so that no visible distortion occurs to the dome when it is properly installed. The dome attachment shall be designed to withstand pole vibration, other pole movement, and the design windload. The fiberglass dome shall be made of material that is not subject to cracking or other deterioration because of aging.

6. Winch Assembly

The winch cable shall be 5/16 in. diameter galvanized steel aircraft cable of seven strands with 19 wires each strand with a minimum breaking strength of 9,800 lb.

The winch shall have a drum with a minimum diameter of 4 in. and drum flanges with a minimum diameter of 8 in. The drum shall be supported at each end by a rigidly mounted, permanently lubricated, bearing capable of carrying the design load. The winch drum shall be designed to allow the cable to lay in even consecutive layers.

- 340 The winch shall be driven by a self locking, worm gear reducer. The gear reducer shall be permanently lubricated and totally enclosed in a cast aluminum or cast iron housing. The winch assembly shall be powered by an external drive system.

7. External Drive System

- The external drive system shall be powered by a heavy duty reversing NEMA frame motor with an electromagnetic friction breaking mechanism rated at a minimum of 6 ft·lb of torque per motor horsepower (746 W). The brake shall be actuated each time the power to the motor is interrupted. The breaking mechanism shall be an integral part of the motor housing. The motor operated drive shall have a factory set torque limiter or clutch. This clutch assembly shall be calibrated to position the ring at the top of the pole and not exceed 80% of yield strength of the cable.

The external drive system shall operate with the 240/480 AC volt power available at the pole or incorporate a transformer into the system. The external drive system may use either the luminaire power plug or a separate outlet with a 600 volt, 30 ampere rating. The external drive system shall be operated from a minimum distance of 25 ft from the pole. The control voltage for any handheld control equipment shall not exceed 120 volts. The handheld control equipment shall be shock proof.

- 360 The external drive system shall be capable of operating all high mast pole installations. Working drawings shall be furnished in accordance with 105.02 and shall include the dimensions and the wiring diagram of the standard connections of the external drive system. The external drive system shall be mounted on a two-wheel cart with wheels at least 12 in. in diameter and the weight shall be distributed so that it presents a balance load.

8. Cable Terminator

- 370 The three luminaire ring support cables shall be attached to three stainless steel helical compression springs incorporated into the cable terminating device. These springs shall be designed to compensate for inequalities in the cable lengths and to maintain adequate tension on the support cables through pole and cable thermal expansion and contraction.

The cable terminator shall incorporate a separate eye bolt on the bottom of the device for the attachment of a cable or chain to hold the luminaire ring in a raised position while the winch cable or winch assembly is being inspected or repaired. The cable terminating device shall be designed to prevent the device from catching on the slip joint of the structure.

- 380 **9. Lightning Rod Assembly and Grounding System**

The lightning rod, air terminal, shall shield the head frame assembly cover and the outer edge of the luminaires within a 45° electrostatic shielded cone. The grounding system shall include bonding plates, grounding clamps, four copper weld grounding rods, a grounding conductor, air terminal, lightning rod, and other

incidental connectors. All hardware shall be stainless steel, brass, copper, copper alloy, or equally corrosion-resistant metal.

390 Bonding plates, with a minimum contact surface area of 8 sq in., shall be installed at locations shown on the plans. The bonding plates shall be welded to the tower shaft during the time of manufacturing. The grounding conductor shall be secured to the bonding plates by a two-bolt pressure plate clamp connector having a minimum of 4 in. of contact with the copper. At the point of termination, the grounding conductor shall extend beyond the bonding plate a minimum of 3 in.

Each ground rod clamp shall have a minimum of 1 1/2 in. of contact between the grounding conductor and the ground rod. The grounding conductor shall be continuous between the bonding plates inside the tower shaft handhole and the grounding rod termination point.

400 Bends of conductors shall form an angle of 90° or more. Unsupported conductors shall have a radius of bend 8 in. or greater.

10. Anchor Bolts

Anchor bolts for high mast poles shall be furnished in a pre-clustered form and shall be a hooked deformed reinforcing bar or a hooked smooth bar. The bolts shall be in accordance with ASTM A615 modified to a minimum yield strength of 75,000 psi. The top 12 in. of each anchor bolt, nut, and washer shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM B695, class 55.

410

(c) Wire and Cable

Lighting circuit cables for direct burial shall be enclosed in polyethylene conduit.

1. Polyethylene Conduit

This conduit shall be in accordance with ASTM D3485 either medium density type II, class C or high density type III, class C smooth wall, coilable polyethylene conduit for preassembled wire and cable. The diameter of the conduit shall be 1 1/4 in for the standard 4-No. 4 conductor cable.

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2. Conductors in Cable-Duct

The cable shall consist of four separate electrically insulated conductors installed in the duct so any one conductor may be easily removed without damage to the other two. The conductors shall not be cabled or twisted together. The conductors shall be stranded copper of the No. 4 AWG size. Conductors shall be stranded in accordance with ASTM B8, class B.

Each conductor shall be insulated with crosslinked polyethylene manufactured in accordance with Insulated Power Cable Engineer Association standard WC 70/ICEA S-95-658-1999, Nonshielded 0-2kV Cables. Each conductor shall have the following

430 characteristics: a 600 volt rating; UL listed; an XHHW conductor temperature rating not to exceed 90°C in dry locations; and not to exceed 75°C in wet locations.

Each of the four conductors shall be imprinted at regular intervals with the following description: Type XHHW; 600 volt; UL; the conductor's AWG size and metal or alloy; the manufacturer's name, trademark, or other distinctive marking by which the product can be readily identified.

440 Identification coding of the conductors shall be accomplished by complete color coding. Color coding of the insulation shall be homogeneous throughout the entire depth and length of the jacket. The colors shall include one black, one white, one red, and one green.

3. Light Pole Circuit Wiring

This wiring shall consist of two 1/C No. 10 AWG, 600 volt, THWN or MTW insulation, stranded copper wire.

4. Sign and Underpass Wiring

450 The wiring from the switch box to the last luminaire shall be 3/C copper stranded No. 10 AWG conductors and shall have imprinted at regular intervals along the length of the insulation jacket the following designation: No. 10 AWG, type MTW or THWN, or Gasoline and Oil Resistant II or AWM, 600 volt, UL. The conductor classifications shall be UL listed and have the following minimum temperature ratings: MTW 90°C; THWN 75°C; and AWM 105°C. It shall be installed in 3/4 in. conduit between the breaker box and luminaires.

5. Aerial Cable

460 This cable shall be triplex secondary distribution cable consisting of two insulated conductors and a steel reinforced bare copper messenger neutral. The insulated conductor shall be No. 6 AWG stranded copper with 600 volt, XHHW-XLP type insulation.

6. High Mast Tower Luminaire Ring Conductors

The wiring from the terminal box on the ring through the last luminaire shall be in accordance with 920.01(c)4.

7. Power Cable-High Mast Tower Poles

470 The power cable shall be a 4/C No. 10 AWG copper insulated electrical cable type "SO" modified for a repetitive reeling operation. It shall be in accordance with ASTM B3, ASTM B173, and IPCEA S-19-83. Conductor insulation shall be in accordance with ASTM D1693 and IPCEA S-19-81, Paragraph 3.12. The sheath or jacket shall meet or exceed IPCEA S-19-81, Paragraph 7.6.20.1.1. Conductors shall be color coded.

The power cable shall have a heavy-duty 600 volt, AC 30 amp rated electrical plug capable of disconnection in a safe manner under load conditions. The electrical

plug shall be moisture resistant and waterproof at both transition points.

8. Electrical Connectors

480 Connectors shall be a compression type of the proper size with only one conductor per groove in the fitting. They shall be designed specifically for use on aluminum and copper conductors, prefilled with an oxide inhibitor and installed with a hydraulic tool according to the manufacturer's specifications. After installation, the connectors shall be fully insulated and weatherproofed. The connectors installed in underground handhole shall be taped and then waterproofed as shown on the plans.

(d) Luminaires

Underpass, Roadway, and High Mast models shall be selected from the QPL of Luminaires.

490 **1. General Requirements**

Luminaires shall be compatible with the lighting materials specified in this section and in the plans. Luminaires, including primary fuse protection, surge protection devices, power drivers, and other major components, shall be rated for a minimum operational life of 50,000 hours at 77°F.

Luminaires shall be a single, self-contained device, not requiring on-site assembly for installation. Connectors shall be crimp or cage-clamp type.

500 All internal components shall be adequately supported to withstand mechanical shock and vibration. Luminaires shall be tested in accordance with ANSI C136.31, 2G loading or ANSI C136.31, 3G loading for luminaires on bridges. Testing about all axes shall be accomplished with a single luminaire.

Luminaires shall include gasketing that will completely seal out dust, moisture, and insects from the interior of the optical assembly and retard the formation of an undesirable film from gaseous vapors on the interior of the optical assembly. The optical assembly shall be rated at IP 66 or better in accordance with ANSI/IEC 60529 while power drivers, and surge protection devices shall be rated at IP 65 or better.

510 Light sources supplied for luminaires shall be electrically compatible with the luminaires. Luminaires shall include an integrally built in power driver. The luminaire shall operate satisfactorily in temperatures from -40°F to 122°F with an input voltage variation of ±10% of the rated operating voltage specified. Power consumption, wattage, shall not exceed that which is shown on the plans. The luminaire power factor shall be 0.9 or greater. The power driver, or combination of power drivers if more than one is used in the luminaire, shall have a Mean Time To Failure, MTTF, of 1,000,000 hrs as determined by Telcordia SR 332, Issue 3 or MIL-HDBK-217F methodology. The MTTF estimate shall be of the driver as a complete and functioning unit. Total Harmonic Distortion, THD, of the power driver shall not exceed 20% as verified by
520 ANSI C82.77.

Roadway lighting luminaires shall have a precision-cast aluminum housing with weatherproof finish.

Refractors or lenses shall be scratch resistant and made from high impact, heat-resistant, glass or UV inhibited, high impact polycarbonate plastic. If utilized, reflectors shall be detachable and made of highly specular aluminum.

530 Luminaires shall have seven wire photocontrol receptacle in accordance with ANSI C136.41 with shorting cap for adaptive lighting control.

Luminaires shall exhibit a color temperature in the range of 3500K to 4500K per ANSI C78.377 and a minimum Color Rendering Index of 70 as verified by the IESNA LM-79 test.

540 A Surge Protection Device, SPD, shall be included to protect the luminaire from damage and failure from transient voltage and currents. The SPD shall conform to UL 1449 and shall be tested in accordance with, and survive, the procedure in ANSI/IEEE C62.41.2 definitions for standard and optional waveform for location category C-High. Once the surge current has subsided, the SPD shall automatically restore normal operation and reset to a state ready to receive the next surge.

Luminaires shall comply with Title 47 CFR Part 15, Class A on unlicensed transmissions in a business, commercial, or industrial environment.

Underpass and post top mounted luminaires shall be protected against salt spray and conform to ASTM B117, 2,000 hrs time horizon.

550 Luminaires shall include vandal shields when installed on an underpass or signs on bridge brackets and when otherwise specified. The vandal shield shall be made of a tough durable plastic, such as Lexan, mounted in a rugged galvanized steel or aluminum frame, and shall withstand severe impact without being damaged or allowing the refractor to be damaged. It shall be fastened securely to the luminaire so it cannot be removed from the outside and shall not interfere with the light distribution pattern. It shall protect the face of the refractor and if ventilation is necessary, the ventilating apertures shall be arranged so that they do not admit a probe of a diameter greater than 1/4 in.

560 Luminaire shall be aimable toward the required direction.

a. LED Luminaires

LEDs shall be connected so that the loss of one LED will not result in the loss of the entire luminaire. LED circuitry shall prevent flickering to the unaided eye at the voltage specified on the plans and the range indicated herein.

LEDs shall deliver a minimum of 85% of the initial rated lumens after 50,000 hours of operation at 130°F ambient temperature as indicated by LM-80 lumen

maintenance test of the light source as calculated by IESNA TM-21, $L85 > 50,000$ hrs.

570 A passive thermal management system to dissipate the heat generated by operation shall be provided. Fans or other mechanical cooling systems shall not be used. The thermal management system shall maintain temperatures during the operation of the luminaire to be within the limits established by the Power Driver Lifetime and LM-80 testing.

b. Light Emitting Plasma Luminaires

Plasma emitters shall deliver a minimum of 70% of the initial lumens after 50,000 hrs of operation.

580 **c. Metal Halide Luminaires**

Metal halide luminaires shall utilize a power driver; external capacitors or igniters shall not be used. Metal Halide lamps used in high mast luminaires shall be supported at both ends with mechanical spring grips or other means to hold the lamp secure against vibration.

2. Roadway Lighting Luminaires

Roadway luminaires shall have a strong, easily operated, positive latch on the street side of the housing with a hinge and a safety catch that prevents accidental unhinging on the house side of the refractor or lens holder. They shall include a four bolt slipfitter capable of adapting to a 2 in. mounting bracket that is adjustable $\pm 5^\circ$ for leveling.

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Luminaires shall be adjustable in the horizontal and vertical directions to meet the specified IESNA light distribution pattern. Luminaire weight shall not exceed 53 lb and its projected area shall not exceed 2.4 sq ft.

3. Sign and Underpass Luminaires

Sign and underpass luminaires shall be LED and operate on no more than 150W of power. Sign luminaires shall have a shield that blocks the view of the refractor from an approaching motorist. This shall be accomplished by the design of the housing or by a shield fabricated from sheet aluminum, approximately 0.05 in. thick, and of sufficient size to be fastened onto the horizontal edge of the refractor holder with self tapping screws and placed between the refractor and approaching traffic.

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Aluminum and steel structural members for luminaire supports shall include aluminum conduit, conduit clamps, fittings, and stainless steel screws.

(e) Circuit Breakers and Enclosure

All circuit breaker enclosures shall be NEMA 4/5.

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1. Circuit Breakers for Type II Service Point

The cabinet and hardware shall be weatherproof and rain tight. The enclosure shall have provisions for pad locking. The fastener and mounting hardware shall be plated

brass, stainless steel, or aluminum. The enclosure shall be made of 14 gauge aluminum or 14 or 16 gauge stainless steel. The circuit breaker operating handles for manual tripping shall be concealed inside the enclosure. Computation of branch circuits shall be based on the National Electrical Code Standard Limitation of loading breakers to 80% of their rated current. Additional details shall be as shown on the plans.

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2. Circuit Breakers for Sign and Underpass Circuits

Sign and underpass circuit protection shall be provided by two single pole, 240 volt AC, 120 volt for 120/240 volt service, circuit breakers with ampere rating of 200% of the normal load. The circuit breakers shall have provisions for padlocking externally. The circuit breaker operating handles for manual tripping shall be concealed inside the enclosure. The enclosure shall be made of aluminum or stainless steel. Additional details shall be as shown on the plans.

3. Circuit Breakers for High Mast Towers

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The enclosure shall be furnished with two single pole, 30 ampere, 480 volt AC circuit breakers with a minimum symmetrical RMS interrupting capacity of 14,000 amperes. The breakers shall be accessible through the pole handhole. The circuit breaker operating handles for manual tripping shall be external to the enclosure. The enclosure shall be made of aluminum or stainless steel. Additional details shall be as shown on the plans.

4. E-Series Magnetic Circuit Breakers

These breakers shall have the following features.

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- a. capable of 10,000 on-off operations;
- b. interrupting capacity of 7,500 amperes;
- c. temperature stable so as not to be adversely affected by temperature changes over their operating environment of -40°F to 185°F;
- d. lug range 1/0 - 14 copper and 1/0 - 12 aluminum; and
- e. trip on overload, even when handle is forcibly held in the ON position.

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(f) Multiple Relay Switches with Photocell Receptacles

Multiple relay switches with photocell receptacles shall have a two-pole relay for connection to a 120/240 or 240/480 volt, three-wire, single phase, 60 Hz power supply. The relay switch components shall match the service voltage being supplied. The unit shall contain two single pole circuit breakers with a minimum rated capacity to withstand 100% of the rated ampere load. The circuit breakers shall trip at not less than 125% of the rated load capacity. Control circuit arresters for lighting protection and a manual control selector switch shall be included within the unit. The enclosure

921.01

660 shall be a cast aluminum weatherproof case, with a hinged cover, having provisions for padlocking and a hanger for pole or wall mounting.

(g) Materials Certification

A type C certification in accordance with 916 shall be provided for the materials in this section unless otherwise specified.

(h) Junction Box

The junction box shall be polymer concrete, of concrete-gray color, with a cover rating of 20,000 lb.

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(i) Handholes

Handholes shall be in accordance with 922.17 except the cover shall be with the logo imprint of "LIGHTING".

SECTION 921 – PAVEMENT MARKING MATERIALS

921.01 Blank

921.02 Durable Marking Material

Durable marking material shall be thermoplastic, preformed plastic, or multi-component pavement markings. The materials shall not contain any toxic heavy metals above the limits of the regulatory levels of 40 CFR 261.24, table 1, when tested in accordance with EPA TCLP, or contain any other material which will require characterization as a hazardous waste when removed from the pavement surface.

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(a) Thermoplastic

This material shall be in solid form in accordance with AASHTO M 249 or supplied in a preformed state and shall not contain lead chromate pigments.

Heat bonded preformed thermoplastic shall be in accordance with AASHTO M 249 with the exception of the application properties outlined in section 5 of AASHTO M 249 shall not apply. Drying time and short term and long term flowability requirements are not applicable at time of installation. The material shall be capable of fusing to itself and previously applied thermoplastic pavement markings when heated. The material shall contain a minimum of 30% beads by weight. The beads shall be homogeneously blended throughout the material. The marking thickness throughout its width, before the material is heated, shall be supplied at a minimum average thickness of 90 mils.

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(b) Preformed Plastic

This material shall consist of a homogeneous preformed plastic film with a width as specified. Dimensional requirements shall meet one of the following:

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1. Preformed plastic material shall have a smooth plane surface,

with a minimum thickness of 60 mils throughout the entire cross section, or

2. Preformed plastic material shall have an embossed patterned surface with 35% to 65% of the surface area raised. The edges of the raised areas shall present a near vertical face to traffic from any direction. The minimum thickness of the raised area shall be 60 mils. The area between the raised areas shall be a minimum of 20 mils measured at the thinnest section of the cross section.

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The material shall have a precoated adhesive. The adhesive shall allow the preformed plastic material to be repositioned on the pavement surface to which it is applied before permanently fixing it in its final position with downward pressure.

The material shall be capable of being affixed to either HMA or PCCP by means of the precoated adhesive and, following the initial application of pressure, shall mold itself to pavement contours, breaks, and faults by traffic action at normal pavement temperatures.

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The near vertical faces of patterned preformed plastic shall be coated with a layer of beads.

A type C certification in accordance with 916 shall be provided for the marking materials except materials used for temporary pavement markings.

1. Packaging

Each package shall be marked to indicate the color of the material, specific symbol or word message, the batch number, the manufacturer's name, address, and the date of manufacture.

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2. Basis For Use

A type C certification in accordance with 916 shall be provided for the performed plastic material.

(c) Multi-Component

The material shall be for use on both HMA and PCC pavements. The material shall consist of a pigmented resin system of epoxy. The multi-component pavement markings shall be ultra-violet light resistant and shall not darken during the heating conditions of application, chalk, crack, show appreciable degradation or discoloration due to sunlight exposure and aging of the markings. The cured multi-component pavement markings shall be impervious to salts, grease, oil, fuels, acids, alkalies, and other common chemicals that may be found in or on HMA and PCC pavements. The pigment in the white material shall contain titanium dioxide in accordance with ASTM D476.

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The material shall be provided in containers, which are in accordance with current Federal DOT regulations. Each container shall be labeled in accordance with 29 CFR 1910.1200 and include the trade name or trade mark, formulation or product identification, date of manufacturer, color, batch or lot number, component identification, and mixing instructions.

A type C certification in accordance with 916 shall be provided for the multi-component pavement marking material.

(d) Snowplowable Raised Pavement Marker and Cast Metal Base

Snowplowable raised pavement marker shall consist of a cast metal base to which is attached a replaceable prismatic reflector for reflecting light longitudinally along the pavement from a single or from opposite directions. Both ends of the casting shall be shaped to deflect a snowplow blade upward.

The prismatic reflectors and cast metal bases shall be in accordance with ASTM D4383. Only prismatic reflectors and cast metal bases from the QPL of Snowplowable Raised Pavement Markers shall be used.

1. Epoxy Adhesive

The epoxy adhesive shall be in accordance with AASHTO M 237, type IV, Table 3 with respect to composition and performance. A type B certification in accordance with 916 shall be provided for the epoxy material. The limits of the following shall be shown on the certification.

Property	Test Standard
Chemical composition	AASHTO M 237
Density	AASHTO M 237
Gel time	AASHTO M 237
Percent air	AASHTO M 237
Bond strength	AASHTO M 237

2. Blank

(e) Pavement Marking Beads

A type C certification in accordance with 916 shall be provided for the pavement marking beads.

1. Standard Beads

Beads shall be glass in accordance with AASHTO M 247, Type 1. The beads shall have a moisture resistant coating.

2. Modified Standard Beads

The modified standard beads shall be glass in accordance with AASHTO M 247, Type 2. These beads shall have a moisture resistant coating and may have an adhesion

promoting coating.

3. Supplemental Beads

120 The supplemental beads shall be glass in accordance with AASHTO M 247, Type
4 except the beads shall have a minimum roundness of 80% by weight.

These beads shall have a moisture resistant coating and may have an adhesion promoting coating.

4. Supplemental Elements

These shall be for color, skid resistance, or wet weather retro-reflectivity and may be used provided they do not exhibit a characteristic of toxicity referenced in AASHTO M 247. A type D certification in accordance with 916 shall be provided for the supplemental elements.

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SECTION 922 – TRAFFIC SIGNAL MATERIALS AND EQUIPMENT

922.01 Description

Unless otherwise specified, traffic signal materials and equipment shall be in accordance with the NEMA TS2 2003 Standards Publication, and be compatible with the Department's current inventory of signal equipment.

922.02 Traffic Signal Control Equipment

10 Models shall be selected from the QPL of Traffic Signal and ITS Devices, unless otherwise specified.

(a) Model Approval

Each model of controller assembly, CA, and all major units, as defined in NEMA TS2-2.1.1, will be tested and evaluated by the Department's Traffic Management Division, and approved prior to use. The CA, as defined by NEMA TS2-1.1.7, as being a complete electrical unit, shall include major units operational in a TS2 environment. Major units of the CA are defined as controller unit, CU; malfunction management unit, MMU; bus interface unit, BIU; cabinet power supply; load switches; vehicle detector equipment; cellular modems; radio modems, and flasher. The evaluation of a product will be considered when the Department receives the preliminary product evaluation submittal form. The Department will advise the manufacturer or vendor of the date of delivery. At the time of delivery, a presentation of the product will be required accompanied by the product brochure, the operational manual containing procedures for all features incorporated in the CU's design, and the maintenance manual containing all schematics, pictorial parts layouts, components parts listings, and documented theory of operation. Certification in accordance with 922.02(d) shall also accompany the preliminary product evaluation form. If a product has TS2 communicative capabilities, then a data analysis interpretation offered in a decimal form expressing frames by an SDLC protocol analyzer shall accompany the initial documentation as well. When accuracy of documentation is validated, the evaluation

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period may commence. In addition, all computer system software applicable to a manufacturer's product shall work with the Department's current operating systems so that upgrades will not be needed to recognize the full potential of the product. Any product under evaluation that has an operational failure occurring during the bench test procedure will be rejected and returned to the submitter. The product will not be considered for future evaluation without a cover letter documenting failures encountered and changes to the design to correct the failures. A presentation by the manufacturer of the product in question and explanation of why the product failed will be required. Resubmittal of the original product will be expected for testing, evaluation, and approval. Furthermore, two more rejections of a product submitted for evaluation will be cause to deny approval of that model permanently.

The controller model shall be fully NTCIP 1202 compliant, and be capable of logging time-stamped controller event data at 100 ms resolution. The events collected shall be logged in the Department specified data file format and shall include but are not limited to, start and termination of all phase green, amber, and red, pattern changes, and all detector actuations and terminations. Data log file shall be accessible for standard FTP retrieval directly from the controller model's internal FTP server via the IP addressable RJ-45 Ethernet port.

Continued failures indicative of a trend, repeated random malfunctions, or NEMA non-compliance of a qualified product shall be cause to remove that model from the QPL of Traffic Signal and ITS Devices. If the manufacturer makes any changes to a qualified model of a major unit or controller cabinet terminal/facilities to correct a non-NEMA compliant or safety issue, the Department shall be notified immediately. The manufacturer shall correct all existing equipment purchased by the Department either directly, by contract, or through agreement prior to the change being incorporated at the manufacturer's production level.

A design change to a qualified model of a CA or any major unit shall require a submittal of documented changes. At the discretion of the Department, resubmission of the model for testing, evaluation, and approval may be required. The permanent addition or removal of component parts or wires, printed circuit board modifications, or revisions to memory or processor software, are examples of items that are considered to be design changes.

(b) Controller Assemblies or Major Units Furnished and Installed by the Contractor

A CA, as defined by NEMA TS2-1.1.7, shall be provided by the Contractor and shall be built to the specifications of the intersection design.

Each CA shall be supplied with three documentation packets. The documentation shall be provided in both paper hard copy and electronically as specified for each document. Each packet shall consist of:

1. One complete set of wiring and schematic diagrams for all of

the CA's panels, racks and wiring. The electronic document shall have a minimum of one indexed page for each paper sheet.

- 80 2. A parts list indicating contract number, vendor, category, manufacturer, model, serial number, software/firmware version as applicable, and inventory number of all major units incorporated in the CA. The electronic document format and the blank worksheet shall be obtained from the Department's Traffic Management Division.
3. An 11 by 17 in. intersection design plan.
- 90 4. A completed Department approved loop tagging table. The electronic document format and the blank worksheet shall be obtained from the Department's Traffic Management Division.
5. Packet number 2 shall also include a paper hard copy and an indexed and searchable electronic format file of the instructional programming manual identical in nature to that approved for use during the evaluation of each product and shall include a TS2 type 2 to TS2 type 1 adapter harness.

100 All electronic documents shall be submitted to the Asset Manager in the Department's Traffic Management Division. Each packet shall be labeled with the name of the intersection, the contract number, the commission number and the date of installation. Packet destinations shall be as per 805.08.

A 60-day burn-in period of traffic control equipment shall be required prior to acceptance of the contract. The Contractor shall be responsible for all costs associated with vendor or manufacturer warranty service until acceptance of the contract, or acceptance of that portion of the contract where the traffic control equipment is installed.

110 **(c) Warranty**

The manufacturer's or vendor's warranty shall be provided for the following components: all major units operating in a TS2 environment, light emitting diode, LED, signal indications, load switches, and flashers. Warranty periods shall commence from the date of field placement of the device or on the date of signal turn-on as shown on the IC 636A form if purchased through a contracting agent.

(d) Certification of NEMA TS2 Traffic Control Equipment

The following certifications shall be provided.

120 **1. Certification of a Production Run Model**

A certification representing each model of approved major unit of a CA shall be on file with the Department. A certification of a production run model for a CU will

be valid for a maximum period of five years from the date of approval or unless a significant change is made in the CU. If a significant change is made, a new certification shall be submitted. A significant change shall be the addition or deletion of any function or feature in the control unit, or any other change as defined in 922.02(a) to the circuitry in the product.

2. Certification of Environmental Testing

130 A certification shall be provided with each major unit approval request indicating it has been tested and is in accordance with the tests from NEMA TS2-2. The certification shall specify the model and serial number of the product being tested. A complete log of each test shall be provided to the Department and will be maintained by the Department. The log shall show which, if any, controller component failed during the test, when it failed, and what steps were taken to repair the controller. The log shall include the date of testing, name and title of person conducting the tests, a record of conditions throughout the tests, and a temperature and humidity verses time chart. The maximum report interval of any chart shall be 24 h. The chart shall be from a recording machine used to monitor the status of the environmental chamber during
140 testing.

(e) NEMA TS2 Fully Actuated Solid State Controller Unit, CU

The following requirements are the minimum for the design and operation of a 16 channel fully actuated solid state CU. The NEMA TS2 configuration will consist of 2 types of CU's, type A1 and type A2, as defined in NEMA TS2-3.2.

The CU shall be in accordance with NEMA TS2 Standards, all provisions contained herein, and the Department's specifications. Manufacturer specific enhancements are acceptable. No function or device shall preclude the
150 interchangeability of a CU with another CU of like NEMA specification within a controller assembly.

1. General Requirements

The CU shall be microprocessor based and both versions shall contain a three-port configuration and shall operate in the NEMA TS2 type A1 environment.

The CU shall include provisions for time-of-day programming. The CU shall be capable of a minimum of 50 programmed events and be in accordance with NEMA
160 TS2-3.8.

A removable nonvolatile EEPROM module or removable serial, flash-based, non-volatile data module shall be utilized in each CU to maintain all programmed data. A real-time clock shall be either battery-backed or powered by a super capacitor and active during a power outage so as to provide complete time keeping functions and leap year corrections. A switch or other means shall be provided to turn off or disconnect battery power during storage. This shall be accomplished without physical removal of the battery. Batteries within the CU shall be turned off or disconnected during storage and shipment.

170 Programming and maintenance manuals for approved CU's shall be identical in nature to that approved for use during the evaluation period of the CU. The Department shall be notified of any changes to the manuals.

Serial number and model numbers shall be permanently applied on or near the front of circuit boards of the CU and viewable without removing or disconnecting the board. Serial number and model number of the main frame shall be permanently applied externally on top or on the front panel.

2. CU Requirements

180 The requirements set forth herein refer to a type A1 and A2 CU. Where differences occur between types, it will be designated.

The CU shall have, as a minimum, the internal diagnostics defined by NEMA TS2-3.9.3.

190 The CU shall monitor and log the status of events as specified in NEMA TS2-3.9.3.1.5 in non-volatile memory and shall be selectable via program entry and be retrievable by the system computer via NEMA port 2 or 3. In addition, the CU shall have the ability to log an MMU fault as it occurs. A minimum of 16 entries shall be stored in non-volatile memory. When capacity is exceeded, the oldest entry will be replaced by the newest. Logged entries shall at minimum contain the date and time denoted in military style with minute resolution, description of the fault as it would appear on the MMU, and the status of each of the channel inputs at the time the fault occurred, clearly denoting the presence of activity on a channel.

200 The CU shall be capable of all inputs and outputs listed by controller type in NEMA TS2-3. Pedestrian timing shall be provided on all phases of a CU. The CU shall be keyboard programmable to enable initialization in any color and phase. Initialization shall occur after a recognized power interruption, upon MMU reset, or upon return from manual or time-of-day flash. The CU shall be programmable from a closed loop computer system, a laptop computer using the RS232 port, front panel programming, and by downloading from another like CU through the RS232 port.

Keystroke buttons shall be clearly marked as to function. All programming buttons and indicators pertinent to the operation of a phase shall be on the front of the CU and shall have programmable phase omitting and phase skipping capabilities.

210 The TS2 type A2 CU shall be in accordance with all applicable requirements for a type A2 CU as defined by NEMA TS2-3 and shall contain a full complement of connectors.

The CU shall have an RJ-45 ethernet port on the front panel and ethernet module that provide 10/100 base T interface in half or full duplex and which supports auto-configuration of the link parameters.

3. Internal Modules

All plug-in modules shall be equipped for easy removal or installation without the use of tools and shall be readily accessible for maintenance. All internal module plugs and edge card plugs shall have the corresponding pin connector position labeled with the first and last numbers or the first and last letters.

4. CU Enclosure

The enclosure shall be of adequate strength to protect the components during normal handling. The keypad, liquid crystal display and all interface connectors required for the operation and standard field adjustments shall be mounted on the front panel. Fusing shall be on the front panel of the CU and shall provide protection from internal or external overload.

The front panel of the controller shall be fastened to the frame such that no special tools shall be required to remove or replace printed circuit board modules or to gain access through the front panel. All hinges shall have stainless steel pins.

5. Firmware and Software Revisions

The Department's Traffic Management Division shall be notified each time an update or revision of the firmware or software is released and be provided with an explanation of the changes and the benefits of the change. The Department will determine if and to what extent a revision is to be placed into field operation and may fully re-evaluate the CU with the revision.

(f) NEMA TS2 Cabinet, Auxiliary Equipment, and Terminal and Facilities, TF, Requirements

These standards define the minimum requirements for a TS2 type A1 cabinet, both inside and out. The performance and construction of the cabinet shall be in accordance with the applicable requirements of NEMA TS2 sections 4, 5, 6, and 7. The serial number and model number of the auxiliary equipment shall be permanently applied externally on or near the front of the product. Programming and maintenance manuals for approved products shall be identical in nature to that approved for use during the evaluation period of the product. The Department shall be notified of all changes to the documentation. Manufacturer specific enhancements are acceptable, however no function or device shall preclude the interchangeability of an auxiliary product with another product of like NEMA specification within a controller assembly.

1. Controller Cabinet Requirements

The NEMA TS2 type A1 controller cabinet shall be in accordance with the following requirements.

a. General

The cabinet and the shelves shall be fabricated of aluminum. The cabinet shall be 1/8 in. minimum thickness sheet aluminum or 1/4 in. minimum thickness die-cast

260 aluminum. The cabinet exterior and interior including shelves shall have a sandblasted, roughened, or chemically etched finish that reduces gloss, reflection, and glare.

The main cabinet door shall use a Corbin lock No. 2 and each cabinet shall be furnished with two No. 2 keys. The lock shall open in a counterclockwise motion only. The door shall be capable of being opened and stopped in at least the following two ranges of degree opening as measured from the face of the cabinet door on the hinged side: 80 to 100°, and 170 to 190°. The door shall be hinged on the right side of the cabinet. The main door and the police panel door shall close against a weatherproof and dustproof gasket seal, which shall be permanently bonded to the cabinet. A
270 standard police panel key shall be provided with each cabinet.

A rain channel shall be incorporated into the design of the main door panel to prevent liquids from entering the enclosure. A 1 1/2 in. deep drawer shall be provided in the cabinet, mounted directly beneath the controller support shelf. The drawer shall have a hinged top cover and shall be capable of accommodating one complete set of cabinet prints and manuals. This drawer shall support 50 lb in weight when fully extended. The drawer shall open and close smoothly. Drawer dimensions shall make maximum use of available depth offered by the controller shelf and be a minimum of
280 24 in. wide.

b. Switches, Auxiliary, and Environmental Feature Requirements

The cabinet shall have a police door and a police control panel within the main door. The police panel shall have three different switches, one switch for field indication cutoff, one switch for flashing operation, and one switch for Auto and Manual with a manual control jack to accept a 1/4 in. monaural phone plug jack. The switches shall be protected from water when the cabinet door is open.

A test switch panel shall be mounted on the inside of the main door. The test switch panel shall include, as a minimum, the following switches. An auto/flash switch
290 shall be installed so that when in the flash position, power shall be maintained to the controller and the intersection shall be placed in flash. A stop time switch shall be installed so that when in the 'On' position the controller shall be stop-timed in the current interval. A controller equipment power On/Off switch shall be installed which shall control AC power to the CU, MMU, and cabinet power supply. All switches mounted on the switch panel on the inside of the main door shall have in place a mechanism to prevent accidental activation of the switch. "Locking bat" type switches or side switch guards are acceptable.

Switch guards, if used, shall be in place for each switch, shall be made of the same
300 material as the cabinet, and shall enable the operation of the switch without the use of tools.

All switch functions shall be permanently and clearly labeled. Handwritten labeling will not be allowed.

The cabinet shall include all required wiring, connectors, and adapters to provide full compatibility and interchangeability with either a TS2 type A1 or type A2 controller.

310 **c. Receptacle**

The cabinet shall contain one duplex convenience outlet and a lamp receptacle that is actuated and turns on when the door is open and goes off upon closing of the door and an internal On/Off switch which can override the preceding. The convenience outlet shall be duplex, three-prong, NEMA type 5-15R grounding outlet in accordance with NEMA WD - 6, with ground-fault circuit interruption as defined by the National Electric Code. These units shall be protected with a 15-ampere cartridge fuse wired ahead of the multi breakers. An additional outlet shall be provided in each cabinet and shall be a duplex, three-prong, NEMA type 5-15R grounding outlet wired after the cabinet surge protection. This unit shall be protected with a 10-ampere cartridge fuse.

320 The additional outlet in master cabinets shall be powered by the 10-ampere circuit breaker and through a separate power interrupt switch providing separate control of the master CU power supply.

d. Fan and Filter

The cabinet shall contain a thermostatically controlled ventilating fan and a vent with a commercially classified uniform 1 in. thick filter. The thermostat shall be manually adjustable from 90 to 115°F. The fan shall be mounted internally at the top and toward the front of the cabinet to exhaust out the front top lip of the cabinet. The fan shall be rated at a minimum of 100 cu ft per minute as designated by NEMA TS2-

330 7.9.1. The thermostat shall be located within 6 in. of the fan.

The filter size shall be in accordance with the provisions for the type of cabinet as stated in NEMA TS2-7.9.2.3 and shall be a replaceable pleated air filter with a minimum efficiency reporting value, MERV, rating of 5 or higher as defined by the ASHRAE 52.2-2007 specification. The cabinet ventilation shall be in accordance with NEMA TS2-7.9. The diameter of circular openings for cabinet ventilation shall not exceed 3/8 in. The short dimension for slotted openings shall not exceed 3/8 in.

340 Each inductive device, including the fan, shall have a separate power surge protection.

2. Load Switch and Flasher Requirements

The cabinet shall contain a jack mounted type 3 solid state non-repairable flasher in accordance with NEMA TS2-6.3 electrical and physical dimensions.

350 The pedestrian load switch and the signal load switch shall be an approved unit meeting all electrical and physical dimension requirements in accordance with NEMA TS2-6. The load switch shall not use a printed circuit board to transmit the 115V AC line input or signal buss output. Each load switch shall offer three indicators, one for each circuit indicating the status of the input to the load switch.

The load switch signal outputs shall be brought to a separate terminal strip for hook-up of the signal displays. Load switches inputs shall be capable of being programmed for flash, overlap, vehicular, or pedestrian phases with the use of a standard slotted or phillips screwdriver via the cabinet terminal strip. The load switch input programming of the TS2 type A1 CU shall be accomplished through front panel data entry of a TS2 type A1 or a TS2 type A2 CU.

3. Terminal and Facilities Requirements

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a. General Requirements

The TF layout shall be in accordance with NEMA TS2-5.2.7. The cabinet shall contain a main TF panel complying with NEMA TS2-5 standards. The model number of the main panel shall be permanently applied to the front of the panel, where it is easily readable, without removing or disconnecting the panel. Each controller input and output circuit shall terminate on the main TF panel or on a supplementary panel. The phase arrangement of the controller shall coincide with the channel arrangement of the load switches and MMU. All outputs on channels 9 through 12 field connections shall have a 1 μ F capacitor placed at each output terminal on the front of the TF panel.

370 All TFs within the cabinet shall be readily accessible for field connection without removing the controller or associated equipment and for maintenance in the cabinet. All stranded wiring shall be tinned. A 24 volt relay shall be used on the TF to remove 24V DC from the common side of the load switches, effectively taking the mercury relay out of the circuit when the signal is put in mechanical flash. The TF panel shall be hinged at the bottom and capable of swinging down to allow accessibility of the wiring and terminals at the rear of the panel. The backpanel shall be attached to the cabinet such that access to the backside of the backpanel, for maintenance purposes, shall be accomplished without the use of special tools or removal of auxiliary panels, shelving, or other cabinet appurtenances. A bracket extending at least half the length

380 of the NEMA load switch shall support all load switches.

Terminals shall be consecutively numbered on both sides of the TF panel and shall be in compliance with the appropriate schematic diagrams. All positions for load switches, flasher, and mechanical relays shall have reference designators on both sides of the TF panel. All nomenclature shall be on or adjacent to the component or terminal. All nomenclature shall be machine produced and not handwritten. Cabinet prints shall identify the function of each terminal position.

390 CU and MMU harness cables shall be of sufficient length to allow units to be placed on either shelf or on top of the cabinet while remaining in operational mode. RS485 port 1 communications cable shall also be of sufficient length to allow any port 1 cable to be utilized with any TS2 unit within the CA. The RS485 harness shall be constructed of a high quality shielded communications cable. The TF panel shall contain a resistor/capacitor network circuit which will provide an external restart pulse to initiate the startup sequence upon initialization from flash.

Remote flashing shall be provided for all signal circuits. Unless otherwise indicated on the plans, phases 2 and 6 shall be wired to flash yellow. All other phases shall be wired to flash red. Flashing for signal circuits shall be activated on one circuit
400 for odd numbered phases and on the other circuit for even numbered phases.

b. Power Panel Requirements

A transparent plexiglass cover shall be provided over the CA power supply panel. The cover shall leave the switches on the breakers exposed as well as leave access to terminals at the bottom of the panel for wiring purposes. No terminals on the power panel shall have silicon protectant on them in lieu of the plexiglass cover. The panel shall contain a multi-breaker with one 10A circuit breaker to provide overload protection to the CU, MMU, BIU, +12/24V DC cabinet power supply, and detection devices. It shall also contain one main circuit breaker of 35 or 40A, to provide over-
410 load protection to the signal and flash bus load. All breakers shall have line and load terminals clearly labeled. The signal bus shall be connected to the incoming AC line through a mercury contact switch or a solid state control device functionally equivalent to the NEMA 5.4.2.3 specified contact switch. The terminals for AC + and - input to the cabinet shall be capable of accepting a No. 6 wire.

With the CA 10A and main 35 or 40A circuit breakers 'Off' (tripped), all units inside the cabinet and the intersection display shall be 'Off'. With the 10A breaker 'On' and main 35 or 40A circuit breaker 'Off', the signal output shall be 'Off' and the major units within the cabinet shall function. With the 10A breaker 'Off' and main 35
420 or 40A circuit breaker 'On', the intersection shall be in flash mode and all units within the cabinet will be 'Off'.

The cabinet shall contain a 50kA, 8x20 μ s surge suppressor. The surge suppressor shall be a 120V AC, 15A, minimum 2-stage parallel/series type device and protect lines: line-neutral, line-ground and neutral-ground, have a maximum continuous operating voltage of 140V AC, maximum clamp voltage of 350 volts and device status indicators of green/good and red/failed. The device shall plug into a NEMA 12 position terminal base wired before and in parallel with the 35 or 40A main signal buss circuit breaker and in series with the 10A circuit breaker for the solid state equipment
430 and provide for a tool-free replacement of the device. There shall be a minimum of two electrical receptacles on the equipment side of the device for future auxiliary equipment. The surge suppressor shall operate between -30 to 165°F. The dimensions of the unit shall not exceed 4 1/2 in. wide by 7 in. long by 3 1/2 in. deep.

All equipment capable of operating at 12 or 24V DC typically powered by an individual receptacle type power supply shall have a power cable permanently wired into the cabinet and the device shall be powered by the cabinet TS2 power supply.

4. MMU Requirements

440 The cabinet shall contain a MMU and shall be in accordance with the standards of NEMA TS2- 4. The MMU shall be wired to monitor each load switch output.

5. BIU Requirements

All BIU's shall be in accordance with NEMA TS2 2008, Section 8. Edge mounted printed circuit boards and rack cards shall not have jumper wire modifications unless the jumper wires are permanently bonded to the PCB over its entire length. BIU's shall be supplied with each cabinet to allow for maximum phase and function utilization for which the cabinet is designed.

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6. Loop Amplifier Units and Rack Requirements

a. General

All loop amplifier units shall be in accordance with NEMA TS2-6 and shall follow type C, two-channel with delay and extend, as stated in NEMA TS2-6.5.2.2.1. All amplifiers shall be selected from the QPL of Traffic Signal and ITS Devices for each type of amplifier. In addition, loop amplifiers shall have an LCD display or a RS232 serial data connection and software interface capable of displaying loop status including but not limited to operating frequency and $-\Delta L/L$, diagnostics, and all amplifier settings and operating parameters. Edge mounted printed circuit boards and rack cards shall not have jumper wire modifications unless the jumper wires are permanently bonded to the PCB over its entire length.

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All detection components including amplifiers, racks, auxiliary BIU, interface panels, lead-ins, and all connecting harnesses shall provide one count output channel per lane of each approach within project limits.

All loop amplifiers designated for counting shall meet all requirements as above and shall additionally transmit channel 1 and 2 count pulses on the edge connection assigned to channels 3 and 4 respectively. Counting amplifiers shall be configured with count outputs mapped to and recorded in the CU detector logs. The status output of each active counting channel, 3 and 4, shall be set to logic ground by software configuration within the amplifier or externally by use of jumper card in the adjacent slot.

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An auxiliary BIU panel may be used strictly for count outputs, channels 3 and 4 only, in this configuration, the status outputs for those count output channels may be wired to logic ground on the BIU panel. The status outputs for all standard output channels shall provide accurate status data at all times. All detector input data to the CU shall remain accurate at all times.

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All M and P-1 cabinets shall incorporate a 16 channel detector rack, configuration No. 2, in accordance with NEMA TS2-5.3.4, and shall allow operation of a two-channel detector in each slot and the capability of operation of a two-channel counting amplifier in each even-numbered slot with the respective count outputs in each odd numbered slot. The number of detector racks provided shall be determined by the loop tagging table. All G cabinets shall incorporate an eight-channel detector rack, configuration No. 1, in accordance with NEMA TS2-5.3.4.

490 All detector loop panels and detector racks shall be labeled according to the loop tagging table and as follows.

All detection shall be labeled in such a way that the numbering for any loop is consistent throughout the cabinet; the loop terminated as Loop or Detector 17 shall be Detector Channel 17 in the detector rack and Detector Input 17 to the controller.

b. Loop Termination Panel

Each loop lead-in panel shall be labeled on the upper left corner with the loop numbers that are terminated on that panel as follows: (1-16), (17-32), (33-48), (49-64). Each loop termination point shall be labeled with the corresponding loop number.
500 Example: For panel 17-32: loops terminated on this panel will start with 17 and end with 32.

c. Detector Rack

Each detector rack shall be labeled at the bottom of the rack with a continuous label. The label shall be 1 in. wide, thermal printed black on clear, white or matte polyester tape with permanent adhesive, water, chemical and scratch resistant printed with 4 lines of Arial, size 10 font. Below the BIU shall be the BIU number and detector channel numbers that are contained within the rack as follows: (1-16), (17-32), (33-48), (49-64). This area shall also contain the intersection for diamond interchanges
510 controlled from one cabinet. Each slot shall be labeled below the module with the corresponding loop tag information; the count output number portion of the information shall be under the first part of the tag information. For each two-channel module, channel 2's label shall be below channel 1's label.

7. Cabinet Power Supply Requirements

The TS2 cabinet power supply shall adhere to the guidelines of NEMA TS2-5.3.5. The power supply shall be encased on all sides so that no circuitry is exposed to the user.

520 (g) Cabinets

1. G Cabinet (Size 3)

The G cabinet shall be pedestal-mounted or pole-mounted. As per NEMA TS2-5.3, the TS2 type 1 G cabinet, at minimum, shall house an eight-load switch bay (configuration 2) terminal and facilities panel and shall have 1 adjustable shelf located 12 in. below the top of the cabinet. The bottom of the cabinet shall be reinforced to ensure a secure pedestal mounting. The G cabinet shall have dimensions of 25 in. wide, 38 in. high, 18 in. deep with a tolerance of + 4 in. in any or all dimensions.

530 A cabinet slipfitter shall be used to attach the cabinet to the pedestal. The slipfitter shall fit a 4 1/2 in. outside diameter pipe and shall have a minimum of three set screws equally spaced around the slipfitter.

A vent of adequate size shall be provided. The size of the vent and the filter requirements shall be in accordance with the manufacturer's recommendations.

2. M Cabinet (Size 5)

540 As per NEMA TS2-5.3, the TS2 type 1 M cabinet, at minimum, shall house an eight-load switch bay (configuration 2) terminal and facilities panel and shall have two adjustable shelves with the first shelf located 15 in. below the top of the cabinet and the second located 7 in. below the first shelf.

The M cabinet shall be ground-mounted on a concrete foundation at locations and dimensions as shown on the plans.

The M cabinet shall have dimensions of 30 in. wide, 48 in. high, and 16 in. deep with a tolerance of ± 2 in. in any or all dimensions.

550 Anchor bolts shall be steel in accordance with ASTM A36. Diameter of the bolt shall be 1/2 in. or 5/8 in. and the minimum length shall be 15 in. plus 3 in. right angle hook on the unthreaded end.

The top 6 in. of the bolt shall be threaded with 13 NC threads on 1/2 in. bolts and 11 NC threads on 5/8 in. bolts. The hexagon nut, the flat washer, and the threaded end of the bolt shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM B695, class 55.

560 The cabinet shall include one loop detector rack.

3. P-1 Cabinet (Size 6)

The P-1 cabinet shall be ground mounted on a concrete foundation at locations and dimensions as shown on the plans with anchor bolts in accordance with 922.02(g)2. As per NEMA TS2-5.3, the TS2 type 1 P-1 cabinet, at minimum, shall house a 16-load switch bay (configuration 3) terminal and facilities panel and shall have two adjustable shelves with the first shelf a minimum of 30 in. above the bottom of the cabinet, the second shelf having a minimum clear opening of 11 in. above the first shelf.

570 The cabinet shall be 44 in. wide, 52 in. high, and 24 in. deep with a tolerance of ± 3 in. in any or all dimensions.

The cabinet shall include two loop detector racks.

4. R Cabinet (Size 7)

The R cabinet shall be ground mounted on a concrete foundation at locations and dimensions as shown on the plans with anchor bolts in accordance with 922.02(g)2. As per NEMA TS2-5.3, the TS2 type 1 R cabinet, at minimum, shall house a 16-load switch bay (configuration 3) terminal and facilities panel and shall have three

922.02

580 adjustable shelves with the first shelf located a minimum of 30 in. above the bottom of the cabinet, the second shelf having a minimum clear opening of 11 in. above the first shelf and the third shelf having a minimum clear opening of 11 in. above the second shelf.

The cabinet shall be 44 in. wide, 72 in. high, and 24 in. deep with a tolerance of ± 3 in. in any or all dimensions.

The cabinet shall include three loop detector racks.

590 **5. Flasher - Two Circuit Alternating Flasher**

Two circuit alternating flasher shall be solid state.

a. General

The solid state flasher shall periodically interrupt a source of alternating current line power. Solid state shall mean electrical circuits, the active components of which are semi-conductors, to the exclusion of electromechanical devices or tubes.

600 The flasher shall be a type 3 solid state flasher conforming to NEMA TS1-1989. The flasher output circuit carrying the signal load shall consist of opto or photo isolated solid state power relays and shall be hard wired to the flasher connector.

Three schematic diagrams and three descriptive parts lists shall be furnished with each flasher.

Two circuit flashers shall be plug-in design. The flasher design shall not allow the unit to be inserted improperly into the plug-in base. The flasher shall have heavy-duty plugs and jacks capable of handling the rated load current. The rate of flash shall be 50 to 60 flashes per minute.

610 The flasher shall operate between 95V and 135V AC 60 Hz. No degradation of performance shall be experienced in environmental changes from -20 to 165°F and 0 to 90% relative humidity.

b. Cabinet Requirements

The cabinet shall be weatherproof and fabricated from cast aluminum or aluminum sheeting with a minimum thickness of 1/8 in. The cabinet door shall be the entire front of the cabinet and shall be hinged on the right or left side of the cabinet. A Corbin No. 2 lock and two No. 2 keys shall be furnished. The lock shall be located near the center of the door on the side opposite the hinge.

620 Minimum dimensions for the cabinet shall be 12 in. deep, 12 in. wide and 12 in. high. The maximum dimensions shall be 18 in. deep, 15 in. wide and 18 in. high.

The cabinet shall have two pole plates for stainless steel band mounting of the cabinet on a pole with a minimum diameter of 4 in. and a maximum diameter of 18 in.

Two blank cover plates shall be provided. Two hub plates for 1 in. diameter conduit shall be provided with gaskets, eight bolts at four bolts per plate, nuts, and washers for attaching the hub plates to the cabinet. The cabinet shall be drilled for the mounting of the pole plates or hub plates as shown on the plans.

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It shall have a screened vent in the bottom with a minimum size of 1 3/4 sq in., and a minimum of one louvered and screened vent towards the top of the cabinet.

The panel in the cabinet shall be capable of being removed and reinstalled with simple hand tools. A 25 ampere radio interference filter and surge arrestor wired ahead of a 15 ampere circuit breaker shall be mounted on the panel. A terminal block capable of the following electrical connections shall be mounted on the panel:

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- Circuit 1 - for connection of field signals (flash circuit 1)
- Circuit 2 - for connection of field signals (flash circuit 2)
- Circuit 3 - for connection of field signals (field neutral)
- AC plus - capable of accepting a No. 6 wire
- AC minus - capable of accepting a No. 6 wire
- Ground lug - capable of accepting a No. 6 wire.

922.03 Signal Head Components

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The components shall be in accordance with the Institute of Transportation Engineers for Adjustable Face Vehicular Traffic Control Signal Heads. All new traffic signal and flasher installations that include new indications shall be fitted with LED modules. All LED indications shall be selected from the QPL of Traffic Signal and ITS Devices.

(a) General

The signal faces shall be sectional in construction, requiring one section for each lens and furnished in the nominal size of 12 in. Each section of a face shall have a rectangular silhouette when viewed from the front or the rear.

(b) Housing, Door, and Visor

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The top and bottom of each housing shall have an integral locking ring with 72 serrations to enable rotation of the signal housing in 5° increments. Hub openings in the top and bottom of the signal housing shall accommodate standard 1 1/2 in. bracket arms. The thickness of the hub at the top and bottom of the housing shall be a maximum of 1 in. and a minimum of 3/8 in. The 12 in. door shall have two simple locking devices. The door on the hinged side shall be attached with hinge pins. Each lens shall have the standard cap type visor. All screws, latching bolts, locking devices, and hinge pins shall be stainless steel.

(c) Signal Indications

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1. LED Signal Indications

All LED indications shall be selected from the QPL of Traffic Signal and ITS Devices.

All LED indications shall have a permanent indelible sticker affixed to the back of the module indicating month and year of initial installation.

680 All LED indications provided shall be individually listed on a parts list indicating the contract number, vendor, category, manufacturer, model, serial number, and inventory number. Hard copy and electronic copies shall be provided. The electronic document format and the blank worksheet shall be obtained from the Department's Traffic Management Division.

2. Incandescent Signal Indications

All new traffic signal and flasher installations that include new indications shall be fitted with LED's. The minimum design requirements for replacement incandescent light bulbs to be used in a traffic signal face shall be in accordance with the Institute of Transportation Engineers standard for traffic signal bulbs.

(d) Wiring

690 The field wiring leads shall be terminated with screw spade lug type connectors. The LED module wiring leads shall be terminated with 1/4 in. female type connectors for ease of connection to the terminal block.

(e) Section Coupling

Any method to connect two or more sections together may be used, if the following requirements are met:

- 700 1. Two or more sections, when jointed together, shall maintain structural integrity when loaded in accordance with Institute of Transportation Engineers Standards.
2. The opening between joined sections shall accommodate two 1/2 in. cables.
3. The maximum length of bolts used to connect sections together shall be 4 in.

710 Nuts, bolts, and lock washers shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and be in accordance with the coating thickness, adherence, and quality requirements of ASTM B695, class 55.

(f) Terminal Block

The center section of the three-section signal head, both center sections of the four-section head, one section of the two-section signal head, and each one-section signal head shall be equipped with a five-position terminal block for termination of field wiring. Each section shall have provisions for two five-position terminal blocks. Each terminal screw shall have a 1/4 in. corresponding spade tab. The terminal block shall have a minimum spacing between screw connections of 1/2 in. The height of the

insulating ridge between screw connections shall be a minimum of 19/32 in. from the
720 base of the terminal blocks.

(g) Material Requirements

1. Polycarbonate Signal Head

The housing, door, and visor of the section shall be made of ultraviolet and heat stabilized polycarbonate. The black color shall be permanently molded into the components.

2. Die-Cast Aluminum Signal Head

730 The housing, door, and visor of the section shall be made of a die-cast, corrosion resistant, copper free, non-ferrous metal which shall be in accordance with ASTM B85. All surfaces of the housing, doors, and visor shall be shop painted or powder coated. The finish shall be nonreflecting flat black, color No. 37038, in accordance with SAE-AMS-STD-595.

(h) Signal Backplates

740 The traffic signal backplate shall be one piece and made of sheet aluminum. The sheet aluminum shall have a nominal thickness of 0.063 in. and shall be according to ASTM B209, alloy 5052. The backplate shall be designed to be attached to a signal face without interfering with the opening and closing of the traffic signal door. It shall be rectangular in shape with round corners and shall be of such dimensions as to give an exposed margin of 5 in. on each side.

The backplate shall have a 2 in. wide yellow retroreflective strip applied to the outside perimeter of the backplate. The sheeting shall be Type IV in accordance with 919.01(b) and applied in the orientation for the maximum angularity according to the manufacturer's recommendations.

750 The aluminum backplates shall be shop painted or powder coated. The finish shall be nonreflecting flat black, color No. 37038, in accordance with SAE-AMS-STD-595.

(i) Certification

A material certification shall accompany each order certifying that a signal head from a normal production run within the past 12 months, passed the Institute of Transportation Engineers criteria for breaking strength and deflection. Deflection testing is not required in the certification for polycarbonate signal heads.

922.04 Pedestrian Signal Components

760 (a) Pedestrian Signal Head

A pedestrian signal shall be one section and rectangular in shape. The dimensions of each side may vary from 18 to 19 in., including the visor and the hinges. The signal shall contain two figures with two different colored messages. The first figure shall transmit an upraised hand symbol message, and the second figure shall transmit a

walking person symbol message. All new installations including new pedestrian indications shall use Light Emitting Diodes with countdown displays. All pedestrian LED indications shall be selected from the QPL of Traffic Signal and ITS Devices. The pedestrian signal shall be in accordance with the standard of the Institute of Transportation Engineers for Pedestrian Traffic Control Signal Indications.

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1. Housing, Door, and Visor

The housing shall be equipped with mounting device hardware, such as a clamshell, with round openings at the top and bottom for mounting with brackets made of iron pipe standard, to fit the 1 1/2 in. pipe. The round openings shall have a common vertical centerline through the housing to allow for rotation. The round openings shall have a serrated ring, with 72 serrations, which enables locking of the housing in 5° increments. The brackets or the clamshell shall serve as the electrical conduit for the pedestrian signal. The housing shall be black and made of die-cast, corrosion resistant, copper free, non-ferrous metal which shall be in accordance with ASTM B85.

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The door on the front of the housing may be hinged from any side. The door shall be gasketed to maintain a weather-tight enclosure when secured to the housing. The door and the visor shall be made of the same material as the housing or of polycarbonate. All materials shall be clean, smooth, and free from flaws, cracks, blowholes, or other imperfections.

The polycarbonate components shall be black in color. The metal components shall be painted or powder coated. The finish shall be nonreflecting flat black, color No. 37038, in accordance with SAE-AMS-STD-595.

790

2. Message

The upraised hand and walking person symbols shall each be a minimum of 11 in. in height. The width of the upraised hand symbol shall be a minimum of 7 in. The width of the walking person symbol shall be a minimum of 6 in. Message configuration, color, and size shall be in accordance with the standard of the Institute of Traffic Engineers for Pedestrian Traffic Control Signal Indications.

800

Each pedestrian signal shall be completely wired internally, and ready for connection of the field wiring. A suitable terminal block for connection of the internal wiring and the incoming field wires to the pedestrian signal head shall be provided in the signal housing.

The light source shall be designed and constructed so that if an electrical or mechanical failure occurs, the upraised hand and walking person symbols shall also remain dark.

(b) Pedestrian Push-Button

Pedestrian push-button assemblies shall meet the standards of the MUTCD and Americans with Disabilities Act, ADA. Pedestrian push-button assemblies shall be 810 vandal and weather resistant, be pressure activated with minimal movement, and

cannot be stuck in a closed or constant call position. A red latching LED and audible tone shall be provided for confirmation of an actuation call.

A type D certification in accordance with 916 shall be provided for the pedestrian push-button. Such certification shall contain the contract number, manufacturer's name, model name, supplier's name, location or intersection name, and for a type APS pedestrian push button, the sound level measurement of the audible features of the device.

820

1. Housing

The pedestrian push-button housing shall be constructed of cast aluminum, cast zinc alloy, or stainless steel and powder coated yellow, and furnished with suitable mounting hardware.

2. Latching LED

The normal state of the LED shall be off. When the push button is pressure activated, the LED shall be lighted and remain on until the beginning of the walk phase. The latching relay shall be mounted in the signal cabinet, controlling two pedestrian phases.

830

3. Actuator

The actuator shall be stainless steel or aluminum with a minimum diameter of 2 in. and a solid state electronic Piezo switch rated for a minimum of 20 million cycles with no moving plunger or moving electrical contacts. The operating voltage shall be 12-24V. The actuator's nominal operating force shall not exceed 5 lb.

4. Sign

The pedestrian sign shall be the R10-3e in accordance with the MUTCD, unless a different MUTCD sign code is indicated on the plans. The sign base shall be sheet aluminum in accordance with 919.01(b).

840

5. Accessible Pedestrian Push Buttons

When accessible pedestrian signals, APS, are specified, the push-button shall have audible and tactile features. The push-button shall activate both the Walk interval and the APS. The color of the actuator shall contrast visually with the housing or mounting. A standard manufacturer's warranty shall be provided.

a. Audible Features

The pedestrian push-button assembly shall include an audible indication of the Walk interval by either tone or voice and shall be audible from the near side of the associated crosswalk. If the tone for the Walk interval is the same as the locator tone of the push-button, it shall have a faster repetition rate than the associated locator tone. The volume of the audible features shall have automatic volume adjustment based on the ambient noise levels. Audible features shall be at least 2 dB but no more than 5 dB louder than ambient sound, up to a maximum volume of 89 dB measured at 36 in. from

850

the device. Audible features may be integral to the pedestrian push-button assembly or through a separate speaker housing.

860 When push buttons are separated by 10 ft or more, the audible indication shall be a tone.

When push buttons are separated by less than 10 ft, the indication shall be a voice message. When voice messages are used, they shall include a clear message that the walk interval is in effect and shall indicate to which crossing it applies.

The pedestrian push button shall have an audible locator tone feature. The locator tone shall have a duration of 0.15 seconds or less and shall repeat at 1 second intervals.

b. Tactile Features

870 The push button assembly shall incorporate a raised arrow. The arrow shall be raised 0.03125 in. minimum and shall be 1.5 in. minimum in length. The arrow color shall contrast with the background. The raised arrow shall vibrate to indicate that the walk interval is in effect.

922.05 Blank

922.06 Disconnect Hanger Junction Box

880 Traffic signal disconnect hanger junction boxes shall consist of a span hanger, a balance adjuster, a disconnect hanger clevis, and a housing with a hinged door with a positive latching device. The span hanger, balance adjuster, and all related hardware shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM B695, class 55. The housing shall be made of a die-cast, corrosion resistant, copper free, non-ferrous metal which shall be in accordance with ASTM B85. The balance adjuster fitting shall be made of ferrous or non-ferrous metal. When made of ferrous metal it shall be galvanized in accordance with the requirements for the components and related hardware as set out above.

890 The disconnect hanger shall be designed so that the maximum allowable space or play between the span hanger and the eye-bolt of the balance adjuster and between the balance adjuster and the disconnect hanger clevis, at points where they are attached to each other by rivet pins or hex head bolts and nuts with lock washers, shall be 0.062 in. The span hanger bolt where the eye-bolt or the balance adjuster is attached shall be 5/8 in. diameter.

900 When serrated locking rings are not integrally cast in the components, the component and locking ring shall be designed so that when the locking ring is placed flush against the component, the component and locking ring shall not rotate or slide when torque is applied. The serrated components shall have 72 serrations to enable rotation of the disconnect hanger clevis, hub plate, or signal head in 5° increments.

There shall be no thread in contact with a wearing surface. Locking rings shall be a minimum thickness of 3/16 in. and a maximum thickness of 1/4 in. from the base of the ring to the serration peaks. The inside diameter shall be 2 in. and the outside diameter shall be 2 7/8 in.

910 The terminal block shall have an 18-point terminal block permanently engraved or etched with sequential numbers indicating the circuits. The terminal block shall not have a method of connection which allows a screw point to damage wires when the wires are securely connected. Each point of connection shall accommodate a minimum of four No. 14 gauge wires.

The disconnect hanger shall have two side entrance holes on opposite sides capable of receiving a 1 1/2 in. plastic or rubber insert to reduce water infiltration. It shall be capable of supporting signal faces in the ambient temperature range of -35 to 120°F without failure.

920 The balance adjuster shall have hex head bolts, lock washers, and nuts for securing the main body of the balance adjuster firmly onto and around the eye-bolt to prevent any twisting or turning of the head suspended below it. The span hanger shall have two J-bolts, lock washers, and hex head nuts adequate in size to securely fasten the hanger to a messenger cable up to 1/2 in. in diameter.

A type C certification in accordance with 916 shall be provided for the disconnect hanger junction box.

922.07 Signal Support Assemblies

(a) Clearance

930 The maximum allowable space or play between the hanger assembly and the eyebolt of the balance adjuster and between the balance adjuster and the weatherhead clevis, at points where they are attached to each other by rivet pins or hex head bolts and nuts with lock washers, shall be 0.062 in. No bushings or shims will be allowed in this assembly.

(b) Balance Adjuster

940 The balance adjuster shall consist of a hex head bolt, a lock washer, and nuts for securing the main body of the balance adjuster onto and around the threads of the eye-bolt to prevent any twisting or turning of the adjuster.

(c) Span Hanger

The span hanger, balance adjuster, weatherhead, and all related hardware shall be made of a non-corrosive metal or shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM B695, class 55. The weatherhead shall have a minimum of 2 1/2 in. of exposed threads. The weatherhead shall have two set screws to fasten the nipple to the weatherhead. If the weatherhead and threaded pipe

has a slip-in connection, the locking device shall be a double nut assembly. If the weatherhead and threaded pipe has a screw-in connection, the locking device shall be a double set screw assembly.

The span hanger shall be furnished with two each of J-bolts, lock washers, and hex head nuts. The J-bolt shall be a minimum of 1/4 in. diameter and shall have sufficient threads to be able to secure the hanger to a 1/4 in. or to a 1/2 in. span cable.

(d) Tether Bracket

The tether bracket shall attach to a 1/4 in. tether and prevent the bottom of the head from moving side-to-side on the tether. Where backplates are installed on the signal heads, the tether bracket shall be of the proper length for the backplate so that the cable is mounted below the bottom of the backplate to avoid interference with head alignment and damage to the backplate. Three bolts, nuts, and washers, shall be used to secure the tether bracket to a three-section or four-section signal head. A wire rope clamp in accordance with 922.10(e)4c, shall be used to secure the tether bracket to the tether. The tether bracket shall have predrilled 1/2 in. diameter holes. In lieu of the wire rope clamp and 1/2 in. diameter holes, a beveled tether plate that completely fills in the extruded portion of the tether bracket may be used to secure the tether bracket to the tether. The tether bracket shall not extend more than 2 in. below the tether.

(e) Pipe Arm Assemblies

The multiple pipe arm assembly shall consist of a span hanger assembly, a balance adjuster, a signal weatherhead, a two, three, or four- way pipe arm, 1 1/2 in. pipe, a lower arm assembly, and all related hardware necessary for a complete assembly.

The two, three, or four-way pipe arms shall have a minimum of 2 in. of exposed thread. Each arm of the pipe arm shall be furnished with two serration locking rings. One locking ring shall have a 3 in. outside diameter and one locking ring shall have a 2 3/8 in. outside diameter.

Assembly	Maximum Allowable Weight
Two-way	19 lb
Three-way	25 lb
Four-way	28 lb

922.08 Signal Cantilever Mount Signal Bracket

The bracket shall allow the following four adjustments:

- (a) rotational adjustment about bracket axis;
- (b) vertical adjustment;
- (c) rotational adjustment about signal cantilever arm; and
- (d) rotational adjustment right and left from vertical plane

990 The bracket shall be fastened to the supporting arm or structure with stainless steel bands. The bracket shall adjust to fit all sizes of round, octagonal, elliptical, or other shape structure without special tools or equipment.

The bracket shall attach to the signal by clamping the signal head both top and bottom and shall be designed to accommodate the specified signal configuration. Each bracket shall be complete with all necessary hardware to attach the traffic signal to the bracket and the bracket to the support.

All electrical wiring shall be concealed within the bracket, except that which runs from the bracket to the signal cantilever arm.

1000 Upper and lower arms shall be cast from aluminum in accordance with ASTM B26, alloy 713.0-T5 or 356.0-T6. The vertical support tube shall be extruded from aluminum in accordance with to ASTM B241, alloy 6061-T6 or 6063-T6, and the strapping to attach the bracket to the arm shall be stainless steel. All steel or malleable iron parts shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A153, B695, class 55.

922.09 Pedestal Poles and Cast Aluminum Pedestal Bases

1010 The pedestal base used for mounting pedestrian signal heads or control cabinets shall be in accordance with 922.09(a). The length of the pedestal pole shall be as shown on the plans.

(a) Cast Aluminum Pedestal Base

A pedestal mounted G cabinet shall have a cast aluminum pedestal base. The cabinet and pedestal base shall be ground mounted on a concrete type A foundation at locations and dimensions as shown on the plans.

1020 The cast aluminum base shall be made of aluminum in accordance with ASTM B179, alloy ANSI 319.1 or 319.2, or in accordance with ASTM B26, alloy ANSI 356.0 - T6. The square base shall include an access door and anchor bolts with nuts and washers. The base shall be 13 3/8 in. square and 15 in. in height $\pm 1/4$ in. The weight shall be 22 lb $\pm 5\%$.

1030 The base shall be designed to support a 150 lb axial load and 11 sq ft of signal head area rigidly mounted. For design purposes, the distance from the bottom of the base to the center of the signal head area is 18 ft. In addition to the dead load, the base shall be designed to withstand wind and ice loads on the specified signal head area and on all surfaces of the support, in accordance with the AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals. Wind speeds used for design shall be based on a 10 year mean recurrence interval and a wind drag coefficient of 1.2 or as shown on the plans. The base shall contain an access door, which is 8 by 8 1/4 in. $\pm 1/4$ in. with a stainless steel hex head bolt for attaching the door.

1040 The base shall be attached to a foundation by four anchor bolts, with an anchor bolt circle of 12 3/4 in. Slotted lugs shall be integrally cast into the four corners of the base for attachment of the anchor bolts. The anchor bolts shall be steel in accordance to ASTM F1554, Grade 36. The diameter of the anchor bolt shall be 3/4 in. with a minimum length of 18 in. $\pm 1/2$ in., plus 2 1/2 to 3 in. right angle hook on the unthreaded end. The top 4 in. of the bolt shall be threaded with 10 NC threads. The threads, plus 3 in., shall be hot-dip galvanized in accordance with ASTM F2329 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM B695, Class 55. Each anchor bolt shall be provided with two high strength heavy hex head nuts in accordance with ASTM A563 and three washers. Two of the washers shall have a minimum 2 in. and maximum 2 1/8 in. outside diameter and be in accordance to ANSI B 27, type B regular series and one shall be a nominal 3/4 in. series W washer, in accordance with ASTM F436.

1050 The cast aluminum pedestal base shall be in accordance with the dimensions and requirements shown on the plans. The casting shall be true to pattern in form and dimensions; free from pouring faults, sponginess, cracks, and blowholes; and free from other defects in positions affecting the strength and value of the intended use for the casting. The base shall not have sharp unfilleted angles or corners. The surface shall have a workmanlike finish.

The door and bolt for the door shall be interchangeable on cast bases from the same manufacturer.

(b) Pedestal Pole

1060 The top of the base shall accommodate a pole having a 4 1/2 in. outside diameter. The threads inside the top of the base shall be 4 in. national standard pipe threads. The pole shall be either a steel pedestal pole or an aluminum pedestal pole.

1070 A steel pedestal pole shall be a seamless Schedule 40 carbon steel pipe in accordance with ASTM A53, grade B. The pole shall have an outside diameter of 4 1/2 in. The pole shall weigh approximately 10.8 lb/ft. The length of the pole shall be as shown on the plans. The pole shall have full depth national standard pipe threads on one end of the pole. The length of threads shall be 2 1/2 in. The pole shall be galvanized, after threading, in accordance with ASTM A123. The threads shall be cleaned of all excess galvanizing and protected by a suitable shield.

An aluminum pedestal pole shall be in accordance with ASTM B241 for seamless aluminum alloy, Schedule 40, 6061-T6. The outside diameter of the pole shall be 4 1/2 in. The length of the pole shall be as shown on the plans. The pole shall weigh approximately 3.7 lb/ft. The pole shall have full depth national standard pipe threads on one end of the pole. The length of threads shall be 2 1/2 in. and protected by a suitable shield. The pole shall have a spun finish.

(c) Pole Cap

1080 A pole cap shall be supplied for the top of the pole if the pole is used for the mounting of pedestrian signal faces or side mounted signal control cabinets. The pole cap shall be either a cast pole cap of aluminum or a pole cap of spun aluminum.

A cast pole cap shall be made of aluminum, in accordance with ASTM B179, alloy ANSI 319.1 or 319.2. The cap shall fit freely on the 4 1/2 in. outside diameter pole. A set screw using a 3/4 in. No. 12 hex head machine screw shall be supplied to hold the cap on the pole. A standard foundry draft will be allowed on the casting.

1090 A pole cap made from spun aluminum shall be in accordance with ASTM B209, alloy 1100-0. The cap shall fit tightly when placed on the end of the pole.

922.10 Signal Supports

All welding shall be in accordance with 711.32. Welds shall generate the full strength of the shaft. Only longitudinal continuous welding will be allowed on the pole shaft. Contacting joint surfaces shall be cleaned before fabrication then sealed by means of welding. Working drawings shall be submitted in accordance with 105.02.

(a) Steel Strain Pole

1100 The steel strain pole shall be an anchor base type pole and shall include a handhole and a pole top or cap. The poles shall be furnished in lengths specified.

The pole shall have a handhole within 18 in. of the base. The pole shall have a top or cap with a set screw that can be removed with small hand tools.

The pole material shall be in accordance with ASTM A595 or A572 with a minimum yield strength of 50,000 psi. The pole shall be galvanized after fabrication in accordance with ASTM A123.

1110 All hardware, handhole cover and latching device, and band-type steel polebands shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM B695, Class 55. All nuts and bolts, except anchor bolts, shall be in accordance with ASTM A307, and shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. If a cast pole top or cap is used it shall be in accordance with ASTM A126 and shall be galvanized with a minimum coating of 2 oz/sq ft.

1120 The polebands shall fit the pole as planned. The wire rope shall not be in contact with any 90° edges or with any threads on the band. The pole band material shall be in accordance with ASTM A572, grade 50; ASTM A606; or ASTM A36 with minimum yield of 50,000 psi. The minimum width of the bands shall be 3 in. and the bands shall be capable of supporting the pole design load. Each half of the band shall be stamped with the corresponding size number.

The pipe coupling for the weatherhead and base plate shall be installed prior to galvanizing. The threads shall be cleaned of all excess galvanizing. An internal J-hook shall be installed near the top of the pole for wire support.

1130 The steel strain pole shall be capable of supporting an 8,000 lb load applied horizontally 18 in. below the top of the pole with a maximum allowable deflection of 0.16 in. per 100 lb of load. The pole shall be tapered 0.14 in./ft of length.

A one-piece base plate shall be secured to the base of the pole and shall develop the full strength of the pole. The base plate material shall be in accordance with ASTM A36, ASTM A572, or ASTM A588. The base plate shall have four holes of adequate size to accommodate 2 1/4 in. anchor bolts. The bolt circle shall have a 22 in. diameter and bolt square of 15 1/2 in.

1140 Four high strength steel anchor bolts, 2 1/4 in. in diameter and 96 in. long, including the hook, shall be furnished with each pole. Each bolt shall have two heavy hex nuts and two washers in accordance with ASTM A563 and F436 respectively. The anchor bolt material shall be in accordance with ASTM A576 or ASTM A675 with a minimum yield strength of 55,000 psi or ASTM A36, special quality, modified to 55,000 psi or approved equal. The threaded end of the anchor bolt shall have 12 in. of 4 1/2 NC threads and shall be galvanized the length of the threads, plus 3 in. The threaded end shall be hot-dip galvanized in accordance with ASTM A153 or be mechanically galvanized in accordance with ASTM B695, Class 55. The unthreaded end of the anchor bolt shall have a standard L bend for a distance of 9 in. from the centerline of the anchor bolt to the end of the L. In lieu of the standard bend a steel plate 4 1/2 sq in. and 1 1/4 in. thick may be welded to the embedded end of the anchor bolt.

1150

(b) Timber Strain Pole

Timber strain poles shall be made from southern yellow pine and shall be in accordance with the current ANSI Specifications and Dimensions for Wood Poles No. 05.1. They shall be of the length and class specified.

1160 All poles shall be full length pressure treated by the full cell process in accordance with current specifications as set forth in the AWWA Standards T1 and U1, Commodity Specification D: Poles, use category UC4B using preservative as outlined in 911.02(h).

Treatment, handling, and storage methods shall be in accordance with the current AWWA Standards.

(c) Signal Cantilever Structures

1. General

All traffic signal cantilever structures, with or without combination arm, shall be as shown on the plans.

1170

There shall be no threads in the wearing surface plane at the point of connection between the clevis clamp and the signal face assembly. The clevis clamp shall have an 11/16 in. diameter bolt hole to receive the signal face assembly.

1180 The signal cantilever structure pole, sections 1 and 2, signal arm, and combination arm shall be a round or multi-sided tapered tube, except the upper 4 to 6 ft of a signal pole may be non-tapered. The pole and arms taper rate shall be 0.14 in./ft. A 1/2 in. 13 NC threaded grounding nut or approved equivalent shall be provided and be accessible through the handhole. The pole cap shall be secured in place with setscrews. The pole shall be provided with a removable pole cap and integral wire support hook for the luminaire electrical cable. The cable shall be attached to the hook by a service drop clamp.

1190 The signal cantilever arm and combination arm, if required, shall be attached to the pole as shown on the plans. The arms shall have cable inlets as shown on the plans. All signal heads on the arm shall be attached as shown on the plans and installed parallel to the horizontal plane and centered to the cantilever arm. The cantilever arms shall be used as an enclosed raceway for wiring and shall be free of burs or rough edges.

The pole top luminaire for roadway lighting, if required, shall be installed on these structures as shown on the plans.

2. Base Plate

A one-piece anchor base shall be supplied as shown on the plans. Four removable bolt covers shall be provided with each base and each cover shall attach to the upright portion of the body of the base by means of one-hex head cap screw.

3. Materials

1200 The signal cantilever pole, arms, base plates, arm flange plates, gusset plates, ring stiffeners, and pole splice plates shall be in accordance with ASTM A595 or A572 with a minimum yield strength of 50,000 psi.

4. Hardware

1210 High strength heavy hex bolts for the pole splice shall be in accordance with ASTM F3125, grade A490 and shall be coated in accordance with ASTM F1136, Grade 3, ASTM F2833, Grade 1, or ASTM F3019, Grade 4, as shown in ASTM F3125. The contact area for both pole splice plates shall be class B in accordance with AASHTO Standard Specifications for Highway Bridges, Table 10.32.3C with a minimum slip coefficient of 0.5. The surfaces shall be blast cleaned with class B coatings. The arm flange plate connection bolts shall be in accordance with ASTM F3125, grade A325. All other hardware shall be in accordance with ASTM A307 and by either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. A cast pole cap shall be in accordance with ASTM A126 and shall be galvanized with a minimum coating of 2 oz/sq ft.

5. Anchor Bolts

1220 Four steel anchor bolts, each fitted with two high strength heavy hex nuts and two flat washers, shall be furnished with each pole. The anchor bolt shall be as shown on the plans with a minimum of 15 in. of seven NC threads on the upper end. The threads, nuts, and washers shall be either hot dip galvanized in accordance with ASTM F2329 or mechanically galvanized in accordance with ASTM B695, Class 55. The steel for the bolt shall be in accordance with ASTM F1554, with a yield strength of 36,000 or 55,000 psi.

6. Finish

1230 All steel material shall be fully galvanized. Galvanizing shall take place after all welding is accomplished and holes cut.

7. Working Drawings

Working drawings and design calculations shall be submitted in accordance with 105.02.

(d) Downguys, Anchors, Rods, and Guards

1240 Pole anchors shall be eight way expanding with a minimum area of 135 sq in. when expanded or a 10 in. diameter screw anchor. They shall have a minimum holding strength of 10,000 lb. They shall be painted and in accordance with ASTM A575. Anchor rods for expanded anchors shall be 3/4 in. diameter steel and for screw anchors shall be 1 1/4 in. diameter steel, 8 ft long, in accordance with ASTM A659, and be galvanized in accordance with ASTM A153.

1250 Guy guards shall be made of 18 gauge galvanized steel, polyethylene, polyvinyl chloride, or melamine phenolic, and shall be 7 ft long. The steel guy guard shall have a tight gripping, non-scarring hook for quick attachment to the guy wire. The bottom shall have a clamp that fits over the anchor rod and securely grips by tightening the bolt. Steel guy guards shall be in accordance with ASTM A659. The nonmetallic guy guard shall be a helical pigtail which shall resist upward movement, a lock strap to secure the lower end, and a guy guard sleeve. Non-metallic guy guards shall be gray or yellow.

(e) Support Cable

1. Messenger Cable

Messenger cable shall be zinc-coated steel wire strand, contain seven wires, and have a nominal diameter of 3/8 in. The cable shall be in accordance with ASTM A475, Siemens-Martin Grade.

2. Span, Catenary, and Downguy Cable

1260 Span, catenary, and downguy cable, shall be aircraft cable for non-aircraft use, and shall be 3/8 in. nominal diameter, made of stainless steel wire, and consist of seven, 19-wire flexible steel strands. The 3/8 in. cable shall have a minimum breaking

strength of 12,000 lb. It shall be in accordance with Military Specifications MIL-W-83420D.

3. Tether and Support Cable

Tether and support cable shall be aircraft cable, for non-aircraft, and shall be 1/4 in. nominal diameter, made of stainless steel wire, and consist of seven, 19-wire flexible steel strands. The 1/4 in. cable shall have a minimum breaking strength of 6,400 lb. It shall be in accordance with Military Specifications MIL-W-83420D.

4. Cable Hardware

a. Messenger Hangers

Messenger hangers shall be either a 3-bolt clamp or a 3/8 by 1 3/4 in. steel hanger with a 90° bend extending from the pole 3 3/4 in. The hanger shall have a curved groove and clamp capable of receiving a 5/16 to 1/2 in. cable.

The messenger shall be clamped by two 1/2 in. high carbon steel bolts. The angle hanger shall be mounted with a 5/8 in. through bolt and a 1/2 in. lag screw. The three-bolt clamp shall be mounted with a 5/8 in. through bolt. The angle hanger shall be in accordance with ASTM A575. The bolts shall be in accordance with NEMA PH 23.

b. Cable Ring

Cable rings shall be galvanized steel in accordance with IMSA 51-1.

c. Clamps

Clamps shall be made of 3/8 in. steel and in accordance with ASTM A575.

Two bolt clamps shall be a minimum of 3 3/4 in. long and 1 1/4 in. wide with two 1/2 in. bolts which shall clamp cable of 1/8 to 1/2 in. diameter.

Three bolt clamps shall be a minimum of 6 in. long and 1 5/8 in. wide with three 5/8 in. bolts which shall clamp cable of 5/16 to 1/2 in. diameter.

The bolt heads shall be large enough to provide maximum clamping area and shall have oval shoulders to prevent the bolts from turning while tightening. The bolts shall be in accordance with NEMA PH 23.

d. Servi-Sleeves

Servi-sleeves shall be 1 1/4 to 2 1/4 in. in length and shall hold the size of the cable specified. The sleeves shall be in accordance with ASTM A659.

e. Straight Eye-Bolts

Straight eye-bolts shall be 3/4 in. diameter drop forged steel, a minimum of 14 in. long, and have 6 in. of thread. The steel washers shall be 2 1/4 by 2 1/4 by 3/16 in. in size with a 13/16 in. hole in the center. All parts shall be in accordance with ASTM A575 and shall be galvanized in accordance with ASTM A123.

1310

f. Hub-Eyes

Hub-eyes shall be made of drop forged steel and in accordance with ASTM A575. They shall receive a 3/4 in. mounting bolt and have a full rounded thimble eye for protection of the guy cable.

922.11 Signal Cable**(a) Hook-up Wire**

Signal hook-up wire shall be stranded one conductor wire, type THW seven strand No. 14 AWG, with a thermoplastic sheath 3/64 in. thick and a 600 volt rating. Insulation shall be color-coded, as required, and labeled with gauge, voltage rating, and insulation type.

1320

(b) Signal Control Cable

Signal control cable shall be in accordance with IMSA 19-1 or 20-1 and shall be stranded No. 14 AWG wire.

(c) Service Cable

Traffic signal service cable shall be color coded, stranded copper No. 8 AWG wire, three conductor cable, type THWN.

1330

922.12 Signal Interconnect**(a) Integral Messenger Interconnect Cable**

Integral aerial interconnect cable shall be figure "8" self-supporting type cable consisting of a messenger cable and seven conductors No. 14 AWG signal cable in accordance with IMSA 20-3.

(b) 6 Pair/19 Telemetry Cable

Six pair telemetry cable shall contain six twisted pairs of 19 gauge conductors and shall be in accordance with IMSA 40-2 for underground application and IMSA 40-4, integral messenger, for aerial application.

1340

(c) Fiber Optic Interconnect Cable

Fiber optic cable shall contain 12-strand multimode, graded index, optic fibers with a minimum of one non-metallic central strength member. The cable shall be gel-free design, loose tube, all dielectric construction, suitable for outdoor use in conduit or on aerial supports. Each length of fiber optic cable in nonmetallic conduit shall include a No. 14 AWG aluminum or No. 6 AWG copper tracer wire.

1350

Each individual fiber shall be 2.5/5 mils (62.5/125 μm) diameter, core/color-coded clad, and each color-coded set of fibers shall be encased in a loose tube buffer with water blocking tape on the outside and fully water blocked inside using craft-friendly, water-swallowable yarns. The fiber optic cable shall be constructed with Kevlar braid and outer polyethylene jackets as a minimum. If an inner jacket is used it shall

1360 be PVC. Maximum attenuation of the cable shall be 4.0 dB/km nominal, measured at room temperature at 850 nm. The bandwidth shall not be less than 160 MHz/km, also at 850 nm. Each fiber shall be continuous with no factory splices except for joining standard length cables to form longer, continuous jacketed cable to fit installation requirements. The cable shall have standard nylon rip cords. Kevlar rip cords will not be accepted.

The cable shall be in accordance with the generic requirements for optical fiber and optical fiber cable per ANSI/ICEA S-104-696 design and test criteria.

1370 The exterior of the polyethylene outer cable jacket shall be stenciled so that every 16.4 ft on each reel is marked with a number. The 16.4 ft of each reel shall be marked with a 5, the 32.8 ft marked with a 10, and so on until the end of the reel. The stencil shall be applied to the outer jacket using permanent ink and shall be permanently engraved into the jacket to provide long lasting readability.

(d) Radio Interconnect Using Spread Spectrum Radio Modems

Spread spectrum radio modems for communications between local controllers and the system master controller shall be on the QPL of Traffic Signal and ITS Devices.

922.13 Detection Components

(a) Loop Detector Lead-in Cable

1380 Runs 700 ft and less of loop detector lead-in cable shall be in accordance with IMSA 50-2 and shall be stranded two conductor No. 16 AWG, 19 strands of No. 29 wire.

Runs greater than 700 ft shall use 14 AWG wire. The nominal capacitance between conductors shall be 57 pF/ft and 98 pF/ft between one conductor and the other conductor connected to the shield.

(b) Roadway Loop Wire

Roadway loop wire shall be 14 AWG gauge IMSA 51-7 duct-loop wire with polyvinyl chloride or polyethylene outer jacket of 1/4 in. diameter.

1390 **(c) Other Vehicle Detection Systems**

Other vehicle detection systems shall be selected from the QPL of Traffic Signal and ITS Devices.

922.14 Ground Wire

The ground wire shall be copper wire No. 6, AWG soft-drawn, solid copper in accordance with ASTM B3.

922.15 Splicing Kit

1400 Splicing kits shall contain a two-piece, transparent snap-together mold body and include an epoxy and sealing compound contained in a unipak. It shall be capable of

insulating and splicing nonshielded cables rated up to 5 kilovolts and multi-conductor cables rated up to 600 volts.

922.16 Ground Rod and Connections

1410 Ground rods shall be 1/2 in. in diameter by 8 ft long with a machined point and chamfered top. They shall be made of steel with a molecularly bonded outer layer of electrolytically applied copper. A single electrode shall have a maximum resistance to ground of 25 ohms. Single electrodes that do not have resistance to ground of 25 ohms or less shall be augmented by additional electrodes, grids, or plates until resistance to ground of 25 ohms or less is achieved. Resistance shall be measured using a three-point ground tester using the fall of potential method. Data, graphs, resistance in ohms, date of test, make and model of ground tester, and the individual’s initials performing the test shall be recorded and submitted to the District Office. Resistance in ohms shall be tagged at the ground connection.

The finished rod shall be cold-drawn and shall have the following minimum physical properties:

Physical Property	Value
Tensile strength, min.	97,000 psi
Yield strength, 0.2% offset, min.	85,000 psi
% of elongation	13 - 40

1420 The ground rod and wire connection shall be made by a thermo weld process or approved equal. The welding material shall cover and secure the conductor to the rod and shall be porous free.

An acceptable alternate shall be a ground grid connection properly sized and shall consist of a shear head bolt, a “C” shaped body, nest, and wedge. The connector components shall be fabricated from an aluminum-bronze alloy, silicone-bronze alloy, or copper.

922.17 Handholes

1430

(a) Type I (Concrete Handhole)

A Type I handhole shall be made of class III reinforced concrete pipe with a cast iron ring and cover. The concrete shall be in accordance with section 907.02. Reinforcement shall be provided as shown on the plans or in accordance with the manufacturer’s design. If reinforcement deviates from the plans, provide calculations showing that the modified design supports HS-20-44 loading. The ring and cover for handholes shall be in accordance with 910.05(b).

(b) Type II (Alternative Handhole)

1440

A Type II handhole shall be made of polymer concrete or other material that is certified to be in accordance with ANSI/SCTE 77 and meet or exceed Tier 22 loading requirements. The handhole shall be stackable.

1. Handhole Box

The handhole box shall be heavy duty. The inner surface of the handhole shall be smooth and free from cracks and imperfections.

2. Handhole Cover

1450 The cover shall be marked with logo imprints of "TRAFFIC SIGNAL" and the ANSI/SCTE Tier rating - "TIER XX". The cover shall be secured with stainless steel, 300 series, 3/8 in., 16 NC hex bolts and washers. The cover shall have a friction coefficient of at least 0.5.

(c) Type III (Handhole located in the Roadway)

A type III handhole shall be AASHTO HS-20 rated. The handhole box shall be concrete. The ring and cover shall be steel and shall be secured to the handhole box.

922.18 Entrance Switch

1460 The entrance switch shall be a double pole, 50A, 120V AC circuit breaker in a NEMA type 3R enclosure in accordance with NEMA 250-2008. The minimum dimensions of the enclosure shall be 5 in. wide, 3 3/4 in. deep and 9 1/4 in. high. A 1 in. rain-tight detachable hub shall be supplied in the top of the enclosure. The enclosure shall have knockouts on the sides, bottom and back with diameters of 7/8 in. to 1 3/4 in. The enclosure shall contain the circuit breaker, an insulated solid bar for connection of AC neutral, a separate lug for attachment of earth ground, have provisions for a padlock, and shall be surface mounted.

1470 The enclosure shall be made of galvanized steel with a rust inhibiting treatment and finished in the manufacturer's standard color of baked enamel.

All wire terminations and breaker to buss-bar contact points inside the enclosure shall be coated with an anti-oxidant to prevent oxidizing and corrosion of components.

922.19 Conduit and Fittings

(a) Steel Conduit

1480 Steel conduit, couplings, and elbows shall be galvanized rigid steel conduit in accordance with UL 6. The conduit shall be galvanized by the hot dip method on the interior and exterior surfaces. Conduit threads shall be cut after galvanizing. The conduit shall be supplied with a threaded coupling attached to one end and the other threaded end protected by a suitable shield.

The various conduit fittings such as bands, bodies, straps, lock nuts, and threadless connectors, shall be in accordance with Federal Specifications A-A-50553 and shall be galvanized if not stainless steel. Conduit straps shall be two hole straps with a minimum thickness of 1/8 in. Conduit lock nuts 3/8 to 1 1/2 in. in size shall be made of steel. Other sizes shall be made of either steel or malleable iron. All conduit lock nuts shall be galvanized. Other nuts shall be either stainless steel or galvanized steel.

1490 **(b) PVC Schedule 40 or 80 Conduit**

Conduit, fittings, and accessories shall be manufactured from PVC meeting ASTM D1784 and shall comply with all the applicable requirements of NEMA TC2 and UL 651. Each length of pipe shall include a coupling.

(c) Fiberglass Conduit

1500 Rigid fiberglass conduit and fittings shall be filament wound consisting of E-glass and corrosion resistant epoxy resin manufactured for use at temperatures from -40 to 230°F. Rigid fiberglass conduit shall be pigmented with carbon black for ultraviolet protection and fire resistant per UL 94. All rigid fiberglass conduit shall have tracer wire, be heavy walled, HW, and meet the specifications, labeling and testing of ANSI/NEMA TC9.

(d) HDPE Schedule 40 or 80 Conduit

Conduit shall be smooth wall, Type III, Grade P-33, Category 5, Class C, coilable, HDPE. Standard dimension ratio, SDR, 13.5 may be used for Schedule 40 HDPE and SDR 11 may be used for Schedule 80. Conduit and fittings shall meet the applicable requirements of ASTM D1248, ASTM D3350, ASTM F2160 and UL 651.

1510 Schedule 40 or 80 HDPE conduit shall be marked in accordance with ASTM D3485 with the producer code and designation type indicated. HDPE conduit shall be produced from material with an orange color and ultraviolet stabilization code of C, D, or E in accordance with ASTM D3350. Schedule 40 HDPE conduit for use above ground shall be black.

922.20 Detector Housing

The entire housing casting shall be made from aluminum alloy in accordance with ANSI 320.

922.21 Certification

1520 A type C certification in accordance with 916 shall be provided for traffic signal materials and equipment unless otherwise specified.

SECTION 923 – TEMPORARY TRAFFIC CONTROL DEVICES

923.01 Temporary Pavement Marking Tape

10 Temporary pavement marking tape shall be furnished in three colors and two types. It shall consist of a white or yellow film that provides both dry and wet retro-reflectivity on a conformable backing which is a minimum of 4 in. wide, and is designed for marking either asphalt or concrete pavements. Black temporary pavement marking tape shall consist of a matte film on a conformable backing which is designed for marking asphalt pavement. White and yellow temporary pavement marking tape shall be in accordance with ASTM D4592.

Type I tape shall be selected from the QPL of Temporary Pavement Marking Tape, Type I. Temporary pavement marking tape type I will be placed and maintained on the QPL in accordance with ITM 806, Procedure H.

A type C certification in accordance with 916 shall be provided for the Type I temporary pavement marking tape.

923.02 Temporary Raised Pavement Marker

- 20 Temporary pavement markers shall be designed to be affixed with adhesive to the pavement surface and shall be in accordance with ASTM D4280. Adhesive shall be in accordance with the manufacturer's recommendations.

Markers shall be selected from the QPL of Temporary Raised Pavement Markers. Temporary raised pavement markers will be placed and maintained on the QPL in accordance with ITM 806.

923.03 Construction Warning Lights

- 30 Construction warning lights shall be self-illuminated by means of an electric lamp behind the lens. Types A and C shall also be externally illuminated by reflex-reflective elements built into the lens to enable it to be seen by the light from the headlights of oncoming traffic.

The batteries shall be entirely enclosed in a case. The case shall be secured by a locking device which can be opened with a special tool.

(a) Flash Requirements

1. Flash Rate

- 40 The light from types A and B shall have a flash rate of 65 ± 10 pulsations per minute from -20°F to 150°F .

2. On-Time

On-time is defined as the period of the flash when instantaneous intensity is equal to or greater than the effective intensity as specified in 923.03(b)1.

a. Type A

The light shall have an on-time of no less than 10% of the flash cycle.

- 50 **b. Type B**

The light shall have an on-time of no less than 8% of the flash cycle.

(b) Optical Requirements

1. Effective Intensity

The light beam projected upon a surface perpendicular to the axis of the light beam shall produce a lighted area within the solid angle bounded by the two vertical

planes 9° from the vertical plane through the axis of the optical system and two planes 5° above and below the horizontal plane through the optical axis of the system.

60

For type A, the effective intensity shall not drop below 4.0 candles within the area specified herein during the first 336 h of continuous flashing.

For type B, the effective intensity shall not drop below 35 candles within the area specified herein during the first 168 h of continuous flashing.

For type C, the effective intensity shall not drop below 2.0 candles within the area specified herein during the first 168 h of continuous burning.

70

2. Lens Illumination

The illuminated lens shall be uniformly bright in appearance over its entire illuminated surface when viewed from any point within the angle defined in 923.03(b).

3. Reflex-Reflective Performance

For types A and C the specific intensity of the lens when acting as a reflex-reflector at an observation angle of 0.2 of a degree shall be no less than the following.

Entrance Angle degrees	Specific Intensity Candles per Footcandle
0	18
10	14
20	7

80

4. Testing Procedure

The effective intensity of types A and B lights shall be calculated using the Guide for Calculating the Effective Intensity of Flashing Signal Lights as approved by the Illuminating Engineering Society, June, 1961. The intensity of the type C light shall be tested in accordance with SAE Standard J 575d, Lighting Equipment and Photometric Tests. Reflex-reflection shall be tested in accordance with SAE Standard J 594d.

(c) Lens Requirements

90

1. Size of Lens

The lens shall be no less than 7 in. in diameter including for a reflex-reflector ring of 1/2 in. minimum width around the periphery for types A and C.

2. Directional Lenses

Unless otherwise directed, types A, B, and C shall have uni-directional lenses.

3. Lens Chromaticity

If the light uses an incandescent lamp, the chromaticity of the lens color shall be

100 defined by the tri-stimulus coordinates of the Commission International d'Eclairage Standards. When tested with illuminants from 2856 K to 2366 K, the lens color shall fall within the area of the chromaticity diagram in accordance with the 1931 Commission International d'Eclairage Standard Observer as defined by the following coordinates.

X	Y	Z
0.543	0.452	0.005
0.548	0.452	0.000
0.584	0.411	0.005
0.589	0.411	0.000

If the light uses other than an incandescent lamp, the light output shall be in the same range as the light obtained with the incandescent lamp and the specific lens.

4. Lens Luminous Transmittance

110 The minimum relative luminous transmittance of the lens with illuminant at 2856 K shall be 0.440.

5. Lens Material

The lens shall be plastic of one-piece construction and shall meet the test requirements in accordance with SAE J 576b, except that the exposure time and condition, paragraph 3.4.3, for the purposes of this standard shall be one year.

(d) Head and Case

120 1. Swivel Head

If swivel capabilities as described herein are not incorporated in the device used to mount a type A or C light on a barricade or sign, the head shall be mounted on the housing in a manner allowing it to be swiveled through a minimum 90° arc in a horizontal plane. If swiveling is accomplished by rotation of the head, construction shall be such that the head rotation shall not damage the wiring.

2. Case

130 The case shall be so constructed and closed as to exclude moisture that would affect the specified operation of the light. The case shall have a weep hole to allow the escape of moisture from condensation.

(e) Photoelectric Controls

Photoelectric controls, if provided on types A or C lights, shall keep the light operating whenever the ambient light falls below 20 footcandles.

923.04 Flashing Arrow Sign

The flashing arrow sign shall be an all weather, self-contained, flashing sign designed to display the required flashing messages continuously for a minimum of 24 h without servicing. A reserve storage battery shall be provided to automatically

- 140 operate the flashing arrow sign for a minimum period of 8 h if there is a power failure of the primary source.

The flashing arrow sign shall have a control unit which incorporates a photo-controlled transfer relay for automatic lamp intensity settings. The highest photo-controlled setting shall be full intensity for daylight operation. The lowest photo-controlled setting shall be for night-time operation and shall be 50% of full intensity when the ambient light level drops below five footcandles. A minimum of two interim photo-controlled settings shall automatically increase or decrease the lamp intensity in direct proportion to the ambient light level.

150

The flashing arrow sign shall have a manual control unit for adjusting lamp intensity when automatic operation becomes unsatisfactory. The manual control shall be fully adjustable between the minimum limit of 30% of full lamp voltage and maximum limit of full lamp voltage.

An indicator light shall be provided on the back of the sign to provide confirmation that the flashing arrow sign is operating. The indicator light shall be visible for 500 ft.

160

(a) Solar Powered

Solar power assisted units shall incorporate a target sight device and leveling mechanism to aid the user for positioning of the unit prior to use. The device shall be attached to the elevated portion of the flashing arrow sign and not to the fixed support frame.

170

The lamps shall be electronically operated by means of a solid state controller. An automatic lamp intensity regulator shall hold the lamp output constant with varying battery voltage. The control system shall incorporate a full time tracking system designed to track ambient light for 24 h a day. The control system shall adjust lamp intensity to provide maximum system efficiency. The controller shall be in a weatherproof, ventilated, lockable enclosure.

The lamps shall provide amber beams with a minimum of 20° horizontal and 6° vertical field of view. The minimum effective luminance within the required beam shall not be less than one-half the effective luminance at the beam center.

180

The battery bank shall consist of 12V, deep cycle, batteries. The battery bank shall be of sufficient capacity to power the unit for 15 days with no assistance from the sun. A battery condition indicator and a test switch shall be provided to monitor the system's battery charge. The batteries shall be secured in a well ventilated, weatherproof lockable housing. A low battery charge indicator which shall be visible to maintenance personnel driving past the sign shall be provided to indicate the need to recharge the batteries. The battery bank shall be at full charge when delivered to the project site.

The unit shall be equipped with a sign/solar panel lifting mechanism. The lifting mechanism shall be designed to safely carry the capacity of the sign's load. The lifting mechanism shall incorporate a positive locking device to secure the panel in a raised or lowered position.

190

Solar power assisted flashing arrow signs to be used shall be selected from the QPL of Solar Power Traffic Control Devices.

(b) Diesel Powered

Flashing arrow sign shall be fueled by diesel fuel only.

(c) AC Powered

When connected to an AC electrical power source, provisions shall be made to prevent electrocution.

200

FLASHING ARROW SIGN GENERAL SPECIFICATIONS

	Type A	Type B	Type C	SOLAR POWER ASSISTED
Minimum Board Size	2 ft high by 4 ft wide**	2.5 ft high by 5 ft wide	4 ft high by 8 ft wide	4 ft high by 8 ft wide
Minimum No. of Lamps Flashing Arrow Flashing Double Arrow Sequential Chevron (3 heads minimum)	5 in. head, 5 in. shaft* 5 in. head, 4 in. shaft* 5 in. head	(See Note)	Same as Type A	5 in. head, 5 in. shaft* 5 in. head, 3 in. shaft* 7 in. shaft
Lamp Type	Sealed Beam: 12.8V, not to exceed 3A Average rated life: 300 h minimum Candlepower: 1000 candles minimum 9700 candles maximum	(See Note)	Same as Type A	Sealed Beam: 12.8V, not to exceed 3A Average rated life: 300 h minimum Candlepower: 600 candles at normal voltage and >250 candles at low voltage
Lens Color	Amber	Amber	Amber	Amber
Board Color	Flat Black	Flat Black	Flat Black	Flat Black
Flashing Rate	30-50 F.P.M. (50% on time)	25-40 F.P.M. (50% on time)	30-50 F.P.M. (50% on time)	25-40 F.P.M. (50% on time)
Message (Left or Right)	Flashing Arrow, Flashing Double Arrow, or Sequential Chevron	Flashing Arrow, Flashing Double Arrow	Flashing Arrow, Flashing Double Arrow	Flashing Arrow, Flashing Double Arrow, or Warning Bar
Minimum mounting height (to bottom of board)	7 ft	7 ft	7 ft	7 ft
Where Allowed	Where normal speed limit is <40 mph	(See Note)	All rural and urban locations	Stationary Operations Tangent Sections (See 801.15(a))
Required minimum Visibility	0.5 mi	0.75 mi	1 mi	1 mi
<p>* When flashing a single or double arrow(s), the lamp(s) nearest the arrow points shall not be illuminated.</p> <p>** Either rectangular or arrow shaped black background sign will be allowed.</p> <p>Note: General specifications for a type B flashing arrow sign are shown in the MUTCD.</p>				

923.05 Portable Changeable Message Sign

Portable changeable message signs shall be capable of displaying 3 lines with of 8 characters per line. Letter height shall be a minimum of 18 in. The sign shall have automatic dimming capability for nighttime operation.

Portable changeable message signs shall be selected from the QPL of Solar Power Traffic Control Devices.

210

923.06 Temporary Worksite Speed Limit Sign Assembly

The temporary worksite speed limit sign assembly shall be an all weather, self-contained unit designed to display speed limit signs in accordance with the MUTCD and as shown on the plans. The signs shall be installed on frangible posts or mounted on movable stands or trailers in accordance with 910.14(f). The power source shall be capable of operating the strobe lights, without service, for the period which the sign is in effect. An on/off switch will be required.

923.07 Tubular Marker

220 The vertically placed portion of this device shall consist of high density polyethylene plastic in accordance with ASTM D5203. The base material shall be butyl rubber in accordance with ASTM D5900 or high impact polystyrene in accordance with ASTM D4549. Epoxy material used to attach the base to the roadway surface shall be in accordance with the manufacturer's recommendations. The tubular portion shall be reflectorized with high intensity reflective sheeting in accordance with 919.01(b)1 as shown on the plans.

923.08 Automated Flagger Assistance Device

230 The Automated Flagger Assistance Device, AFAD, shall alternately display either a STOP sign and a SLOW sign or a steadily illuminated CIRCULAR RED and a flashing CIRCULAR YELLOW lens to control traffic while being operated by a handheld remote control. AFADs shall meet the requirements of the Indiana Manual on Uniform Control Devices, Chapter 6E. Each AFAD shall be equipped with two handheld remote controls. Trailer mounted AFAD's shall be equipped with a gate arm.

Only automated flagger assistance devices from the QPL of Solar Powered Traffic Control Devices shall be used. Automated flagger assistance devices will be placed and maintained on the QPL in accordance with ITM 955.

240

(a) Signs**1. STOP/SLOW AFAD**

The STOP and SLOW signs shall have a minimum width of 24 in. with lettering that is at least 8 in. in height. The WAIT ON STOP sign shall be visible along the same line of view of the STOP sign face.

2. RED/YELLOW Lens AFAD

A "STOP HERE ON RED", R10-6 or R10-6a, sign shall be installed on the right-

hand side of the approach at the point at which drivers are expected to stop when the
250 CIRCULAR RED lens is illuminated.

(b) Signals

Red/Yellow lens AFAD shall have at least one set of CIRCULAR RED and CIRCULAR YELLOW lenses that are 12 in. in diameter and in accordance with the Institute of Transportation Engineers, ITE, Purchase Specification for Vehicle Traffic Control Signal Heads.

(c) Supplemental Conspicuity Devices

260 The STOP sign face in STOP/SLOW AFAD shall be supplemented by a circular, red stop beacon. The SLOW sign face shall be supplemented by either: a circular, yellow warning beacon, or Type B warning lights with a minimum viewing distance of 1,000 ft.

(d) Gate Arm

Gate arms shall be made of reinforced thermoplastic or tubular aluminum. When in the horizontal positions the arm shall have a 2 ft to 4 ft mounting height above the pavement surface.

(e) Cabinets and Controller

270 The battery and controller cabinets shall be in accordance with NEMA Standard
250 Enclosure 3R requirements and be provided with a hasp and lock. The AFAD shall include a manual override of the handheld remote at the device. The AFAD shall not have any means by which it can operate on a pre-set or pre-timed basis.

(f) Remote Control Device

280 Two handheld, cordless remote controls shall be provided with each AFAD. The remote control shall be waterproof and display signal receipt confirmation. The remote shall use a frequency hopping, spread spectrum radio signal with frequencies outside the 700 MHz band, 698 MHz to 806 MHz. The remote control device shall be programmable to control either one unit or two units simultaneously and shall control the units over a one-mile range.

(g) Batteries and Charging System

Batteries shall be deep cycle type and be capable of operating the AFAD continuously for two days, 24 hrs per day without a need of re-charging. An audible low battery voltage alarm sound system shall be provided. The battery charging system shall consist of a solar panel. Solar panels shall be UL 1703 certified.

(h) Trailer

290 The trailer, if used, shall be designed to withstand a 60 mph wind loading with a 1.3 gust factor when the AFAD is set up in operating position. The trailer shall be painted safety orange, SAE-AMS-STD-595, color No. 12300. The trailer shall be provided with a minimum of two leveling jacks, each operated by a crank which locks in place.

923.09 Acceptance of Temporary Traffic Control Devices

Temporary traffic control devices will be accepted by visual inspection unless otherwise indicated.

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SECTION 924 – WELDING SUPPLIES**924.01 Welding Supplies****(a) Aluminum Alloy Base Metals****1. Bare Wire Electrodes and Welding Rods**

10 Bare wire electrodes for use with the gas metal arc welding process and welding rods for use with the gas tungsten-arc welding process shall be in accordance with AWS A5.10. Tungsten electrodes for the gas tungsten-arc welding process shall be in accordance with the Specifications for Tungsten-Arc Welding Electrodes, AWS A5.12.

2. Filler Metal

Filler metals to be used with particular base metals shall be as shown in the table below. Other filler metals may be used if approved.

Base Metal	Filler Metal
3003 to 3003	ER1100
3004 to 3004	ER4043
5052 to 5052	ER5356*
5083 to 5083	ER5183
5086 to 5086	ER5356*
5456 to 5456	ER5556
6061 to 6061	ER5356*
6063 to 6063	ER5356*
356.0 to 6061	ER4043
356.0 to 6063	ER4043
*ER5183, ER5356, and ER5556 may be used interchangeably for these base metals.	

20 Filler metals shall be kept covered and stored in a dry place at relatively uniform temperatures. Original rod and wire containers shall not be opened until time to be used. Rod and wire shall be free of moisture, lubricant, or other contaminants. Spools of wire temporarily left unused on the welding machine shall be kept covered to avoid contamination by dirt and grease collecting on the wire. If a spool of wire is to be unused for more than a short length of time, it shall be returned to the carton and the carton tightly sealed.

3. Shielding Gases

Shielding gases shall be welding grade or better. Shielding gas for gas metal-arc

30 welding shall be argon, helium, or an approximate 75% helium and 25% argon mixture. Shielding gas for gas tungsten-arc welding done with alternating current shall be argon. Shielding gas for gas tungsten-arc welding done with direct current, straight-polarity, shall be helium.

Hose used for shielding gases shall be made of synthetic rubber or plastic. Hose which has been previously used for acetylene or other gases shall not be used.

(b) Blank

SECTION 925 – ITS CONTROLLER CABINET

925.01 General Requirements

ITS controller cabinets shall be constructed such that it has a NEMA 3R rating. The cabinet shall be a rainproof cabinet with dimensions of 66 in. by 24 in. by 30 in. in depth. The cabinet top shall be crowned or slanted to the sides to prevent standing water.

10 The cabinet, sunshields, doors, and all panels shall be fabricated of 1/8 in. minimum thickness aluminum. The only exception to this aluminum thickness is the detector rack, which shall be fabricated of 0.090 in. thickness aluminum. All exterior seams for the cabinets and doors shall be continuously welded. All exterior welds shall be ground smooth. All edges shall be filed to a radius of 5/16 in. minimum.

The cabinet, sunshields, doors, and all panels shall be fabricated from aluminum sheet in accordance with ASTM B209, 5052-H32 aluminum sheet.

20 Welding on aluminum shall be done by the gas metal arc welding process using bare aluminum welding electrodes. Electrodes shall be in accordance with AWS A5.10 for ER5356 aluminum alloy bare welding electrodes.

Procedures, welders, and welding operators for welding on aluminum shall be qualified in accordance with the requirements of AWS B2.1 “Specification for Welding Procedure and Performance Qualification” or AWS D9.1M/D9.1 Sheet Metal Welding Code.

30 Each aluminum surface shall be finished in accordance with Military Specification MIL-A-8625F(1), “Anodic Coatings for Aluminum and Aluminum Alloys”, type II, class I coating, except that the anodic coating shall have a minimum thickness of 0.0008 in. and a minimum coating weight of 0.04 mg/sq mm. The anodic coating shall be sealed in a 5% aqueous solution of nickel acetate (pH 5.0 to 6.5) for 15 minutes at 206°F. The anodized coating shall be silver in color. Prior to applying the anodic coating, the cabinets shall be cleaned and etched as follows:

- (a) Clean by immersion in inhibited alkaline cleaner such as Oakite 61A or Diversey 909, or equivalent, 45 to 60 g per liter, 160°F for 5 minutes.
- (b) Rinse in cold water.
- 40 (c) Etch in a solution of 11 g of sodium fluoride, plus 30 to 45 g of sodium hydroxide per liter of distilled water at 140 to 150°F for 5 minutes.
- (d) Rinse in cold water.
- (e) Dissolve in a 50% by volume nitric acid solution at room temperature for 2 minutes.
- 50 (f) Rinse in cold water.

The cabinet shall have single front and rear doors equipped with a lock. The doors shall use a Corbin lock No. 2, and each cabinet shall be equipped with two No. 2 keys. When each door is closed and latched, the door shall be locked. Keys shall be removable in both the locked and unlocked positions. The door handles shall have provision for padlocking in the closed position. The handle shall have a minimum length of 7 in. and shall be provided with a 5/8 in., minimum, steel shank. The handle shall be fabricated of cast aluminum or stainless steel. The cabinet door frame shall be designed so that the latching mechanism shall hold tension on and form a firm seal
60 between the door gasket and the door frame.

The cabinet shall not include a police door or have provisions for a police door.

The latching mechanism shall be a three-point cabinet latch with nylon rollers. The center catch and pushrods shall be zinc-plated or cadmium-plated steel. Pushrods shall be turned edgewise at the outer supports and shall be 1/4 by 3/4 in, minimum. The nylon rollers shall have a minimum diameter of 3/4 in. and shall be equipped with ball bearings.

70 All cadmium plating shall be in accordance with the Society of Automotive Engineers, SAE-AMSQQP416. All zinc plating shall be in accordance with ASTM B633.

The door's hinging shall be three or four bolt butt hinges. Each hinge shall have a fixed pin. Doors larger than 22 in. in width or 6 sq ft in area shall be provided with catches to hold the door open at both 90° and 180°, ±10°. The catches shall be 1/3 in. diameter, minimum, plated steel rods. The catches shall be capable of holding the door open at 90° in a 56 mi/h wind at an angle perpendicular to the plane of the door. Door hinges, pins, and bolts shall be made of stainless steel. The hinges shall be bolted to
80 the cabinet. The hinge pins and bolts shall not be accessible when the door is closed.

Door gaskets shall be provided on all door openings and shall be dust tight. Gaskets shall be permanently bonded to the metal. The mating surface of the gasket shall be covered with a silicone lubricant to prevent sticking to the mating surface.

Both cabinet doors shall have louvered openings and shall provide ventilation. A filter shall be provided over the louvers and shall include an aluminum filter cover secured with a spring loaded latch as shown on the plans. The filter shall be 12 by 16 by 1 in. Two spare filters shall be provided with each cabinet.

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The cabinet shall be provided with two metal lifting eyes to be used when placing the cabinet on the foundation. Each eye shall have a minimum diameter of 3/4 in. and shall be capable of lifting 990 lb.

Machine screws and bolts shall not protrude beyond the outside wall of the cabinet.

925.02 Model Approval

Each cabinet model shall be approved prior to use. A period of evaluation will commence when the Department receives a preliminary product evaluation form accompanied by the product brochure, detailed electrical schematics, and cabinet assembly drawings. The Operations Support Division will advise the manufacturer or vendor, in writing, of the date and location to deliver the cabinet for which model approval is requested. Electrical schematics for the cabinet, cabinet assembly drawings, and parts lists shall be furnished with the controller when it is submitted to the Operations Support Division for evaluation and testing.

Only models from the QPL of Traffic Signal and ITS Devices in effect as of the date of letting, or as otherwise specified, shall be used on the contract. Continued failure and repeated malfunctions of a qualified controller or control equipment shall be cause to remove that model from the QPL. A design change to a qualified model or cabinet will require re-submittal of the model for testing, evaluation, and approval. Permanent addition or removal of component parts or wires will be considered to be a design change.

110

925.03 Warranty

The cabinet, sunshields, doors, and all other exterior surfaces shall carry a five year warranty against all material imperfections. All other electrical components and wiring shall carry a three year warranty against all imperfections in workmanship or materials.

120

925.04 Cabinet Accessories

The following accessories shall be furnished and installed with each ITS cabinet.

(a) Rack Frame Assembly

The cabinet shall come equipped with standard Electronic Industries Alliance

19 in. rack frame assembly. The rack frame assembly shall have standard Electronic Industries Alliance vertically spaced threaded holes for attachment of equipment, mounting angles, and shelves. Frame mounting of equipment and shelves shall be
130 available on both door sides of the cabinet.

(b) Equipment Shelves

The equipment rack shall be furnished with two adjustable equipment shelves. A 3 in. hole shall be provided in each shelf. The hole shall be fitted with a nylon snap bushing liner with an outside diameter of 3.16 in., inside diameter of 2 1/2 in. and a height of 0.72 in. The shelves shall be constructed of an aluminum screen tack welded between the shelf bottom and upper ribs. The shelves shall be capable of being moved in any location.

140 **(c) Sunshield**

An aluminum panel sunshield shall be mounted on standoffs on the top and each side of each cabinet.

(d) Side Panels

Two aluminum side panels shall be provided and mounted on the Electronic Industries Alliance rack parallel to the cabinet sides. One panel shall be designated as the “power distribution panel” and the other panel shall be designated the “heater panel”.

150 **(e) Data Pocket**

The data pocket is to be large enough to hold several drawings, a maintenance log notebook, and several pieces of reference material but not so large as to contact any of the installed equipment.

(f) Equipment Labels

The labels shall have a non-reflective, exterior grade, low glare matte surface finish applied to flexible ABS plastic. The labels shall be black with white lettering and have an engraving depth of 0.002 to 0.003 in. Labels shall conform to the designations on the cabinet diagrams.

160

(g) Primary Power Terminal Block

A power distribution terminal block shall be mounted on the power distribution panel. The power distribution block shall be a mechanical three-pole connector. The connectors for the incoming power shall be able to accept wire sizes between 12 AWG and 2/0 AWG. The load side connectors shall be able to accept wire sizes between 14 AWG and 4 AWG. The rating of the connector shall be 195 amps per pole. The connector elements shall be made from a tin plated, high conductivity aluminum alloy and insulated with high strength thermoplastic housing with a relative temperature index of 260°F. It shall be rated 600 volt, AL9CU. The dimensions shall be 4 by 5.2
170 by 3.23 in. high. The block shall come with one polycarbonate safety cover per pole. Mounting screws shall be No. 10, 0.19 in. diameter. The block shall be UL Listed. The terminal block shall be a Burndy Model BDB-11-2/0-3.

(h) Ground Lug

The ground lug mounted on the power distribution panel shall be a heavy-duty one-hole ground lug, manufactured from electrolytic copper tubing and strip stock. UL Listed and CSA certified for stranded CU wire and for 600 volts. Wire range: 6 AWG to 14 AWG. Bolt size: #10. Tang length shall be 1/2 in. Width shall be 5/16 in. The lug shall be an Ilsco Model SLUH-35.

180

(i) Ground Bus

The ground bus shall be rated to 600 volts. A maximum of 12 taps per ground bar suitable for wire ranging from 6 AWG to 14 AWG will be allowed. The main ground connection wire shall have a range from 4 AWG to 14 AWG. The ground bar shall be 5 15/16 in. by 3/4 in. by 11/32 in. and shall be UL Listed. The ground bus shall be an Ilsco Model D167-12.

(j) Transient Voltage Surge Suppression

The transient voltage surge suppression, TVSS, shall have individually fused suppression modes, thermal cutout, LED operational indicators to indicate loss of protection or circuit fully operational, including neutral-to-ground, AC tracking filter with EMI/RFI filtering up to -50dB from 100 kHz to 100 MHz, and a short circuit current rating of 200,000 rms symmetrical amperes. Surge suppression shall be provided for each mode (L-N or L-L, L-G, N-G). The TVSS shall be UL 1449 Second Edition Listed and UL 1283 Recognized. The TVSS shall have 120/240 volt split phase service voltage and dry contacts for each phase providing a summary alarm. The contacts shall be terminated in a DB-9 connector.

The surge capacity shall be 80 kA/phase. The response time shall be less than 1/2 nanosecond. The unit shall withstand 5000 category C3 impulses with less than 10% drift. It shall be suitable for use under non-condensing relative humidity range of 0 - 95%. The suppressed voltage rating shall be 330 volts L-N, L-G, N-G and 700 volts L-L. Operating frequency: 47 - 63 Hz. Operating temperature: -40°F to 140°F. External mount NEMA 1 standard enclosure. Standard size: 6 in. by 6 in. by 4 in. depth. Weight: 8 lb. The unit shall be an Advanced Protection Technologies Model TE/1XF.

200

(k) Load Center Main Breaker

The load center main breaker shall be an enclosed, two-pole, 240/240V AC, 60 amp breaker. It shall have a 10,000 rms symmetrical ampere short circuit current rating. The circuit breaker enclosure shall be a Square D, Model QO2TR.

210

(l) Load Center Panelboard

The panelboard shall be a 120/240V AC, 600 volt, eight pole panelboard. The panelboard shall have a neutral bus bar with three 10 amp breakers, four 15 amp breakers and one spare. The load center shall be main lug only Square D, Model QO. The circuit breakers shall be Square D, Model QO.

(m) GFI Duplex Receptacle

220 The convenience receptacle shall be a duplex, three-prong, NEMA type 5-15R grounding type outlet and shall be in accordance with UL 943.

(n) Duplex Receptacle

A standard three-prong, NEMA type 5-15R grounding type outlet shall be mounted on the power distribution panel.

(o) Terminal Strip Surge Protector

One 48 in. surge protected terminal strip with ten 15A outlets shall be furnished and installed.

230

The terminal strip shall have a low profile aluminum housing measuring 1 1/2 by 1 3/16 in. and have a 14/3 SJT cord and a NEMA 5-15P plug. The spacing between the outlets shall be 4 in. and the grounding pin shall be positioned so that it is oriented toward the bottom of the cabinet. The unit shall be in accordance with UL 1449 with a 330 volt clamping level. The unit shall be a Wiremold Model 4810BCS with a 6 ft cord.

(p) Door Open Switches

240 Four dry-contact, one-pole-form-C (single-pole, double throw), switches shall be provided and installed. Switch poles are to be electrically isolated. One set of switches shall be rated for 5 amp at 120 volt AC to be used to automatically turn the lights off when both cabinet doors are closed. The other set shall be rated for 1 amp at 5 volt DC and are to be used to send a door open alarm. The switches shall be Omron part No. Z-15GQ-B.

(q) Light Switch

250 A toggle switch 20 amp, DPDT with 1/8 in. diameter hole in solder lugs shall be provided and installed that will manually switch on the lights regardless of the door switch position. The switch shall be McGill Mfg. Co., part No. 0121-7013 or Eaton part No. 7803K13.

(r) Lamp Holders

Each cabinet shall be furnished with two lamp holders. The UL Listed device shall have a medium phenolic base measuring 1.9 by 1.9 by 1.5 in. and rating 660 watt and 250 volt. The lamp holder shall be a Leviton Model 9063.

(s) Lamps

Each lamp holder shall be provided with a 100 watt rugged service incandescent bulb.

260

(t) Circulating Fans

Three 110 cu ft/min, 4.7 by 4.7 by 1.5 in. cooling fans shall be installed within the cabinet to circulate internal air. The fans shall have an allowable ambient temperature range of 14°F to 158°F and a voltage rating of 115 volt. The fan casings shall be

aluminum alloy. The impeller shall be UL94V-O reinforced plastic. The fans shall have ball bearings and an impedance protected, shaded pole induction motor. The fans shall not be exposed or routed to the external environment. The environmental controller shall control fan operation. The fans shall activate at 80°F. The fans shall be NMB Model 4715FS-12T-B50-D00.

270

(u) Enclosure Heaters

Two 250 watt ceramic insulated strip heaters shall be furnished and installed in the cabinet to protect against condensation damage and to keep the electronic components above freezing in the winter. The strip heaters shall have a seamless stainless steel sheath with ceramic element support and magnesium oxide packing. The environmental controller shall control enclosure heater operation. Heating strips shall not be installed on either door. The heaters shall be 8 in. long by 1 1/2 in. wide and shall have two wire terminals. The strip heaters shall be UL Recognized. The heaters shall be Hotwatt Model CS-8.

280

(v) Heater Relays

Two solid state SPST-NO heater relays shall be installed on the power distribution side panel. Load current range 0.04 to 25 amp, one-cycle surge 250 amp peak. Rated for 120 volt AC and UL Recognized.

(w) Thermostats

The cabinet shall be furnished with two thermostats installed. One thermostat shall activate the enclosure heaters and circulating fan with the internal cabinet temperature goes below 35°F. The other thermostat shall activate the two circulating fans at the top of the cabinet when the internal cabinet temperature goes above 80°F. The thermostats shall be Thermodisc, Type AL-1.

290

(x) Detector Card DIN Rail Terminal Blocks

Double-deck compression clamp DIN rail terminal blocks shall be hard wired to the Canoga Card Racks. A total of 64 terminal blocks shall be mounted to an aluminum panel that is secured to the Electronic Industries Alliance rack. The terminal blocks shall allow wires between 24 AWG and 10 AWG. Each measures 2.5 in. by 0.2 in. The terminal blocks shall be the Entretec part number 011527122 type M 4/6 D2.

300

(y) I/O Module

An isolated 8-Bit digital input module shall be provided and installed. It shall have six fully isolated inputs and two share common ground inputs. High voltage inputs. Logic levels: LOW +1.0 volt DC max, HIGH +3.5 to +30 volt DC. Input impedance: 3 kohm. Input isolation: 3000 vrms. Power consumption: 0.4 watt. Operating temperature: 14°F to 158°F. The I/O module shall be a Measurement Computing, Model CB-7052.

(z) Detector Card Rack

The detector card rack shall be as shown on the plans.

310

(aa) Padlocks

Padlocks shall be classified as a high security padlock with hardened shackles, laminated body, a minimum four-pin cylinder, and come complete with a weather cover to protect the lock body and cylinder from sand, dirt, water, and ice. A wafer cylinder shall not be used. Keys shall not be provided with each padlock supplied. All padlocks shall be keyed alike and shall be keyed identical to the keys currently in use by the Department. The main body width of the padlock shall not exceed 3 in. and shall have a shackle length of 2 1/4 to 3 3/4 in. and a shackle diameter of 5/16 in. For padlock information, contact the ITS Operations Engineer.

320

(bb) Other Cabinet Equipment

In addition to the equipment specified above, the cabinet shall be furnished with all ancillary equipment, brackets, wiring ducts, and hardware as is necessary to provide a neat and finished appearance. These items along with all associated cables, connectors, wiring, and other incidental items shall be labeled on the required submittal drawings.

925.05 Cabinet Wiring

All conductors used in ITS cabinet wiring shall be in accordance with the following color-code requirements.

330

- (a) The AC neutral conductor of a circuit shall be identified by a continuous white or natural gray color.
- (b) The equipment grounding conductor shall be identified by a continuous green color or by a continuous green color with one or more yellow stripes.
- (c) The ungrounded conductors shall be identified by any color not specified in (a) or (b) above.

340

All wire shall be type THHN with color and gauge as shown on the plans with the exception of the microloop card rack wiring which will be two-pair twisted with a shield and plenum rated.

Connectors used for interconnecting various portions of circuits together shall be designed and constructed for the application involved. Connectors shall be designed to provide positive connection of all circuits, and easy insertion and removal of mating contacts. Connections shall be permanently keyed to prevent improper connection of circuits.

350

925.06 Drawings

The Contractor shall provide three sets of cabinet wiring diagrams. The diagrams shall be non-proprietary and shall identify all circuits, as installed, in such a manner as to be readily interpreted. In addition, three cabinet drawings shall be provided with each cabinet to show the component layout in elevation views from the front and rear.

360 An elevation of both aluminum side panels shall also be shown. Elevation views are to be detailed down to the level showing mounting brackets and wiring ducts. All other mounting hardware and cable ties need not be shown. All cables and connectors shall be clearly labeled. Any data sheets for internal cabinet components that have been made available by the manufacturer shall also be provided. One set of the wiring diagram and cabinet drawing shall be placed in a heavy-duty side-opening clear plastic pouch and inserted into the data pocket. The pouch shall be of such design and material that it provides adequate storage and access to the drawings. The other two sets of drawings shall be delivered to the attention of the ITS Field Engineer.

SECTION 926 – MISCELLANEOUS MATERIALS

926.01 Flexible Delineator Posts

Flexible delineator posts shall be made of impact resistant thermoplastics. The post shall be straight along its center line and have a smooth surface free from cracks, flaws, seams, laps, blisters, and edges affecting the strength, durability, or appearance. The cross section width shall not exceed 6 in.

10 The reflective sheeting on all posts shall be in accordance with 919.01(b)1 and shall have minimum dimensions of 3 by 8 in. Reflective sheeting shall be applied directly to the post and protected in a manner that minimizes damage to the sheeting upon impact.

The color of the post and the reflective sheeting shall match the color of the adjacent edgeline.

Only flexible delineator posts from the QPL of Flexible Delineator Posts shall be used. Flexible delineator posts will be placed and maintained on the QPL in accordance with ITM 806, Procedure H.

20

(a) Type I. Ground Mounted Flexible Delineator Post

Roadside delineator post shall use an anchor sufficient to keep the post securely embedded in the soil.

(b) Type II. Surface Mounted Flexible Delineator Post

30 Surface-mounted post shall have either a surface-mounted base capable of bolting or adhering to the pavement or an anchor cup embedded in the pavement. Bases shall be made of materials suitable for securely mounting the vertical portion to the roadway. Materials used to attach the base or in-pavement anchor cup to the roadway surface shall be in accordance with the manufacturer's recommendations.

The reflective sheeting on surface-mounted posts shall consist of two 3 in. wide wraps around the post separated by a 3 in. gap beginning 1 in. down from the top, or as shown on the plans.

926.02 Delineators

(a) Acrylic Plastic Delineators

40 Acrylic plastic delineators shall consist of a hermetically sealed optical system with a circular plastic face and prismatic molded rear surface. The optical system shall have a minimum diameter of 3 in. with a minimum area of approximately 7 sq in. The trademark of the manufacturer shall be molded legibly into the face of the lens. Color shall be clear, red, or yellow in daylight as well as when viewed by reflected light at night. Photometric or optical requirements shall equal or exceed the following minimum values.

Observation Angle, Degrees	Entrance Angle, Degrees	Specific Intensity, Candlepower/Footcandle		
		Clear	Yellow	Red
0.1	0	119	79	28
0.1	20	47	28	11

Note: The observation angle is the angle at reflector between the observer's line of sight and direction of light incident on reflector. The entrance angle is the angle at the reflector between the direction of light incident on it and the direction of reflector axis. The specific intensity is the candlepower returned at the chosen observation angle by a reflector or reflective surface for each footcandle of illumination at the reflector.

50 The opaque backing shall be made from aluminum sheet having a minimum thickness of 0.02 in. The backing shall form an integral part of the delineator and shall retain the optical system securely. A single aluminum grommeted hole in the center of the reflector shall be provided for mounting. The inside diameter of the grommet hole shall be 3/16 in.

Only acrylic plastic delineator models and colors from the QPL of Delineators shall be used. Acrylic plastic delineators will be placed and maintained on the QPL in accordance with ITM 806, Procedure G.

(b) Reflective Sheeting Delineators

60 Reflective sheeting delineators shall consist of reflective sheeting affixed to an aluminum backing material. The white delineator shall be 3 by 8 in. $\pm 1/8$ in. The yellow delineator shall be 5 by 5 in. $\pm 1/8$ in. The backing material shall be in accordance with 919.01(a) except the minimum thickness shall be 0.064 in. Reflective sheeting shall be in accordance with 919.01(b)1.

There shall be two mounting holes, 3/16 in. in diameter, with one at the top and one at the bottom. The holes shall be 6 in. $\pm 1/16$ in. center to center and in the corners of the square units. Completed delineators shall be dip coated with a high gloss clear finish coat as specified and supplied by the sheeting manufacturer. The finished units shall be clean cut, sharp, and have essentially a plane surface.

70

A type C certification in accordance with 916 shall be provided for the reflective sheeting delineators.

(c) Barrier Delineators

The delineators shall consist of a transparent acrylic plastic face, herein referred to as the lens, and an opaque back fused to the lens under heat and pressure around the entire perimeter to form a unit permanently sealed against dust, water, and water vapor. The reflector lens shall be colorless.

80 The lens shall consist of a smooth front surface free from projection or indentations other than for purposes of identification or orientation of the reflector. The rear surface shall have a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

The reflector lens, having a minimum effective reflex area of 6.5 sq in., shall be methyl methacrylate in accordance with Federal Specification LP-380C, type 1, Class 3. Photometric or optical requirements shall equal or exceed the minimum values in 926.02(a).

90

Only barrier delineator models and colors from the QPL of Delineators shall be used. Barrier delineators will be placed and maintained on the QPL in accordance with ITM 806, Procedure G.

(d) Temporary Barrier Delineator

Temporary barrier delineators shall consist of a type III or higher sheeting in accordance with 919.01(b)1 affixed to a reboundable substrate. The delineator shall be 8 by 12 in. vertically mounted. The mounting bracket used to affix the delineator to the barrier shall not be more than 3 in. vertical.

100

926.03 Alternate Material Guardrail Blockouts

Non-timber blockouts shall be dimensioned as tested and shall be used with the type of guardrail as tested in accordance with NCHRP 350 or MASH. Blockouts shall be accompanied by a copy of the FHWA eligibility letter stating that the product complies with the requirements of NCHRP 350 or MASH test level 3.

Alternate material blockouts meeting the criteria may be used interchangeably with timber blockouts as long as the line and grade of the face of the guardrail is true to that shown on the plans.

110

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Structure Extension, Reinforced Concrete, Box Sections, <i>(span)</i> ft x <i>(rise)</i> ft.....	LFT.....	714.12,
		723.18
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Structure, Coated Reinforced Concrete, Box Sections, <i>(span)</i> ft x <i>(rise)</i> ft.....	LFT.....	714.12,
		723.18
Structure, Reinforced Concrete, Box Sections, <i>(span)</i> ft x <i>(rise)</i> ft.....	LFT.....	714.12,
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