INDIANA

DEPARTMENT
OF
TRANSPORTATION

STANDARD
SPECIFICATIONS

2006

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METRICS

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 mostly in the English System of Units such as feet and inches, pounds, gallons, and acres. In this text where the standard measure is given in the English System, metric equivalents are shown in parentheses. The measures shown in parentheses are intended only for those contracts in which they are specified. No guarantee is provided, explicit or implicit, that the units are accurate conversions. Work included in the contract will be accepted on the basis of measures shown in parentheses only when such measures are specified.

In addition to the English equivalents shown in the text, the following general notes and table 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	in^2	645.16 exactly	square millimeter	mm^2
	square foot	ft^2	0.092 9	square meter	m^2
	square yard	yd^2	0.836 1	square meter	m^2
	acre	ac	0.404 7	hectare	ha
	square mile	mi^2	2.59	square kilometer	km^2
Density	pound per cubic foot	lb/ft^3	16.018 46	kilogram per cubic meter	kg/m^3
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/in^2	6.894 8	kilopascal	kPa
	pound per square foot	lb/ft^2	0.047 88	kilopascal	kPa
	kilopound per square inch	kip/in^2	6.894 8	megapascal	MPa
Speed/Velocity	foot per second	ft/s	0.304 8 exactly	meter per second	m/s
	mile per hour	mi/h	1.609 3	kilometer per hour	km/h
Temperature	degree Fahrenheit	°F	(°F -32)/1.8(**) exactly	degree Celsius	°C
Volume, Fluid	cubic inch	in^3	16.387 1	milliliter	mL
	fluid ounce	fl oz	29.573 4	milliliter	mL
	gallon	gal.	3.785 4	liter	L
	1000 gallons	M.G.	3.785 4	kiloliter	kL
Volume, Solid	cubic inch	in^3	16.387.06 exactly	cubic millimeter	mm^3
	cubic foot	ft^3	0.028 32	cubic meter	m^3
	bushel	bu	0.035 24	cubic meter	m^3
	cubic yard	yd^3	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 x °C) +32. This is an exact conversion.

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

GENERAL NOTES

1. The SI unit of millimeter should be used to convert inches to millimeters.

2. The SI unit of Mass is the Kilogram (Kg) which should be used for smaller masses expressed in pounds. The megagram (Mg) should 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) are to 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 should 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", must be handled so that the stated limit is not violated.

7. Conversion of quantities should 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 should 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 should 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 should be used as follows;

   (a) When the first digit discarded is less than 5, the last digit retained should 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 should 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 E 380 Standard Practice for Use of 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.

TABLE OF CONTENTS

SECTION TITLE PAGE

SECTION 100 – GENERAL PROVISIONS

SECTION 101 – DEFINITIONS AND TERMS 1
101.01 Abbreviations 1
101.02 Above Normal Inclement Weather Days 3
101.03 Blank 3
101.04 Bid Bond 3
101.05 Bidder 3
101.06 Bridge 3
(a) Length 3
(b) Roadway Width 4
101.06.1 Business Day 4
101.07 Calendar Day 4
101.08 Blank 4
101.09 Change Order 4
101.10 Construction Limits 4
101.11 Contract 4
101.12 Contract Information Book 4
101.13 Contract Item (Pay Item) 4
101.14 Contract Time 4
101.15 Contractor 5
101.16 Culvert 5
101.17 Department 5
(a) Materials and Tests Division 5
(b) Contract Services Section 5
(c) Procurement and Distribution Division 5
101.18 Commissioner 5
101.19 Embankment Foundation 5
101.20 Engineer 5
101.21 Equipment 5
101.22 Extra Work 5
101.23 Failed Material 5
101.24 Force Account Work 6
101.25 Frequency Manual 6
101.26 Holidays 6
101.26.1 Indianapolis Traffic Management Center 6
101.27 Invitation for Bids 6
101.28 Itemized Proposal 7
101.29 Laboratory 7
101.30 Major and Minor Contract Items 7
101.31 Materials 7
101.32 Notice to Proceed 7
101.33 Open to Unrestricted Traffic 7
101.34 Pavement Structure 7
101.35 Performance Bond 7
101.36 Plans 7
101.37 Professional Engineer 7
101.38 Profile Grade 8
101.39 Project 8
101.40 Proposal 8
101.41 Proposal Book 8
101.42 Quality Assurances Adjustments 8
101.43 Reasonably Close Conformance 8
101.44 Right-of-Way 8
101.45 Road 8
101.46 Roadbed 9
101.47 Roadside 9

TABLE OF CONTENTS

SECTION TITLE PAGE

101.48 Roadside Development 9
101.49 Roadway 9
101.50 Schedule of Pay Items 9
101.51 Shoulder 9
101.52 Sidewalk 9
101.53 Special Provisions 9
101.54 Specifications 9
101.55 Specified Completion Date 9
101.56 State 9
101.57 Street 9
101.58 Structures 10
101.59 Substantial Completion 10
101.60 Blank 10
101.61 Subcontractor 10
101.62 Subgrade 10
101.63 Substructure 10
101.64 Superintendent 10
101.65 Superstructure 10
101.66 Supplemental Specifications 10
101.67 Surety 10
101.68 Technician or Inspector 11
101.69 Titles (Headings) 11
101.70 Township, Town, City 11
101.71 Traveled Way 11
101.72 Work 11
101.73 Work Day 11
101.74 Working Drawings 11

SECTION 102 – BIDDING REQUIREMENTS AND CONDITIONS 11
102.01 Prequalification and Bidding 11
102.02 Certification Regarding Lobbying for Contracts, Grants, Loans, and Cooperative Agreements 12

SECTION 103 – AWARD AND EXECUTION OF CONTRACT 12
103.01 Disadvantaged Business Enterprise Program 12
(a) General Requirements 12
(b) Definitions 12
1. DBE 12
2. Small Business Concern 13
3. Socially and Economically Disadvantaged Individuals 13
4. Certified DBE 13
(c) Goal 13
1. DBE Joint Venture Type A 13
2. DBE Joint Venture Type B 14
(d) Affirmative Actions 14
(e) Guidelines for Determining Good Faith Efforts 15
(f) Affirmative Action Certification 17
(g) Subcontracts 17
(h) Leases and Rentals 17
(i) Records and Reports 18
103.02 Specific Equal Employment Opportunity Responsibilities 18
103.03 Blank 19
103.04 Insurance 19
(a) Worker's Compensation and Employer's Liability 19
(b) Commercial General Liability 19
(c) Business Automobile Liability 20
(d) Railroad's Protective Liability 20
(e) Owner's and Contractor's Protective Liability Insurance Coverage for Operations of Designated Contractor 20

TABLE OF CONTENTS

SECTION TITLE PAGE

(f) Basis of Payment 21
103.05 Waiver of Damages 21
103.06 Wage and Labor Requirements 21
(a) Non-discrimination of Employees 21
(b) Affidavits and Payrolls 21
(c) Wage Stipulations 22
1. General Decision Included in Contract Information Book 22
2. General Decision Not Included in Contract Information Book 23
103.07 Accident Prevention and Safety 23

SECTION 104 – SCOPE OF WORK 23
104.01 Intent of Contract 23
104.02 Differing Site Conditions, Suspension of Work, and Significant Changes in the Character of Work 24
(a) Differing Site Conditions 24
(b) Suspensions of Work Ordered by the Engineer 24
(c) Significant Changes in the Character of Work 25
(d) Pre-established Remedies to Changed Conditions 25
104.03 Extra Work 26
104.04 Maintenance of Traffic 26
(a) Special Detours 26
(b) Maintenance Directed by the Engineer 27
(c) Blank 27
(d) Traffic Control for Patching on a Two-Lane Roadway 27
104.05 Removal and Disposal of Structures and Obstructions 28
104.06 Removal and Disposal of Regulated Materials 28
(a) For Such Materials which are Identified in the Proposal Book as Being Present on the Project Site 29
(b) For Such Materials which are not Identified in the Proposal Book as Being Present on the Project Site 29
104.07 Rights in and Use of Materials Found in the Project Site 31
104.08 Final Clean-Up 32

SECTION 105 – CONTROL OF WORK 32
105.01 Authority of the Engineer 32
105.02 Plans and Working Drawings 32
105.03 Conformance with Plans and Specifications 33
105.04 Coordination of Plans, Standard Specifications, Supplemental Specifications, and Special Provisions 34
105.05 Cooperation by Contractor 34
105.06 Cooperation with Utilities 35
105.07 Cooperation Between Contractors 36
105.08 Construction Stakes, Lines, and Grades 36
(a) Construction Engineering by the State 36
(b) Construction Engineering by the Contractor 37
(c) Production Staking by the Contractor 39
105.09 Duties of Technician and Inspector 40
105.10 Inspection of Work 41
105.11 Removal of Unacceptable and Unauthorized Work 41
105.12 Load Restrictions 42
105.13 Maintenance During Construction 42
105.14 Failure to Maintain Roadway, Structures, Barricades, and Construction Signs 42
105.15 Acceptance and Final Inspection 43
(a) Partial Acceptance 43
(b) Final Acceptance 43
105.16 Claims for Adjustment and Disputes 44
105.17 Field Office 44
105.18 Method of Measurement 51

TABLE OF CONTENTS

SECTION TITLE PAGE

105.19 Basis of Payment 51

SECTION 106 – CONTROL OF MATERIAL 51
106.01 Source of Supply and Quality Requirements 51
(a) Approved or Prequalified Materials 51
(b) Material Records 52
1. Documentation of Material Delivery 52
2. Delivery Ticket Information 52
3. Payment Procedures 53
(c) Buy American Requirement 53
106.02 Samples, Tests, Cited Specifications 53
106.03 Plant Inspection 54
106.04 Field Laboratory 55
106.05 Storage of Materials 55
106.06 Handling of Materials 55
106.07 Unacceptable Materials 55
106.08 Hazard Communication Program 55
106.09 Department Furnished Materials 56
106.10 Proportioning Materials 56
106.11 Sample Asbestos Exclusion Letter 56

SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC 56
107.01 Laws to be Observed 56
107.02 Permits, Licenses, and Taxes 58
107.03 Patented Devices, Materials, and Processes 58
107.04 Restoration of Surfaces Opened by Permit 58
107.05 Federal Aid Provisions 58
107.06 Equal Employment Opportunity Trainees 59
107.07 Sanitary Conditions Requirements 60
107.08 Public Convenience and Safety 61
(a) Employee Safety 61
(b) Dust and Air Pollution 61
(c) Protection to Traffic 61
(d) Notice to Local Public Officials 61
(e) Convenience to Traffic and Property Owners 62
107.09 Railroad-Highway Requirements 62
(a) Protection of Track Ballast 63
(b) Hold Harmless Clause 63
107.10 Blank 63
107.11 Bridges over Navigable Waters 64
107.12 Traffic Control Devices 64
107.13 Use of Explosives 65
107.14 Protection and Restoration of Property and Landscape 65
107.15 Erosion Control Plan and Proof of Publication 66
107.16 Forest Protection 67
107.17 Responsibility for Damage Claims 67
107.18 Opening Sections of Project to Traffic 68
107.19 Contractor's Responsibility for Work 68
107.20 Contractor's Responsibility for Utility Property and Services 69
107.21 Furnishing Right-of-Way 70
107.22 Personal Liability of Public Officials 70
107.23 Waiver of Legal Rights 70
107.24 Governing Law 70
107.25 Severability 70

SECTION 108 – PROSECUTION AND PROGRESS 71
108.01 Subletting of Contract 71
108.02 Release of Retainage to Subcontractors 71
108.03 Notice to Proceed 71

TABLE OF CONTENTS

SECTION TITLE PAGE

108.04 Prosecution of the Work 72
108.05 Pre-phase Site Construction Meetings 74
108.06 Limitation of Operations 74
108.07 Character of Workers, Methods, and Equipment 75
108.08 Determination and Extension of Contract Time 76
108.09 Failure to Complete on Time 79
108.10 Default and Termination of Contract 80
108.11 Termination of Contractor's Responsibility 81
108.12 Contract Documentation 82

SECTION 109 – MEASUREMENT AND PAYMENT 82
109.01 Measurement of Quantities 82
(a) General Requirements 82
(b) Scales and Measurement by Weight (Mass) 83
(c) Measurement by Volume 85
(d) Measurement of Asphalt Materials 85
(e) Measurement of PCC 86
(f) Measurement of Aggregates 86
(g) Measurement of Timber or Lumber 87
(h) Rental of Equipment 87
(i) Manufactured Materials 87
109.02 Scope of Payment 87
109.03 Compensation for Altered Quantities 88
109.04 Cost Reduction Incentive 88
(a) Cost Reduction Incentive Proposal Requirements 89
(b) Approval of Proposal 90
(c) Method of Measurement 91
(d) Basis of Payment 91
109.05 Extra Work and Force Account Work 92
(a) Labor Costs 92
(b) Bond and Insurance 92
(c) Materials 92
(d) Equipment 92
(e) Miscellaneous 93
(f) Subcontracting 93
(g) Compensation 93
(h) Statements 93
(i) Cost Breakdown 94
109.05.1 Quality Adjustments 94
(a) HMA 94
(b) PCCP 94
(c) Superstructure Concrete, SC 94
(d) Temporary Traffic Control Devices, TTCD 94
(e) Failed Materials, FM 94
109.06 Eliminated Pay Items 95
109.07 Partial Payments 95
109.08 Final Payment 95

SECTION 110 – MOBILIZATION AND DEMOBILIZATION 96
110.01 Description 96
110.02 Limitations 96
110.03 Method of Measurement 96
110.04 Basis of Payment 96

SECTION 111 – STOCKPILED MATERIALS 96
111.01 Description 96
111.02 General Requirements 96

TABLE OF CONTENTS

SECTION TITLE PAGE

111.03 Structural Steel and Concrete Structural Members 97
(a) Delivered to the Job Site 97
(b) Acceptably Stored at the Fabricator's or Manufacturer's Storage Facilities 97
111.04 Dowel Bar Assemblies 97
111.05 Granular Base, Subbase Materials, and Aggregates for HMA and Concrete Pavements 97
111.06 Bridge Expansion Joints 98
(a) Type SS 98
(b) Type M 98
111.07 Structural Supports for Signals, Signs, and Luminaires 98
111.08 Precast Concrete Median Barrier 98
111.09 Additional Requirements 98
111.10 Method of Measurement 99
111.11 Basis of Payment 99

SECTION 200 – EARTHWORK

SECTION 201 – CLEARING AND GRUBBING 1
201.01 Description 1
201.02 General 1
201.03 Clearing and Grubbing 1
201.04 Scalping 2
201.05 Hedge Removal 2
201.06 Method of Measurement 2
(a) Area Basis 2
(b) Lump Sum Basis 2
(c) Linear Basis 2
(d) Individual Unit Basis 2
201.07 Basis of Payment 3
(a) Area Basis 3
(b) Lump Sum Basis 3
(c) Linear Basis 3
(d) Individual Unit Basis 3
(e) Clearing Right-of-Way 4
(f) Exclusions 4

SECTION 202 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS 4
202.01 Description 4
202.02 General Requirements 4
(a) Type Y Waste 6
(b) Type Z Waste 6
202.03 Removal of Bridges, Culverts, and Other Drainage Structures 6
(a) Complete 6
(b) Portions 7
(c) Disposal of Concrete 8
202.04 Removal of Pipe and Tile Drains 8
202.05 Removal of PCCP, Sidewalks, Curbs, etc. 8
202.06 Removal of Houses and Buildings 9
202.07 Inspection and Removal of Asbestos 9
202.08 Removal of Underground Storage Tanks Containing Petroleum Products or Other Hazardous Chemicals 10
(a) Type A Waste 12
(b) Type B Waste 12
(c) Type C Waste 12
202.09 Remediation of Contaminated Soil and Groundwater 13
202.10 Remediation of Other Regulated Materials 13
202.11 Transportation and Disposal of Regulated Materials 13
202.12 Blank 14
202.13 Method of Measurement 14

TABLE OF CONTENTS

SECTION TITLE PAGE

202.14 Basis of Payment 15

SECTION 203 – EXCAVATION AND EMBANKMENT 20
203.01 Description 20
203.02 Common Excavation 20
203.03 Rock Excavation 20
203.04 Unclassified Excavation 20
203.05 Peat Excavation 20
203.06 Waterway Excavation 20
203.07 Class Y Excavation 20
203.08 Borrow or Disposal 21
203.09 General Requirements 23
203.10 Disposal of Excavated Material Except Waterway and Peat Excavation 25
203.11 Disposal of Waterway Excavation 25
203.12 Disposal of Peat 26
203.13 Slides 26
203.14 Drainage 26
203.15 Excavating Rock 27
203.16 Peat Deposit Treatment 29
(a) Treatment of Existing Fills 29
(b) Treatment by Removal 30
(c) Treatment by Displacement 30
203.17 Cased Test Holes 31
203.18 Embankment Construction 31
203.19 Embankment Over and Around Structures 32
203.20 Rock and Shale Embankment 32
(a) Rock Embankment 32
(b) Shale, Shale and Soft Rock Mixtures, or Soft Rock 33
(c) Shale and Thinly Layered Limestone 34
203.21 Embankment on Hillsides or Slopes 34
203.22 Embankment Over Existing Roadbeds 35
203.23 Embankment Other Than Rock and Shale, With Density Control 36
203.24 Method of Making Density Tests 37
(a) Laboratory 37
(b) Field 37
203.25 Embankment Without Density Control 37
203.26 Proofrolling 38
203.27 Method of Measurement 38
(a) Contract Quantity 38
(b) Measured Quantities 38
(c) Measurement on a Linear Basis 39
(d) Measurement of Excavation Items on a Weight Basis 39
(e) Measurement of Embankments 39
(f) Measurement of Borrow 40
(g) Measurement of Embankment Foundation Soils Treatment 40
(h) Measurement of Water for Shale, Shale and Soft Rock Mixtures, or Soft Rock 41
(i) Lump Sum 41
(j) Measurement of Exploratory Cores 41
203.28 Basis of Payment 41

SECTION 204 – GEOTECHNICAL INSTRUMENTATION 44
204.01 Description 44
204.02 Materials 44

Structure Backfill, Size No. 30 904 45
204.03 Settlement Plates 45
(a) Installation Requirements 45
(b) Instrument Readings and Settlement Period 45

TABLE OF CONTENTS

SECTION TITLE PAGE

204.04 Standpipe Piezometers....46
(a) Installation Requirements....46
(b) Readings and Maintenance of Piezometer....48
204.05 Method of Measurement....48
204.06 Basis of Payment....48

SECTION 205 – TEMPORARY EROSION AND SEDIMENT CONTROL....49
205.01 Description....49
205.02 Materials....49
205.03 Control Measures....49
(a) Silt Fence....50
(b) Temporary Mulching....50
(c) Check Dams....50
1. Revetment Riprap....50
2. Straw Bales....50
(d) Interceptor Ditches....50
(e) Sediment Traps....50
(f) Sediment Basins....50
(g) Ditch Inlet Protection....50
(h) Slope Drains....50
(i) Temporary Seeding....51
(j) Vegetative Filter Strips....51
(k) Splashpads....51
(l) Deck and Curb Inlet Protection....51
(m) Detention Ponds....51
(n) Retention Ponds....51
205.04 Maintenance....51
205.05 Removal....51
205.06 Method of Measurement....51
205.07 Basis of Payment....52

SECTION 206 – STRUCTURE EXCAVATION....53
206.01 Description....53
206.02 Class X Excavation....53
(a) General Excavation....53
(b) Excavation for Foundation of Traffic Support Structures....54
206.03 Wet Excavation....54
206.04 Dry Excavation....54
206.05 Foundation Excavation, Unclassified....54
206.06 General Requirements....55
206.07 Disposal of Excavated Material....55
206.08 Preparation of Foundation Surfaces....56
206.09 Cofferdams and Temporary Construction Dikes....57
206.10 Method of Measurement....58
206.11 Basis of Payment....58
(a) Culverts and Retaining Walls....61
(b) Bridges....61
(c) Traffic Structure Supports....63

SECTON 207 – SUBGRADE....63
207.01 Description....63
207.02 Materials....63
207.03 General Requirements....63
207.04 Subgrade Treatments....64
207.05 Method of Measurement....65
207.06 Basis of Payment....66

SECTION 208 – FINISHING SHOULDERS, DITCHES, AND SLOPES....66
208.01 Description....66

TABLE OF CONTENTS

SECTION TITLE PAGE

208.02 Finishing Shoulders 66
208.03 Finishing Ditches 67
208.04 Finishing Slopes 67
208.05 Blank 67
208.06 Finishing at Contract Drainage Structures 67
208.07 Method of Measurement 67
208.08 Basis of Payment 67

SECTION 209 – FINISHING EARTH GRADED ROADS 68
209.01 Description 68
209.02 Construction Requirements 68
209.03 Method of Measurement 68
209.04 Basis of Payment 68

SECTION 210 – FINAL TRIMMING AND CLEANING 68
210.01 Description 68
210.02 Construction Requirements 68
210.03 Method of Measurement 69
210.04 Basis of Payment 69

SECTION 211 – B BORROW FILL AND BACKFILL 69
211.01 Description 69
211.02 Materials 69
211.03 General Requirements 70
211.04 Mechanical Compaction 71
211.05 Embankment for Bridges 71
211.06 B Borrow Around Bents 71
211.07 Aggregate For End Bent Backfill 72
211.08 Spandrel Filling 72
211.09 Method of Measurement 72
211.10 Basis of Payment 73

SECTION 212 – STOCKPILED SELECTED MATERIALS 74
212.01 Description 74
212.02 Materials 74
212.03 Construction Requirements 74
212.04 Method of Measurement 74
212.05 Basis of Payment 74

SECTION 213 – FLOWABLE BACKFILL 75
213.01 Description 75
213.02 Materials 75
213.03 Flowable Backfill Mix Design 75
213.04 Flowable Backfill Mix Criteria 76
213.05 Flowable Backfill Trial Batch 76
213.06 Mixing Equipment 76
213.07 Placement 77
213.08 Method of Measurement 77
213.09 Basis of Payment 77

SECTION 214 – GEOGRID 77
214.01 Description 77
214.02 Materials 78
214.03 Foundation Preparation 78
214.04 Geogrid Placement 78
214.05 Fill Placement 78
214.06 Method of Measurement 79
214.07 Basis of Payment 79

TABLE OF CONTENTS

SECTION TITLE PAGE

SECTION 215 – CHEMICAL MODIFICATION OF SOILS 79
215.01 Description 79
215.02 Materials 79
215.03 Testing and Mix Design 79
215.04 Storage and Handling 80
215.05 Weather Limitations 80
215.06 Preparation of Soils 80
215.07 Spreading of Chemical Modifiers 80
215.08 Mixing 81
215.09 Compaction 81
215.10 Method of Measurement 81
215.11 Basis of Payment 81

SECTION 216 – CELLULAR CONCRETE, CCF 82
216.01 Description 82
216.02 Materials 82
216.03 Mix Design 82
216.04 Properties and Tests 83
(a) CCF Cast Density 83
(b) Foam Density 83
216.05 Storage and Handling 83
216.06 Weather Limitations 83
216.07 Preparation of Subgrade 83
216.08 Installation 83
216.09 Lots 84
216.10 Testing 84
216.11 Method of Measurement 84
216.12 Basis of Payment 84

SECTION 300 – AGGREGATE PAVEMENT AND BASES

SECTION 301 – AGGREGATE BASE 1
301.01 Description 1
301.02 Materials 1
301.03 Preparation of Subgrade 1
301.04 Temperature Limitations 1
301.05 Spreading 1
301.06 Compacting 1
301.07 Checking and Correcting Base 2
301.08 Priming 2
301.09 Method of Measurement 2
301.10 Basis of Payment 2

SECTION 302 – SUBBASE 2
302.01 Description 2
302.02 Materials 2
302.03 Preparation of Subgrade 3
302.04 Temperature Limitations 3
302.05 Spreading 3
302.06 Compacting 3
(a) Aggregate Separation Layers and Dense Graded Subbase 3
(b) Aggregate Drainage Layers 3
302.07 Checking and Correcting Subbase 4
302.08 Method of Measurement 4
302.09 Basis of Payment 4

TABLE OF CONTENTS

SECTION TITLE PAGE

SECTION 303 – AGGREGATE PAVEMENTS OR SHOULDERS 4
303.01 Description 4
303.02 Materials 4
303.03 Preparation of Subgrade 4
303.04 Temperature Limitations 5
303.05 Spreading 5
303.06 Compacting 5
303.07 Checking and Correcting Base and Surface 5
303.08 Dust Palative 5
303.09 Method of Measurement 5
303.10 Basis of Payment 5

SECTION 304 – ASPHALT BASES 6
304.01 Description 6
304.02 Materials 6
304.03 Sealing Cracks and Joints 6
304.04 Patching 6
304.05 Widening 7
304.06 Method of Measurement 7
304.07 Basis of Payment 7

SECTION 305 – CONCRETE BASES 8
305.01 Description 8
305.02 Materials 8
305.03 New PCC Base 8
305.04 Existing PCCP 9
(a) Patching 9
(b) Surface Milling 9
(c) Retrofit Load Transfer 9
(d) Rubblizing Existing PCCP 9
305.05 Widening With PCC Base 10
305.06 Method of Measurement 11
305.07 Basis of Payment 11

SECTION 306 – MILLING 12
306.01 Description 12
306.02 General 12
306.03 Equipment 13
(a) Roadway Milling Machine 13
(b) Power Saw 13
(c) Rotary Power Broom 13
(d) Straightedge 13
1. Straightedge – 16 ft (4.9 m) 13
2. Straightedge – 10 ft (3 m) 13
306.04 Asphalt Scarification and Profile Preparation 13
306.04.1 Approach Milling 14
306.05 Asphalt Milling 14
306.06 Asphalt Removal 15
306.07 PCCP Milling 15
306.08 Transition Milling 16
306.09 Method of Measurement 16
306.10 Basis of Payment 16

SECTION 307 – BLANK 17

SECTION 308 – BLANK 17

SECTION 309 – BLANK 17

SECTION 310 – BLANK 17

TABLE OF CONTENTS

SECTION TITLE PAGE

SECTION 400 – ASPHALT PAVEMENTS

SECTION 401 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HOT MIX ASPHALT, HMA, PAVEMENT 1
401.01 Description 1
401.02 Quality Control 1
401.03 Materials 1
401.04 Design Mix Formula 1
401.05 Volumetric Mix Design 2
401.06 Recycled Materials 5
401.07 Lots and Sublots 6
401.08 Job Mix Formula 6
401.09 Acceptance of Mixtures 6
401.10 General 8
401.11 Preparation of Surfaces to be Overlaid 8
401.12 Process Control 9
401.13 Weather Limitations 9
401.14 Spreading and Finishing 9
401.15 Joints 10
401.16 Density 10
401.17 Shoulder Corrugations 11
401.18 Pavement Smoothness 11
401.19 Pay Factors 13
(a) Mixture 13
(b) Density 15
(c) Smoothness 16
401.20 Appeals 17
(a) MSG 18
(b) BSG of the Gyratory Specimen 18
(c) Binder Content 18
(d) BSG of the Density Core 18
401.21 Method of Measurement 18
401.22 Basis of Payment 18

SECTION 402 – HOT MIX ASPHALT, HMA, PAVEMENT 20
402.01 Description 20
402.02 Quality Control 20
402.03 Materials 20
402.04 Design Mix Formula 20
402.05 Volumetric Mix Design 21
402.06 Job Mix Formula 21
402.07 Mix Criteria 21
(a) Composition Limits for HMA Rumble Strip Mixtures 21
(b) Composition Limits for HMA Wedge and Leveling Mixtures 21
(c) Composition Limits for Temporary HMA Mixtures 21
(d) Composition Limits for HMA Curbing Mixes 22
402.08 Recycled Materials 22
402.09 Acceptance of Mixtures 22
402.10 General 23
402.11 Preparation of Surfaces to be Overlaid 23
402.12 Weather Limitations 23
402.13 Spreading and Finishing 24
402.14 Joints 25
402.15 Compaction 25
402.16 Low Temperature Compaction Requirements 26
402.17 Shoulder Corrugations 27
402.18 Pavement Smoothness 27
402.19 Method of Measurement 27

TABLE OF CONTENTS

SECTION TITLE PAGE

402.20 Basis of Payment 28

SECTION 403 – COLD MIX ASPHALT, CMA, PAVEMENT 29
403.01 Description 29
403.02 Materials 29
403.03 Weather Limitations 29
403.04 Equipment 29
403.05 Preparation of Mixtures 29
403.06 Preparation of Subgrade or Base 30
403.07 Spreading Mixture 30
403.08 Curing 30
403.09 Compaction 30
403.10 Surface Tolerances 31
403.11 Method of Measurement 31
403.12 Basis of Payment 31

SECTION 404 – SEAL COAT 31
404.01 Description 31
404.02 Asphalt Material 31
404.03 Cover Aggregate 31
404.04 Weather Limitations 32
404.05 Equipment 32
404.06 Preparation of Surface 32
404.07 Applying Asphalt Material 33
404.08 Application of Cover Aggregate 33
404.09 Method of Measurement 33
404.10 Basis of Payment 34

SECTION 405 – PRIME COAT 34
405.01 Description 34
405.02 Asphalt Materials 34
405.03 Cover Aggregate 34
405.04 Weather Limitations 34
405.05 Equipment 34
405.06 Preparation of Surface 35
405.07 Application of Asphalt Material 35
405.08 Cover Aggregate 35
405.09 Method of Measurement 35
405.10 Basis of Payment 35

SECTION 406 – TACK COAT 35
406.01 Description 35
406.02 Materials 35
406.03 Equipment 36
406.04 Preparation of Surface 36
406.05 Application of Asphalt Material 36
406.06 Method of Measurement 36
406.07 Basis of Payment 36

SECTION 407 – DUST PALATIVE 36
407.01 Description 36
407.02 Asphalt Material 36
407.03 Weather Limitations 37
407.04 Equipment 37
407.05 Preparation of Surface 37
407.06 Application of Asphalt Material 37
407.07 Method of Measurement 37
407.08 Basis of Payment 37

TABLE OF CONTENTS

SECTION TITLE PAGE

SECTION 408 – SEALING CRACKS AND JOINTS....37
408.01 Description....37
408.02 Materials....37
408.03 Equipment....38
408.04 Weather Limitations....38
408.05 Routing and Filling Cracks and Joints....38
408.06 Sealing Cracks and Joints....38
408.07 Method of Measurement....38
408.08 Basis of Payment....39

SECTION 409 – EQUIPMENT....39
409.01 Production, Transportation, and Laydown of Asphalt Mixtures....39
409.02 Mixing Plant....39
(a) Certified HMA Plant....39
(b) CMA Mixing Plant....39
409.03 HMA Laydown Operations....39
(a) Distributor....39
(b) Hauling Equipment....40
(c) Laydown Equipment....40
1. Paver....40
2. Widener....40
3. Other Mechanical Devices....40
(d) Compaction Equipment....40
1. Tandem Roller....41
2. Three Wheel Roller....41
3. Pneumatic Tire Roller....41
4. Vibratory Roller....41
5. Trench Roller....41
6. Specialty Roller/Compactor....41
(e) Miscellaneous Equipment....41
1. Aggregate Spreader....41
2. Rotary Power Broom....41
(f) Smoothness Equipment....41
1. Profilograph....41
2. Straightedge – 16 ft (4.9 m)....42
3. Straightedge – 10 ft (3 m)....42

SECTION 410 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HMA SURFACE – SMA PAVEMENT....42
410.01 Description....42
410.02 Quality Control....42
410.03 Materials....42
410.04 Design Mix Formula....42
410.05 SMA Mix Design....43
410.06 Recycled Materials....45
410.07 Lots and Sublots....45
410.08 Job Mix Formula....45
410.09 Acceptance of Mixtures....45
410.10 General....47
410.11 Preparation of Surfaces to be Overlaid....47
410.12 Process Control....47
410.13 Weather Limitations....47
410.14 Spreading and Finishing....47
410.15 Joints....48
410.16 Density....48
410.17 Shoulder Corrugations....49
410.18 Pavement Smoothness....49

TABLE OF CONTENTS

SECTION TITLE PAGE

410.19 Adjusted Points 49
(a) Mixture 50
(b) Density 51
410.20 Appeals 51
(a) Mixture 52
(b) Density 52
410.21 Method of Measurement 52
410.22 Basis of Payment 52

SECTION 500 – CONCRETE PAVEMENT

SECTION 501 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, PORTLAND CEMENT CONCRETE PAVEMENT, PCCP 1
501.01 Description 1
501.02 Quality Control 1
501.03 Materials 1
501.04 Concrete Mix Design 1
(a) Change in Materials 2
(b) Change in Source 2
501.05 Concrete Mix Criteria 3
501.06 Trial Batch 3
501.07 Lots and Sublots 4
501.08 Acceptance 4
501.09 General 5
501.10 Preparation of Grade 5
501.11 Preparation of Subbase 5
501.12 Placement 5
501.13 Process Control 5
501.14 Concrete Mixing and Transportation 5
501.15 Weather Limitations 6
501.16 Placing Concrete 6
501.17 CMDT Adjustments 7
501.18 Joints 7
501.19 Finishing 7
501.20 Curing 7
501.21 Form Removal 7
501.22 Pavement Inspection 7
501.23 Opening to Traffic 7
(a) Construction 7
(b) Non-Construction 8
501.24 Shoulder Corrugations 8
501.25 Pavement Smoothness 8
501.26 Pavement Thickness 9
501.27 Tolerance 9
(a) Plastic Unit Weight 9
(b) Water to Cementitious Ratio 10
(c) Flexural Strength 10
(d) Air Content 10
501.28 Pay Factors 10
(a) Flexural Strength 11
1. Lots 11
2. Sublots 12
(b) Air Content 12
1. Lots 12
2. Sublots 13
(c) Thickness 13
(d) Smoothness 13

TABLE OF CONTENTS

SECTION TITLE PAGE

501.29 Appeals 14
(a) Flexural Strength 15
(b) Air Content 15
501.30 Method of Measurement 16
501.31 Basis of Payment 16

SECTION 502 – PORTLAND CEMENT CONCRETE PAVEMENT, PCCP 17
502.01 Description 17
502.02 Materials 17
502.03 Concrete Mix Design 17
502.04 Concrete Mix Criteria 18
(a) Portland Cement Concrete 18
(b) High-Early Strength Concrete 19
502.05 Job Control 19
502.06 General 20
502.07 Preparation of Grade 20
502.08 Preparation of Subbase 20
502.09 Placement 20
502.10 Concrete Mixing and Transportation 21
(a) Central Mixed Concrete 22
(b) Shrink Mixed Concrete 22
(c) Transit Mixed Concrete 22
502.11 Weather Limitations 22
502.12 Placing Concrete 23
502.13 Joints 23
502.14 Finishing 23
502.15 Curing 23
502.16 Form Removal 24
502.17 Pavement Inspection 24
502.18 Opening to Traffic 24
(a) Construction 24
(b) Non-Construction 24
502.19 Shoulder Corrugations 24
502.20 Pavement Smoothness 24
502.21 Pavement Thickness 24
(a) Sections 25
(b) Average PCCP Thickness 25
(c) PCCP Adjusted Payment 26
(d) PCCP Non-Payment 26
(e) PCCP Removal 26
502.22 Method of Measurement 26
502.23 Basis of Payment 26

SECTION 503 – PCCP JOINTS 28
503.01 Description 28
503.02 Materials 28
503.03 Joints 28
(a) Type D-1 Contraction Joint 28
(b) Longitudinal Joint 29
(c) Transverse Construction Joints 29
(d) Longitudinal Construction Joint 29
(e) Terminal Joints 30
(f) Expansion Joints 30
(g) Retrofitted Tie Bars 30
503.04 Dowel Bar Assemblies 30
503.05 Sealing Cracks and Joints 31

TABLE OF CONTENTS

SECTION TITLE PAGE

503.06 Random Crack Remediation 32
(a) Transverse 32
(b) Longitudinal 32
503.07 Method of Measurement 32
503.08 Basis of Payment 32

SECTION 504 – PCCP FINISHING AND CURING 33
504.01 Description 33
504.02 Materials 33
504.03 Finishing 33
504.04 Curing 34
(a) Liquid Membrane Forming Compounds 34
(b) Double Burlap 34
(c) Waterproof Covers 35
(d) Straw 35
504.05 Method of Measurement 35
504.06 Basis of Payment 35

SECTION 505 – TESTS AND PROCEDURES 35
505.01 Test Methods and Procedures 35
(a) Exceptions to AASHTO T 23 36
(b) Exceptions to AASHTO T 97 36
(c) Exceptions to AASHTO T 121 36
(d) Exceptions to AASHTO T 141 36
(e) Exceptions to AASHTO T 152 37

SECTION 506 – PCCP PATCHING 37
506.01 Description 37
506.02 Materials 37
506.03 Concrete Mix Design 38
506.04 Concrete Mix Criteria 39
506.05 Trial Batch 39
506.06 Job Control 39
506.07 PCCP Removal 40
(a) Partial Depth Removal 40
(b) Full Depth Removal 40
506.08 Concrete Mixing and Transportation 41
(a) Central Mixed Concrete 41
(b) Shrink Mixed Concrete 41
(c) Transit Mixed Concrete 41
506.09 Weather Limitations 41
506.10 Placing Concrete 41
(a) Partial Depth 42
(b) Full Depth 42
506.11 Opening to Traffic 42
506.12 Method of Measurement 43
506.13 Basis of Payment 43

SECTION 507 – PCCP RESTORATION 44
507.01 Description 44
507.02 Materials 44
507.03 Cracks 44
(a) Routing, Cleaning and Sealing 44
(b) Cleaning and Filling 45
507.04 Joints 45
(a) Sawing, Cleaning and Sealing 45
(b) Cleaning and Filling 46

TABLE OF CONTENTS

SECTION TITLE PAGE

507.05 PCCP Patching 46
(a) Full Depth Patching 46
(b) Partial Depth Patching 46
507.06 Profiling 46
507.07 Undersealing 47
507.08 Retrofit Load Transfer for PCCP 47
507.09 Method of Measurement 47
507.10 Basis of Payment 48

SECTION 508 – EQUIPMENT 49
508.01 Production, Transportation, and Placement of PCC Mixtures 49
508.02 Mixing Plant 49
(a) Plant Inspection 49
(b) Proportioning System 49
(c) Material Storage 49
1. Aggregates 49
2. Cementitious Materials 50
3. Admixtures 50
(d) Hoppers 50
(e) Mixing System 50
1. Central or Stationary Mixers 50
2. Truck Mixers 50
508.03 Transportation 50
(a) Truck Mixers and Truck Agitators 50
(b) Non-Agitator Trucks 50
508.04 Placement Equipment 50
(a) Slipform 51
(b) Form Riding Equipment 51
(c) Hand Placement 52
1. Steel Forms 52
2. Wood Forms 52
3. Finishing Equipment 52
4. Vibrators 53
508.05 Curing 53
508.06 Texturing Equipment 53
508.07 Sawing Equipment 53
508.08 Miscellaneous Equipment 53
(a) Hand Tools 53
(b) Joint Sealing 53
(c) Grinding 54
508.09 Testing Facility and Equipment 54
(a) Testing Facility 54
(b) Testing Equipment 54
(c) Profilograph 54
(d) Straightedge – 16 ft (4.9 m) 54
(e) Straightedge – 10 ft (3 m) 54

SECTION 600 – INCIDENTAL CONSTRUCTION

SECTION 601 – GUARDRAIL 1
601.01 Description 1
601.02 Materials 1
601.03 General Requirements 2
601.04 Guardrail Erection 2
601.05 Curved W-Beam Guardrail Systems 3
601.06 Guardrail Transitions 3
601.07 Guardrail End Treatments 3
601.08 Impact Attenuators 4

TABLE OF CONTENTS

SECTION TITLE PAGE

601.09 Extension of Existing Guardrail 5
601.10 Removal of Existing Guardrail 5
601.11 Adjusting Existing Guardrail Height 5
601.12 Resetting Guardrail 5
601.13 Method of Measurement 5
601.14 Basis of Payment 6

SECTION 602 – CONCRETE BARRIER 8
602.01 Description 8
602.02 Materials 8
602.03 Concrete Barrier and Concrete Glare Screen 8
(a) Precast Concrete Barrier and Concrete Glare Screen 8
(b) Cast-in-Place Concrete Barrier and Concrete Glare Screen 9
(c) Finishing 9
(d) Sealing 9
(e) Joints 9
(f) Reflectorization 9
602.04 Blank 9
602.05 Method of Measurement 9
602.06 Basis of Payment 10

SECTION 603 – FENCES 10
603.01 Description 10
603.02 Materials 10
603.03 General Requirements 10
603.04 Setting Posts 11
603.05 Placing Barbed and Tension Wire and Fabric 12
603.06 Resetting Fence 12
603.07 Method of Measurement 13
603.08 Basis of Payment 13

SECTION 604 – SIDEWALKS, CURB RAMPS, STEPS, AND HANDRAILS 14
604.01 Description 14
604.02 Materials 14
604.03 Portland Cement Concrete Sidewalks and Curb Ramps 14
(a) General Requirements 14
(b) Excavation 15
(c) Forms 15
(d) Placing Concrete 15
(e) Finishing 15
(f) Joints 15
(g) Detectable Warning Elements 16
(h) Curing 16
(i) Painting 16
604.04 PCC Steps 16
604.05 Reconstructed PCC Sidewalk 16
604.06 Re-Laid Sidewalk 17
604.07 HMA Sidewalk 17
(a) Excavation and Forms 17
(b) Bed Course 17
(c) Placing HMA Sidewalk 17
604.08 Backfilling and Finishing Shoulders and Slopes 17
604.09 Hand Rails 17
604.10 Method of Measurement 18
604.11 Basis of Payment 18

SECTION 605 – CURBING 20
605.01 Description 20
605.02 Materials 20

TABLE OF CONTENTS

SECTION TITLE PAGE

605.03 Precast Cement Concrete Curbing 20
(a) Excavation 20
(b) Installation 20
(c) Joints 20
(d) Backfilling 20
605.04 Cast in Place Cement Concrete Curbing 21
(a) Excavation 21
(b) Forms 21
(c) Proportioning and Placing 21
(d) Curb Turnouts and Combined Concrete Curb and Gutter Turnouts 21
(e) Joints 22
(f) Curing 22
(g) Backfilling 22
(h) Curb Machine 22
605.05 Reflecting Cement Concrete Curbing 22
605.06 Concrete Center Curbing 22
605.07 HMA Curbing 23
(a) Excavation 23
(b) Preparation of Bed 23
(c) Mixture 23
(d) Placing 23
(e) Painting and Sealing 24
605.08 Resetting Curbing 24
(a) Salvage of Curbing 24
(b) Curb Removal 24
(c) Excavation 24
(d) Resetting 24
(e) Backfilling 24
605.09 Method of Measurement 25
605.10 Basis of Payment 25

SECTION 606 – SHOULDER CORRUGATIONS 26
606.01 Description 26
606.02 Method of Measurement 26
606.03 Basis of Payment 26

SECTION 607 – PAVED SIDE DITCH OR CONCRETE GUTTER 26
607.01 Description 26
607.02 Materials 26
607.03 General Requirements 27
607.04 Cement Concrete Gutter and Turnout 27
607.05 Method of Measurement 27
607.06 Basis of Payment 28

SECTION 608 – SHOULDER DRAINS 28
608.01 Description 28
608.02 Materials 28
608.03 General Requirements 28
608.04 Method of Measurement 29
608.05 Basis of Payment 29

SECTION 609 – REINFORCED CONCRETE BRIDGE APPROACHES 29
609.01 Description 29
609.02 Materials 29
609.03 General Requirements 29
609.04 Forms 29
609.05 Joints 29
609.06 Reinforcing Bars 30
609.07 Thickness 30

TABLE OF CONTENTS

SECTION TITLE PAGE

609.08 Concrete Placement 30
609.09 Finishing 30
609.10 Curing 31
609.11 Smoothness 31
609.12 Opening to Traffic 31
609.13 Method of Measurement 31
609.14 Basis of Payment 32

SECTION 610 – APPROACHES AND CROSSOVERS 32
610.01 Description 32
610.02 Materials 32
610.03 General Requirements 32
610.04 Existing Approaches and Crossovers 33
610.05 Method of Measurement 33
610.06 Basis of Payment 33

SECTION 611 – MAILBOX INSTALLATIONS 34
611.01 Description 34
611.02 Materials 34
611.03 Mailbox Assembly 34
611.04 Method of Measurement 35
611.05 Basis of Payment 35

SECTION 612 – UNDERSEALING 35
612.01 Description 35
612.02 Materials 35
612.03 Shoulders 35
612.04 Drilled Holes 35
612.05 Pumping Asphalt 36
612.06 Method of Measurement 37
612.07 Basis of Payment 37

SECTION 613 – SALVAGED ROAD MATERIALS 37
613.01 Description 37
613.02 Materials 37
613.03 Construction Requirements 37
613.04 Method of Measurement 38
613.05 Basis of Payment 38

SECTION 614 – CONCRETE HEADER 39
614.01 Description 39
614.02 Materials 39
614.03 PCC Header 39
614.04 Reconstructed Cement Concrete Header 39
614.05 Method of Measurement 39
614.06 Basis of Payment 39

SECTION 615 – MONUMENTS, MARKERS, AND PARKING BARRIERS 40
615.01 Description 40
615.02 Materials 40
615.03 Reinforced Cement Concrete Right-of-Way Markers 40
615.04 Monuments 41
615.05 Bench Mark Posts 41
615.06 Parking Barriers 41
615.07 Setting Right-of-Way Markers 41
615.08 Resetting Right-of-Way Markers 42
615.09 Setting Monuments 42
615.10 Re-Established Monuments 42
615.11 Setting Bench Mark Posts and Tablets 43
615.12 Reset Bench Mark Posts 43

TABLE OF CONTENTS

SECTION TITLE PAGE

615.13 Method of Measurement 43
615.14 Basis of Payment 43

SECTION 616 – RIPRAP AND SLOPEWALL 44
616.01 Description 44
616.02 Materials 44
616.03 Placing Dumped Riprap 44
616.04 Placing Grouted Riprap 44
616.05 Placing Revetment, Class 1, and Class 2 Riprap 44
616.06 Placing Uniform Riprap 45
616.07 Blank 45
616.08 Placing Precast Cement Concrete Riprap 45
616.09 Slopewall 45
616.10 Undermined Paved Side Ditch 45
616.11 Installation of Geotextile Under Riprap 46
616.12 Method of Measurement 47
616.13 Basis of Payment 47

SECTION 617 – BLANK 48

SECTION 618 – BLANK 48

SECTION 619 – PAINTING BRIDGE STEEL 48
619.01 Description 48
619.02 Materials 48
619.03 Quality Control and Quality Assurance 49
(a) Acceptance Testing Definitions 49
1. Lot 49
2. Series 49
3. Phase 49
(b) Testing Procedure 50
(c) Test Methods and Procedures 50
619.04 Prosecution of Work 50
619.05 Inspection Access to Bridges 51
619.06 Maintaining Traffic 51
619.07 Environmental and Safety Requirements 51
(a) Pollution Control 51
(b) Waste Disposal 52
1. Laws to be Observed 52
2. Time Limitations 53
3. Marking of Spent Material Containers 53
4. Instruction for Disposal of Paint Waste 53
5. Instructions for Disposal of Other Project Generated Waste 54
619.08 Surface Preparation 54
(a) Pressure Washing 55
(b) Solvent Cleaning 55
(c) Near-White Blast Cleaning 55
(d) Commercial Blast Cleaning 55
(e) Hand Tool Cleaning 55
(f) Brush-Off Blast Cleaning 55
(g) Power Tool Cleaning 55
(h) Power Tool Cleaning to Bare Metal 55
619.09 Paint Systems 55
(a) Structural Steel Paint System 55
(b) Partial Paint System 55
619.10 Painting 56
(a) Weather Limitations 56
(b) Storage 56
(c) Mixing 56

TABLE OF CONTENTS

SECTION TITLE PAGE

(d) Thinning 57
(e) Application of Paint 57
(f) Curing Time 57
(g) Stencil Identification 58
619.11 Shop Painting 58
619.12 Field Painting New Steel Bridge 58
619.13 Painting Existing Steel Bridges 59
619.14 Drain Castings Treatment 59
619.15 Claims 59
619.16 Responsibility for Damage 59
619.17 Method of Measurement 60
619.18 Basis of Payment 60

SECTION 620 – BLANK 61

SECTION 621 – SEEDING AND SODDING 61
621.01 Description 61
621.02 Materials 61
621.03 Preparation of Ground Before Seeding 61
621.04 Preparation of Ground Before Applying Erosion Control Blankets 62
621.05 Applying Fertilizer, Seed, and Mulch 62
(a) Fertilizer 62
(b) Seed 62
(c) Mulch 62
1. Method A 63
2. Method B 63
3. Method C 63
4. Method D 64
5. Method E 64
(d) Excelsior Blankets 64
(e) Paper Mat 64
(f) Straw Mat 65
(g) Wood Cellulose Fiber Mulch 65
621.06 Seed Mixtures 65
(a) Seed Mixture R 66
(b) Seed Mixture U 66
(c) Seed Mixture P 66
(d) Blank 66
(e) Seed Mixture D 66
(f) Seed Mixture T 66
1. Spring Mix 67
2. Fall Mix 67
(g) Seed Mixture Grass 67
1. Type 1 67
2. Type 2 67
(h) Seed Mixture Legume 67
1. Type 1 67
2. Type 2 67
621.07 Mulched Seeding 67
621.08 Preparation of Ground Before Sodding 68
621.09 Laying Sod 68
621.10 Watering Sod 68
621.11 Seeding or Sodding Disturbed Areas Outside Construction Limits 69
621.12 Seasonal Limitations 69
621.13 Method of Measurement 69
621.14 Basis of Payment 69
(a) Warranty Bond 71
(b) Changed Fertilizer 71

TABLE OF CONTENTS

SECTION TITLE PAGE

(c) Mulching 71

SECTION 622 – PLANTING TREES, SHRUBS, AND VINES 72
622.01 Description 72
622.02 Materials 72
622.03 Care and Handling of Plants 73
(a) Bare Rooted Plants 73
(b) Balled and Burlapped Plants and Container Grown Plants 73
622.04 Collected Plants 73
622.05 Excavation for Plant Holes 74
622.06 Planting Season 74
622.07 Pruning 74
622.08 Planting, Backfilling, and Watering 75
(a) Plants with Bare Roots 76
(b) Balled and Burlapped Plants 76
(c) Seedlings for Wildlife Habitat 76
622.09 Liquid Fertilizer Application 76
622.10 Mulching 76
622.11 Guying and Staking 76
622.12 Plant Protection 77
(a) Borer Control Coatings 77
(b) Wrapping for Rodent Protection 77
622.13 Retaining Walls and Tree Wells 78
622.14 Tree Root Protection 78
622.15 Pipe Underdrains 78
622.16 Damage to Plants 78
622.17 Grass and Weed Control 78
622.18 Care, Inspection, and Replacement 79
(a) Care 79
(b) Inspection and Replacement 79
622.19 Crown Vetch Plants and Seedlings 80
622.20 “Do Not Mow or Spray” Signs and “Do Not Disturb” Signs 80
622.21 Method of Measurement 80
622.22 Basis of Payment 80

SECTION 700 – STRUCTURES

SECTION 701 – DRIVEN PILING 1
701.01 Description 1
701.02 Materials 1
701.03 Handling of Epoxy Coated Piles 1
701.04 Equipment for Driving Piles 1
(a) Approval of Pile Driving Equipment 1
1. Wave Equation Analysis Method 2
2. Alternate Method 3
(b) Pile Hammers 3
1. Gravity Hammers 3
2. Steam and Air Hammers 3
3. Diesel Hammers 4
4. Pile Driving Aids 4
(c) Pile Driving Appurtenance 4
1. Hammer Cushion 4
2. Pile Drive Head 4
3. Pile Cushion 5
4. Leads 5
5. Followers 5
6. Jets 5
701.05 Test Piles 6

TABLE OF CONTENTS

SECTION TITLE PAGE

701.06 Driven Pile Capacity 6
(a) Wave Equation Analysis Program, or WEAP 6
(b) Dynamic Formula 7
(c) Dynamic Pile Load Test 7
(d) Static Load Test 8
1. Load Test Procedure 8
2. Hydraulic Jacks and Load Gages 9
3. General Requirements 9
701.07 Piling Length 9
701.08 Required Bearing Capacity 10
701.09 Preparation and Driving 10
(a) Pilot Holes 10
(b) Location and Alignment Tolerance 11
(c) Heaved Piles 11
(d) Installation Sequence 12
(e) Inspection 12
(f) Pouring Concrete 12
701.10 Unsatisfactory Piles 12
701.11 Splicing Piles 13
701.12 Steel H Pile Tips 13
701.13 Cut-Off Lengths 14
701.14 Method of Measurement 14
701.15 Basis of Payment 14
(a) Timber Pile Furnished 14
(b) Timber Piles Driven 14
(c) Epoxy Coated Piles 14

SECTION 702 – STRUCTURAL CONCRETE 16
702.01 Description 16
702.02 Classes of Concrete 16
702.03 Materials 17
702.04 Shipping and Storage 17
702.05 Proportioning 17
702.06 Batching 19
(a) Portland Cement 20
(b) Water 20
(c) Aggregates 20
(d) Bins and Scales 20
(e) Batching 21
702.07 Mixing 21
702.08 Mixing at Site of Work 21
702.09 Ready-Mixed Concrete 22
(a) General Requirements 22
(b) Mixers and Agitators 23
(c) Mixing and Delivery 24
(d) Non-Agitating Equipment 25
702.10 Pumping Concrete 25
702.11 Cold Weather Concrete 26
702.12 Consistency 27
702.13 Forms 27
(a) Construction 27
(b) Ties 28
(c) Walls 28
(d) Surface Treatment 28
(e) Metal Forms 28
1. Removable 28
2. Permanent 28
(f) Precast Concrete Deck Panels 30

TABLE OF CONTENTS

SECTION TITLE PAGE

(g) Removal and Re-Use of Forms....31
(h) Test Beams....31
702.14 Falsework and Centering....32
(a) Design and Construction....32
(b) Removal....33
702.15. Joints....34
(a) Construction Joints....34
(b) Expansion Joints....35
(c) Folded Metal Joints....35
(d) Sliding Joints....35
702.16 Drainage Pipes Through Concrete Masonry....35
702.17 Incased Pipes and Conduits....36
702.18 Roadway Surface Drainage....36
702.19 Pouring Bent Caps....36
702.20 Placing Concrete....36
(a) General Requirements....36
(b) Chutes and Troughs....37
(c) Vibrating....37
(d) Depositing Concrete Under Water....38
(e) Placing Footing Concrete....38
(f) Concrete Foundation Seal....39
702.21 Finishing Concrete Surfaces....39
702.22 Curing Concrete....40
(a) Protective Covering Curing Methods....40
(b) Membrane Forming Curing Compound....41
(c) Curing-Sealing Materials....41
702.23 Waterproofing....42
702.24 Application of Loads to and Acceptance of New Concrete....42
702.25 Field Drilled Holes in Concrete....44
702.26 Artificial Lighting....44
702.27 Method of Measurement....44
702.28 Basis of Payment....44

SECTION 703 – REINFORCING BARS....46
703.01 Description....46
703.02 Materials....46
703.03 Bar List....46
703.04 Protection of Materials....46
703.05 Bending....47
703.06 Placing and Fastening....47
703.07 Method of Measurement....48
703.08 Basis of Payment....49

SECTION 704 – CONCRETE FLOOR SLABS....50
704.01 Description....50
704.02 Materials....50
704.03 Forms....50
704.04 Placing Reinforcement and Concrete....51
704.05 Finishing Concrete....51
704.06 Curing....53
704.07 Method of Measurement....53
704.08 Basis of Payment....53

SECTION 705 – SIDEWALKS ON STRUCTURES....54
705.01 Description....54
705.02 Materials....54
705.03 Construction Requirements....54
705.04 Method of Measurement....54
705.05 Basis of Payment....55

TABLE OF CONTENTS

SECTION TITLE PAGE

SECTION 706 – BRIDGE RAILINGS 55
706.01 Description 55
706.02 Materials 55
706.03 Concrete Railing 55
706.04 Steel Railings 56
706.05 Method of Measurement 56
706.06 Basis of Payment 57

SECTION 707 – PRECAST AND PRESTRESSED CONCRETE STRUCTURAL MEMBERS 57
707.01 Description 57
707.02 Materials 57
707.03 General Requirements 58
707.04 Steel and Concrete Requirements 58
(a) Reinforcing Steel 58
(b) Welding Reinforcing Steel 58
(c) Concrete 59
707.05 Forms 60
707.06 Placing and Finishing Cement Concrete 60
707.07 Removal of Forms and Curing 61
707.08 Handling and Shipping 62
707.09 Placing Structural Members 63
707.10 Precast Prestressed Concrete Deck Panels 64
707.11 Method of Measurement 64
707.12 Basis of Payment 64

SECTION 708 – PNEUMATICALLY PLACED MORTAR 65
708.01 Description 65
708.02 Materials 65
708.03 Preparing Surface 65
708.04 Reinforcement 65
708.05 Proportioning and Mixing 66
708.06 Placing Mortar 66
708.07 Finishing 66
708.08 Method of Measurement 67
708.09 Basis of Payment 67

SECTION 709 – PORTLAND CEMENT CONCRETE SEALERS 68
709.01 Description 68
709.02 Materials 68
709.03 Surface Preparation 68
709.04 Environmental Requirements 68
(a) General Requirements 68
(b) Epoxy Penetrating Sealers 68
(c) Other Portland Cement Concrete Sealers 68
(d) Low Temperature Epoxy Penetrating Sealer 68
709.05 Sealer Application 69
(a) General Requirements 69
(b) Epoxy Penetrating Sealer 69
(c) Other Portland Cement Concrete Sealers 70
(d) Clear Sealers 70
(e) Alternate To Concrete Sealers 70
709.06 Safety Precautions 70
709.07 Method of Measurement 70
709.08 Basis of Payment 70

SECTION 710 – REPOINTING MASONRY IN STRUCTURES 71
710.01 Description 71
710.02 Materials 71
710.03 Repointing Concrete Masonry 71

TABLE OF CONTENTS

SECTION TITLE PAGE

710.04 Repointing Rubble Masonry 71
710.05 Repointing Dressed Stone and Brick Masonry 72
710.06 Method of Measurement 72
710.07 Basis of Payment 72

SECTION 711 – STEEL STRUCTURES 72
711.01 Description 72
711.02 Materials 72
711.03 General Requirements 73
711.04 Certification of Fabricators 73
711.05 Shop Drawings 73
711.06 Storage of Materials 74
711.07 Mill Orders and Shipping Statements 74
711.08 Mill Test Reports 74
711.09 Notice of Beginning Work 74
711.10 Facilities for Inspection 74
711.11 Straightening Material 75
711.12 Finish 75
711.13 Flame Cutting 75
711.14 Edge Planing 76
711.15 Abutting Joints 76
711.16 End Connection Angles 76
711.17 Blank 77
711.18 Blank 77
711.19 Bent Plates 77
711.20 Fit of Stiffeners 77
711.21 Bolt Holes 78
(a) High Tensile Strength Bolts, and Unfinished Bolts 78
(b) Ribbed Bolts, Turned Bolts, or other Approved Bearing-Type Bolts 78
711.22 Punched Holes 78
711.23 Reamed or Drilled Holes 78
711.24 Subpunching and Reaming of Field Connections 79
711.25 Accuracy of Punched or Subdrilled Holes 79
711.26 Accuracy of Reamed Holes and Holes Drilled Full Size 79
711.27 Fitting for Bolting 79
711.28 Filler Plates 80
711.29 Toothed Expansion Plates 80
711.30 Blank 80
711.31 Blank 80
711.32 Welds 80
(a) AWS Requirements 80
(b) Edge Blocks 80
711.33 Stud Shear Connectors 81
711.34 Annealing and Stress Relieving 81
711.35 Eyebars 81
711.36 Facing of Bearing Surfaces 81
711.37 Pins and Rollers 82
711.38 Boring Pin Holes 82
711.39 Pin Clearances 82
711.40 Threads for Bolts and Pins 82
711.41 Pilot and Driving Nuts 82
711.42 Finishing Cast Steel 83
711.43 Finished Members 83
711.44 Shop Assembling 83
(a) Full Truss or Girder Assembly 83
(b) Progressive Beam or Girder Assembly 83
(c) Full Chord Assembly 84
(d) Progressive Chord Assembly 84

TABLE OF CONTENTS

SECTION TITLE PAGE

(e) Special Complete Structure Assembly 84
711.45 Drifting of Holes 84
711.46 Match Marking 84
711.47 Shop Cleaning and Painting 85
711.48 Shop Cleaning and Storage of ASTM A 709 Grade 50W (ASTM A 709M Grade 345W) Steel 85
(a) Hot Rolled Products 85
(b) Welded Area 85
711.49 Furnishing Bolts 85
711.50 Weighing of Members 85
711.51 Full Size Tests 85
711.52 Acceptance 85
711.53 Shipping 86
711.54 General Requirements 86
711.55 Delivery of Materials 86
711.56 Handling and Storing 86
711.57 Falsework 87
711.58 Bearings and Anchorages 87
711.59 Field Straightening Material 87
711.60 Field Assembly of Steel 87
711.61 Misfits 88
711.62 Pin Connections 88
711.63 Blank 88
711.64 Diaphragm Connections 88
711.65 Bolted Connections Using High Strength Bolts 88
(a) General 88
(b) Bolts, Nuts, and Washers 89
(c) Bolted Parts 89
(d) Installation 89
1. Bolt Tension 89
2. Washers 90
3. Calibrated Wrench Tightening 90
4. Turn-of-Nut Tightening 90
(e) Inspection 91
711.66 Bolted Connections Using Other Than High Strength Bolts 92
711.67 Final Clean-Up 92
711.68 Structural Steel Cutting, Rivet and Bolt Removal, and Drilled Bolt Holes in Repair Projects 92
711.69 Jacking and Supporting Beams 92
711.70 Field Cleaning and Storage of ASTM A 709 Grade 50W (ASTM A 709M Grade 345W) Steel 92
711.71 Painting 93
711.72 Method of Measurement 93
711.73 Basis of Payment 93
(a) Lump Sum Basis 94
(b) Unit Weight Basis 94

SECTION 712 – TIMBER STRUCTURES 95
712.01 Description 95
712.02 Materials 96
712.03 General Requirements 96
712.04 Caps 97
712.05 Stringers 98
712.06 Bents 98
712.07 Wheel Guards and Railings 98
712.08 Painting 98
712.09 Single-Ply Plank Floors 99
712.10 Two-Ply Plank Floors 99
712.11 Method of Measurement 99
712.12 Basis of Payment 99

TABLE OF CONTENTS

SECTION TITLE PAGE

SECTION 713 – TEMPORARY BRIDGES AND APPROACHES 100
713.01 Description 100
713.02 Materials 100
713.03 General Requirements 100
713.04 Temporary Bridge 100
713.05 Temporary Approaches 100
713.06 Maintenance 101
713.07 Removal 101
713.08 Method of Measurement 101
713.09 Basis of Payment 101

SECTION 714 – CONCRETE CULVERTS AND RETAINING WALLS 102
714.01 Description 102
714.02 Materials 102
714.03 General Requirements 103
714.04 Extension of Existing Culverts 103
(a) Precast Concrete Box Sections Extension 103
(b) Cast-In-Place Concrete Culvert Extension 103
714.05 Precast Reinforced Concrete Box Section Joints 104
714.06 Sealing Existing Culverts 104
714.07 Method of Measurement 104
714.08 Basis of Payment 104

SECTION 715 – PIPE CULVERTS, AND STORM AND SANITARY SEWERS 105
715.01 Description 105
715.02 Materials 105
(a) Type 1 Pipe 106
(b) Type 2 Pipe 106
(c) Type 3 Pipe 106
(d) Type 4 Pipe 106
(e) Type 5 Pipe 107
(f) Slotted Drain Pipe 107
(g) Slotted Vane Drain Pipe 107
(h) End Bent Drain Pipe 107
(i) Underdrain Outlet Pipe 107
(j) Grated Box End Sections 107
715.03 General Requirements 108
715.04 Excavation 109
715.05 Laying Pipe 109
715.06 Joining Pipe 110
715.07 Tee and Stub-Tee Connections 110
715.08 Blank 111
715.09 Backfilling 111
715.10 Pipe End Sections, Anchors, Grated Box End Sections, and Safety Metal End Sections 112
715.11 Re-Laid Pipe 112
715.12 Pavement Replacement 112
715.13 Method of Measurement 113
715.14 Basis of Payment 114

SECTION 716 – TRENCHLESS PIPE INSTALLATION 117
716.01 Description 117
716.02 Materials 118
716.03 General Requirements 119
716.04 Method of Measurement 121
716.05 Basis of Payment 121

SECTION 717 – STRUCTURAL PLATE PIPE, PIPE-ARCHES, AND ARCHES 121
717.01 Description 121
717.02 Materials 121

TABLE OF CONTENTS

SECTION TITLE PAGE

717.03 General Requirements 122
717.04 Backfill 123
717.05 Relaid Pipe and Pipe-Arch 123
717.06 Blank 124
717.07 Concrete Paved Inverts 124
717.08 Method of Measurement 124
717.09 Basis of Payment 124

SECTION 718 – UNDERDRAINS 125
718.01 Description 125
718.02 Materials 125
718.03 Pipe Installation 125
718.04 Geotextile 126
718.05 Underdrain Outlets 126
718.06 Underdrain Outlet Protectors 126
718.07 Video Inspection 126
718.08 Patching Underdrains 127
718.09 Method of Measurement 127
718.10 Basis of Payment 127

SECTION 719 – TILE DRAINS 129
719.01 Description 129
719.02 Materials 129
719.03 Trench Excavation 129
719.04 Laying Tile 130
719.05 Backfilling 130
719.06 Blank 130
719.07 Method of Measurement 130
719.08 Basis of Payment 130

SECTION 720 – MANHOLES, INLETS, AND CATCH BASINS 131
720.01 Description 131
720.02 Materials 131
720.03 General Requirements 132
720.04 Grade Adjustment of Existing Structures 134
720.05 Method of Measurement 135
720.06 Basis of Payment 135

SECTION 721 – AUTOMATIC DRAINAGE GATES 136
721.01 Description 136
721.02 Materials 136
721.03 Construction Requirements 136
721.04 Method of Measurement 136
721.05 Basis of Payment 137

SECTION 722 – LATEX MODIFIED CONCRETE BRIDGE DECK OVERLAYS 137
722.01 Description 137
722.02 Materials 137
722.03 Storage and Handling of Materials 137
722.04 Proportioning 138
722.05 Preparation of the Bridge Floor 139
(a) Concrete Removal 139
1. Deck Surface 139
2. Bridge Floor 139
(b) Cleaning 140
722.06 Patching of the Bridge Floor 140
(a) Full Depth Patching 140
1. Patching with Bridge Deck Patching Concrete 140
2. Patching with Latex Modified Concrete 140

TABLE OF CONTENTS

SECTION TITLE PAGE

(b) Partial Depth Patching 141
1. Patching with Bridge Deck Patching Concrete 141
2. Patching with Latex Modified Concrete 141
722.07 Overlay Dam 141
722.08 Mixing 141
722.09 Placing and Finishing 142
722.10 Texturing 143
722.11 Curing 143
722.12 Calibration of Continuous Mixers 144
(a) Frequency 144
(b) Equipment 144
(c) Pre-calibration 145
(d) Calibration 145
1. Cement Meter 145
2. Water Flow Meter 145
3. Aggregate Bin Gates 146
4. Latex Throttling Valve 146
5. Admixture Dispensers 146
722.13 Patching an Existing Bridge Deck Overlay 146
(a) Materials 146
(b) Storage and Handling of Materials 146
(c) Proportioning 146
(d) Preparation of the Bridge Floor 146
(e) Patching 146
(f) Mixing 147
(g) Placing and Finishing 147
(h) Texturing 147
(i) Curing 147
(j) Calibration of Continuous Mixers 147
722.14 Method of Measurement 147
722.15 Basis of Payment 148

SECTION 723 – BLANK 149

SECTION 724 – STRUCTURAL EXPANSION JOINTS 149
724.01 Description 149
(a) Structural Expansion Joint 149
(b) Replacement of Existing Structural Expansion Joint 149
(c) Replacement of Existing Structural Expansion Joint Seal 150
724.02 Materials 150
(a) Expansion Joint SS 150
(b) Expansion Joint M 150
724.03 General Requirements 150
(a) Expansion Joint SS 151
(b) Expansion Joint BS 151
(c) Expansion Joint M 151
(d) Replacement of Existing Structural Expansion Joint 152
(e) Replacement of Existing Structural Expansion Joint Seal 152
724.04 Method of Measurement 152
724.05 Basis of Payment 152

SECTION 725 – SLIP LINING OF EXISTING PIPE 153
725.01 Description 153
725.02 Materials 153
725.03 Construction Requirements 154
(a) Right-of-Entry Areas 154
(b) Filling of Cavities Outside the Existing Pipe 154
(c) Liner Installation 155
725.04 Method of Measurement 158

TABLE OF CONTENTS

SECTION TITLE PAGE

725.05 Basis of Payment 158

SECTION 800 – TRAFFIC CONTROL DEVICES AND LIGHTING

SECTION 801 – TRAFFIC CONTROLS FOR CONSTRUCTION AND MAINTENANCE OPERATIONS 1
801.01 Description 1
801.02 Materials 1
801.03 General Requirements 2
801.04 Construction Signs 4
(a) Type A 4
(b) Type B 4
(c) Type C 4
(d) Type D 5
(e) Temporary Panel Sign 5
801.05 Detour Route Marker Assembly 5
801.06 Road Closure Sign Assembly 5
801.07 Barricades 5
(a) Type III-A Barricade 5
(b) Type III-B Barricade 6
(c) Permanent Type III Barricade 6
801.08 Cones and Tubular Markers 6
801.09 Drums 6
801.10 Temporary Traffic Barriers 7
(a) Placement 8
(b) Connection 8
(c) Anchorage 9
(d) Delineation 9
(e) End Treatment 10
(f) Storage 10
801.10.1 Construction Zone Energy Absorbing Terminal, CZ 10
801.11 Temporary Crossovers 11
801.12 Temporary Pavement Marking 12
(a) Temporary Pavement Marking Methods 12
1. Paint 12
2. Temporary Pavement Marking Tape 12
a. Type I 13
b. Type II 13
3. Temporary Raised Pavement Marker 13
4. Temporary Buzz Strips 13
(b) Quality Assurance Unit 13
801.13 Temporary Illumination 13
801.14 Construction Warning Lights 14
(a) Type A 14
(b) Type B 14
(c) Type C 14
(d) Vehicle Warning Lights 14
801.15 Electronic Devices 14
(a) Flashing Arrow Sign 14
(b) Changeable Message Signs 15
(c) Temporary Worksite Speed Limit Sign Assembly 15
(d) Temporary Traffic Signals 15
801.16 Temporary Traffic Control Zone 16
(a) Temporary Traffic Control Signs 16
(b) Maintenance of Traffic for Mobile Operations 17
(c) Traffic Control for Temporary Traffic Stoppage 17
1. On Multi-Lane Divided Highways 17
2. On Non-Divided Highways 17

TABLE OF CONTENTS

SECTION TITLE PAGE

801.17 Method of Measurement 17
801.18 Basis of Payment 19

SECTION 802 – SIGNS 23
802.01 Description 23
802.02 Materials 24
802.03 Location of Signs and Sign Structures 24
802.04 Shop Drawings 24
802.05 Excavation and Backfill 24
802.06 Placing Concrete 25
802.07 Installing Supports 25
(a) Posts 25
(b) Structural Frames 25
1. Trusses 26
2. Monotube 26
3. Cantilever Arms 26
4. Bridge Brackets 26
802.08 Installing Signs 26
(a) Sheet Signs 27
(b) Panel Signs 27
802.09 Removal or Relocation of Signs or Support Assemblies 27
802.10 Roadway and Bridge Reference Signs 27
802.11 Method of Measurement 28
802.12 Basis of Payment 28

SECTION 803 – WELDING ALUMINUM ALLOYS 31
803.01 Description 31
803.02 Materials 31
803.03 Welding Processes 31
(a) Preparation of Materials 32
(b) Welding Procedure 32
(c) Weld Quality 33
(d) Inspection 33
(e) Corrections 33
1. Cracks in Welds or Base Metal 34
2. Excessive Porosity and Lack of Fusion 34
3. Copper or Tungsten Inclusions 34
4. Excessive Concavity of Crater, Undercut and Undersize Weld 34
5. Overlap 34
803.04 Qualification of Procedures, Welders, and Welding Operators 34

SECTION 804 – DELINEATORS 34
804.01 Description 34
804.02. Materials 34
804.03 Delineator Visibility 35
804.04 Posts 35
804.05 Flexible Delineator Posts 35
804.06 Method of Measurement 35
804.07 Basis of Payment 35

SECTION 805 – TRAFFIC SIGNALS 36
805.01 Description 36
805.02 Materials 36
805.03 General Requirements 36
805.04 Pole Installation 38
805.05 Placing Signal Heads 38
805.06 Grounding 39
805.07 Wire and Cable Installations 39
805.08 Controller Cabinet, Signal Service, and Detector Housing Installation 40

TABLE OF CONTENTS

SECTION TITLE PAGE

805.09 Loop Wire Detector Installation 41
(a) Megohm Test Before Splice is Made at Detector Housing for Loop Wire 42
(b) Megohm Test Before Splice is Made at Detector Housing for Lead-in Cable 42
(c) Megohm Test After Splice is Completed at Cabinet 42
(d) Vehicle Simulator Test 42
(e) Acceptance Criteria 42
805.10 Magnetometer and Microloop Detectors 43
805.11 Steel Conduit 43
805.12 PVC Conduit 44
805.13 Foundations 44
805.14 Final Clean-Up 44
805.15 Method of Measurement 44
805.16 Basis of Payment 45

SECTION 806 – BLANK 48

SECTION 807 – HIGHWAY ILLUMINATION 48
807.01 Description 48
807.02 Maintenance of Highway Illumination 48
807.03 Materials 48
807.04 Excavation 49
(a) Trench Excavation 49
(b) Foundation Excavation 49
(c) Landscape Replacement 49
807.05 Backfilling 50
807.06 Placing Conduit 50
807.07 Connections in Base of Lighting Standards 51
807.08 Placing Wire and Cable 52
(a) Underground Through Cable-duct 52
1. Cable-duct 52
2. Cable Markers 53
(b) Underground Through Conduit 53
1. Cable-duct 53
2. Cable Markers 53
(c) In Conduit Risers 53
(d) Through Conduit in Bridge Coping 53
(e) Aerial Cable 54
807.09 Lighting Handholes 54
807.10 Concrete Foundations For Lighting Standards 54
(a) Cast-in-Place Foundations 55
(b) Precast Foundations 55
(c) Grading of Foundations 55
807.11 Placing Lighting Standards 55
(a) Lighting Standards Under 80 ft (24 m) in Height 55
(b) High Mast Lighting Standards of 80 ft (24 m) Height and Over 56
807.12 Grounding 56
807.13 Luminaire Installation 58
(a) Roadway Luminaires 58
(b) Sign Luminaires 58
(c) Underpass Luminaires 58
(d) High Mast Luminaires 59
807.14 Sign, Underpass, Roadway, and High Mast Lighting Location Identification 59
807.15 Service Point Power Entry 59
(a) Types of Service Points 59
1. Type I Service Point 59
2. Type II Service Point 60
(b) Sign and Underpass Circuits 60
(c) Multiple Relay Switches 60

TABLE OF CONTENTS

SECTION TITLE PAGE

807.16 Testing of Highway Lighting System 60
(a) Testing Lighting Circuitry 60
(b) Testing and Inspecting Luminaires 61
807.17 Pay Item and Installation Summary Sheets 61
807.18 Method of Measurement 62
807.19 Basis of Payment 62

SECTION 808 – PAVEMENT TRAFFIC MARKINGS 64
808.01 Description 64
808.02 Materials 64
808.03 General Requirements 65
808.04 Longitudinal Markings 65
(a) Center Lines 66
(b) Lane Lines 66
(c) Edge Lines 66
(d) Barrier Lines 66
808.05 Transverse Markings 66
808.06 Curb Markings 67
808.07 Pavement Marking Material Application and Equipment 67
(a) Traffic Paint 67
1. Application 67
2. Equipment 67
(b) Durable Pavement Marking Material 68
1. Thermoplastic 68
a. Application 68
b. Equipment 68
2. Preformed Plastic 68
a. Application 68
b. Equipment 69
3. Epoxy 69
a. Application 69
b. Equipment 69
808.08 Marking Protection and Maintenance of Traffic 69
(a) Vehicle Signs 70
(b) Vehicle Warning Lights 70
(c) Cones 70
(d) Front Escort Vehicles 70
(e) Marking Application Vehicles 70
(f) Rear Escort Vehicles 70
808.09 Warranty for Durable Pavement Marking Material 71
808.10 Removal of Pavement Markings 71
808.11 Snowplowable Raised Pavement Markers 72
(a) Surface Preparation 72
(b) Location 72
(c) Reflector Color 72
(d) Installation 72
(e) Removal of Markers 73
(f) Replacement of Prismatic Reflectors 73
808.12 Method of Measurement 73
808.13 Basis of Payment 74

SECTION 809 – ITS CONTROLLER CABINETS AND FOUNDATIONS 76
809.01 Description 76
809.02 Materials 76
809.03 General 76
809.04 Grounding 76
809.05 Cabinet Wiring 76
809.06 Field Testing 77

TABLE OF CONTENTS

SECTION TITLE PAGE

809.07 Clean-Up 77
809.08 Method of Measurement 77
809.09 Basis of Payment 77

SECTION 900 – MATERIALS DETAILS

SECTION 901 – PCC MATERIALS 1
901.01 Hydraulic Cement 1
(a) General 1
(b) Portland Cement 1
1. Requirements 1
2. Acceptance Criteria 2
a. General Requirements 2
b. Requirements for Domestic Source Qualification 2
c. Requirements for Foreign Source Qualification 3
d. Certification 3
(c) Masonry Cement 4
901.02 Fly Ash Used as a Pozzolan 4
(a) General 4
(b) Acceptance Criteria 4
1. Requirements 4
2. Test and Calibration Procedure 4
3. Documentation 5
901.03 Ground Granulated Blast Furnace Slag Used As a Pozzolan 6
(a) General 6
(b) Acceptance Criteria 6
1. Requirements 6
2. Test and Calibration Procedure 6
3. Documentation 7
901.04 Silica Fume Used As a Pozzolanic Mineral Admixture 7
(a) General 8
(b) Acceptance Criteria 8
1. Requirements 8
2. Frequency of Testing 8
3. Test and Calibration Procedure 9
4. Documentation 9
901.05 Chemical Anchor System 10
(a) Requirements 10
(b) Laboratory Testing 10
901.06 PCC Sealer/Healers 10
(a) Requirements 10
(b) Laboratory Testing 10
901.07 Rapid Setting Patch Materials 11
(a) Normal Weather Mixes 11
(b) Hot Weather Mixes 11
(c) Requirements 11
(d) Test Report 12
901.08 Packaged, Dry, Combined Materials for Mortar and Concrete 12

SECTION 902 – ASPHALT MATERIALS 13
902.01 Asphalt 13
(a) Performance Graded Asphalt Binders 13
1. Appeals 13
(b) Asphalt Emulsions 14
(c) Cutback Asphalts 16
1. Medium Curing Asphalts With and Without Additives 16
2. Slow Curing Asphalts With and Without Additives 16
(d) Utility Asphalt 17

TABLE OF CONTENTS

SECTION TITLE PAGE

(e) Asphalt for Coating Corrugated Metal Pipe....17
902.02 Sampling and Testing Asphalt Materials....18
902.03 Application Temperatures....22

SECTION 903 – CLASSIFICATION OF SOILS....23
903.01 Definitions....23
903.02 Soils Having 0% to 19% Retained on No. 10 (2.00 mm) Sieve....23
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....24
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....24
903.05 Organic Soils....24
903.06 Marly Soils....24

SECTION 904 – AGGREGATES....25
904.01 Aggregates....25
904.02 Fine Aggregates....26
(a) For Portland Cement Concrete....27
(b) For HMA Mixtures....27
(c) For SMA Mixtures....28
(d) For Pneumatically Placed Mortar....28
(e) Mortar Sand....28
(f) Mineral Filler for SMA....28
(g) Snow and Ice Abrasives....29
(h) Sizes of Fine Aggregates....29
(i) Sampling and Testing....29
904.03 Coarse Aggregates....29
(a) Classification of Aggregates....30
(b) Coarse Aggregate Angularity for HMA and SMA....31
(c) Flat and Elongated....31
(d) Surface Aggregate Requirements for HMA and SMA....31
1. HMA Coarse Aggregate....32
2. SMA Coarse Aggregate....32
(e) Sizes of Coarse Aggregates....33
(f) Sampling and Testing....33
904.04 Riprap....34
(a) Dumped Riprap....34
(b) Grouted Riprap....34
(c) Revetment, Class 1, and Class 2 Riprap....34
(d) Uniform Riprap....34
(e) Precast Concrete Riprap....34
(f) Sizes of Riprap....35
904.05 Structure Backfill....35
904.06 Exceptions to AASHTO Standard Methods....35
(a) Exceptions to AASHTO T 2....35
(b) Exceptions to AASHTO T 11, T 27, and T 37....36
(c) Exceptions to AASHTO T 27 for Coarse Aggregates....36
(d) Exceptions to AASHTO T 85....36
(e) Exceptions to AASHTO T 103 and 104....36

SECTION 905 – MASONRY UNITS....37
905.01 Clay or Shale Brick....37
(a) Sewer Brick....37
(b) Manhole Brick....37
(c) Building Brick....37
905.02 Concrete Brick....37
905.03 Concrete Masonry Blocks....37
905.04 Precast Concrete Curbing....37
905.05 Detectable Warning Elements....37

TABLE OF CONTENTS

SECTION TITLE PAGE

905.06 Precast Concrete Units Not Otherwise Covered 38

SECTION 906 – JOINT MATERIALS 38
906.01 Joint Fillers 38
906.02 Joint Sealing Materials 38
(a) Joint Sealers 38
1. Silicone Joint Sealants 38
a. Physical Requirements 38
b. Field Evaluation 38
c. Specific Requirements for Installation of Silicone Joint Sealant 38
2. Hot Poured Joint Sealant 39
a. General Requirements 39
b. Packaging and Marking 39
c. Requirements for Installation 39
d. Sampling and Testing 39
3. Preformed Elastomeric Joint Seals 39
4. Asphalt Rubber Sealant 39
a. Requirements 39
b. Packaging 39
c. Installation 40
d. Certification 40
(b) Backer Rod 40
1. Requirements 40
2. Certification 40
906.03 Joint Mortar 40
906.04 Rubber Type Gaskets 40
906.05 Bituminous Mastic Pipe Joint Sealer 40
(a) General Requirements 40
(b) Certification 41
906.06 Joint Membrane System for Precast Reinforced Concrete Box Sections 41
906.07 Bridge Expansion Joints 41
(a) Type SS 41
(b) Type BS2, BS6, BS8, BS9, and BS11 42
(c) Type M 42

SECTION 907 – CONCRETE, CLAY, AND PLASTIC DRAINAGE COMPONENTS 44
907.01 Non-Reinforced Concrete Pipe 44
907.02 Reinforced Concrete Pipe 44
907.03 Reinforced Concrete Horizontal Elliptical Pipe 44
907.04 Precast Concrete Manholes, Inlets, and Catch Basins 44
907.05 Precast Reinforced Concrete Box Sections 45
907.06 Blank 45
907.07 Blank 45
907.08 Clay Pipe 45
907.09 Perforated Clay Pipe 45
907.10 Blank 46
907.11 Drain Tile 46
907.12 Blank 46
907.13 Blank 46
907.14 Blank 46
907.15 Blank 46
907.16 Plastic Pipe Manufacturer Requirements 46
907.17 Corrugated Polyethylene Drainage Tubing 47
907.18 Perforated Polyvinyl Chloride Semicircular Pipe 47
907.19 Corrugated Polyethylene Pipe 47
907.20 Ribbed Polyethylene Pipe 47
907.21 Smooth Wall Polyethylene Pipe 47
907.22 Profile Wall Polyvinyl Chloride Pipe 47

TABLE OF CONTENTS

SECTION TITLE PAGE

907.23 Smooth Wall Polyvinyl Chloride Pipe 48
907.24 Smooth Wall Pipe for Outlets 48
(a) Type PSM Polyvinyl Chloride Pipe and Fittings 48
(b) Schedule 40 Polyvinyl Chloride Pipe 48
907.25 Thermoplastic Pipe Liners 48
(a) Solid Wall HDPE Pipe Liner 48
(b) Profile Wall HDPE Pipe Liner 48
(c) Profile Wall PVC Pipe Liner 48
907.26 Solvent Cements for Polyvinyl Chloride Pipe and Pipe Fittings 49
907.27 Elastomeric Seals 49

SECTION 908 – METAL PIPE 49
908.01 Blank 49
908.02 Corrugated Steel Pipe and Pipe-Arches 49
908.03 Blank 50
908.04 Corrugated Aluminum Alloy Pipe and Pipe-Arches 50
908.05 Blank 50
908.06 Metal End Sections 50
908.07 Fully Bituminous Coated Corrugated and Lined Steel Pipe and Pipe-Arches 51
908.08 Polymer Precoated Galvanized Corrugated Steel Culvert Pipe and Pipe-Arches 52
908.09 Structural Plate Pipe, Pipe-Arches, and Arches 52
(a) Steel 52
(b) Aluminum Alloy 52
908.10 Cast Iron Soil Pipe 52
908.11 Steel Pipe 53
908.12 Straps, Hook Bolts and Nuts Used in Anchors 53
908.13 Blank 53
908.14 Slotted Drain or Slotted Vane Drain Pipe 53

SECTION 909 – PAINT AND LIQUID EPOXY 54
909.01 General Requirements 54
909.02 For Metal 54
(a) Zinc Primers 54
1. Multi-Component Inorganic Zinc Silicate Primer 54
2. Organic Zinc Primer 55
3. Approval of Formulation 55
(b) Epoxy Intermediate Paint 55
(c) Polyurethane Finish Coat 56
(d) Waterborne Finish Paint 57
1. Vehicle Component 57
2. Pigment Component 57
3. Mixed Paint Properties 57
4. Color 58
5. Approval of Formulation 58
(e) Finish Coat for Weathering Steel 58
909.03 Structural Steel Coating System 58
(a) Toxicity 58
(b) Resistance 59
(c) Approval of Structural Steel Coating System 59
909.04 Field Paint for Wood or Metal 59
909.05 White and Yellow Traffic Paint 59
(a) Blank 59
(b) Fast Dry Traffic Paint 59
1. General Requirements 59
2. Specific Requirements 60
(c) White and Yellow Waterborne Traffic Paint 61
1. Composition Requirements 62
2. Specific Requirements 62

TABLE OF CONTENTS

SECTION TITLE PAGE

3. Formulation Approval 64
909.06 Blank 64
909.07 Blank 64
909.08 Blank 64
909.09 Epoxy Penetrating Sealers 64
(a) Polysulfide Type 64
(b) Unmodified Type 65
(c) Specific Requirements 65
(d) Low Temperature Epoxy Penetrating Sealer 67
(e) Packaging and Marking 67
(f) Approval of Formulation 67
909.10 Proprietary PCC Sealers 68
(a) Properties 68
(b) Test Report 68
909.11 Epoxy-Resin-Base System for Bonding Plastic Concrete to Hardened Concrete 68

SECTION 910 – METAL MATERIALS 68
910.01 Reinforcing Bars and Dowel Bars 68
(a) General 68
(b) Specific Requirements 69
1. Billet Steel Bars 69
2. Threaded Tie Bar Assembly 69
3. Splicing Systems 69
4. Blank 69
5. Welded Steel Wire Fabric for Concrete Reinforcement 69
6. Welded Deformed Steel Wire Fabric for Concrete Reinforcement 69
7. Uncoated 7 Wire Strand for Prestressed Concrete 70
8. Steel Spiral Reinforcement 70
9. Epoxy Coated Reinforcing Bars 70
10. Dowel Bars 71
(c) Inspection, Sampling, and Testing 72
910.02 Structural Steel 72
(a) Structural Steel 72
(b) High Strength Structural Steel 72
(c) Charpy V-Notch Toughness Tests 72
(d) Mill Test Reports 73
(e) High Strength Bolts, Nuts, and Washers 73
1. General Use 73
2. Assembly of Structural Steel in Bridges 73
a. Bolts 73
b. Nuts 73
c. Tests 74
(1) Rotational Capacity 74
(2) Proof Loads 74
(3) Wedge Tension Test 74
d. Certification 74
(f) Bolts other than High Strength Bolts 74
1. General 74
2. Unfinished Bolts 75
3. Turned Bolts 75
4. Ribbed Bolts 75
910.03 Permanent Metal Forms 75
910.04 Steel Forgings and Steel Shafting 75
(a) Carbon Steel Forgings 75
(b) Cold Finished Carbon Steel Shafting 76
(c) Alloy Steel Forgings 76
(d) Certification 76

TABLE OF CONTENTS

SECTION TITLE PAGE

910.05 Castings 76
(a) Steel Castings 76
(b) Iron Castings 76
(c) Ductile Iron Castings 77
(d) Malleable Castings 77
(e) Carbon Steel Castings 77
910.06 Bronze and Copper Alloy 77
(a) Bronze Castings 78
(b) Copper Alloy Plates 78
910.07 Steel Drain Pipe 78
910.08 Blank 78
910.09 Guardrail 78
910.10 Guardrail Posts 79
(a) Steel Guardrail Posts 79
(b) Wood Guardrail Posts 79
910.11 Guardrail Accessories, Fittings, and Hardware 79
(a) For Steel Beam Guardrail 79
(b) For Steel Tube Guardrail 81
910.12 Certification of Guardrail Suppliers 82
910.13 Steel Fence Posts 82
(a) Line Posts 82
(b) Tubular Steel Fence Posts 83
1. Group 1 83
2. Group 2 83
(c) Fence Fastenings 83
910.14 Sign Posts 84
(a) Steel, Flanged, Channel Posts 84
1. General Requirements 84
2. Deflection Test Requirements 85
3. Type of Posts 85
(b) Wide Flange Posts 86
(c) Structural Steel Posts 86
(d) Structural Aluminum Posts 86
(e) Square Steel Posts 86
1. Steel 86
2. Fabrication 87
3. Protective Coating 87
(f) Portable Construction Sign Trailer 88
910.15 Delineator Posts 88
910.16 Copper Flashing 88
910.17 Bronze or Copper Alloy Plates 88
910.18 Fence, Fittings, and Gates 89
(a) Farm Field or Woven Wire Fence 89
(b) Steel Fabric Chain Link Fence 90
1. Tension Wire 90
2. Stretcher Bars, Truss Rods, and Turnbuckles 90
3. Braces 90
4. Barbed Wire 91
(c) Aluminum Fabric Chain Link Fence 91
(d) Gates 92
1. Steel Gates 93
2. Aluminum Gates 93
(e) Control Procedures for Furnishing Fence and Accessories 93
1. General Requirements 93
2. Suppliers of Pretested Approved Stockpiled Material 93
3. Suppliers Not Furnishing Pretested Approved Stockpiled Material 94

TABLE OF CONTENTS

SECTION TITLE PAGE

910.19 Overhead Sign Structures 94
(a) Aluminum Overhead Sign Structures, Box Truss and Bridge Attached 94
(b) Steel Overhead Sign Structures, Box Truss, Cantilever, Monotube, and Bridge Attached 95
910.20 Steel Bridge Railing Components 96
910.21 Steel Sheet Piling 97

SECTION 911 – WOOD MATERIALS 97
911.01 Untreated Lumber 97
(a) General 97
1. Boards 98
2. Dimension Lumber 98
3. Structural Lumber 98
4. Timbers 98
5. Timbers, Round 98
6. Yard Lumber 98
7. Surfaced or Dressed Lumber 98
8. Rough Lumber 98
(b) Species and Grade 98
(c) Inspection 99
(d) Tolerances 99
(e) Untreated Piling 100
911.02 Treated Lumber 100
(a) General 100
(b) Bridge Lumber 101
(c) Piling 101
(d) Guardrail Posts, Braces, and Battens 101
(e) Sign Posts 102
(f) Sawed Timber Posts and Blocks for Thrie-Beam and W-Beam Guardrail 102
1. Species and Grades 102
2. Department Grade GRP 104
a. Splits 104
b. Checks 104
c. Shakes 104
d. Stains 104
e. Slope of Grain 104
f. Wane 104
g. Knots 104
3. Department Grade GRB 104
a. Splits 104
b. Checks 104
c. Shakes 105
d. Stains 105
e. Wane 105
f. Knots 105
4. General Requirements 105
a. Decay 105
b. Unsound Wood 105
c. Crook or Bow 105
d. Dimensional Tolerances 105
5. Pressure Treating Posts and Blocks 105
a. Machining 105
b. Blank 105
c. Inspection Before Treatment 106
d. Test for Moisture Content 106
e. Preservative Treatment 106
f. Material for Preservative Treatments 106
g. Treatment Methods 106
h. Sorting and Spacing 106

TABLE OF CONTENTS

SECTION TITLE PAGE

i. Conditioning 107
j. Blank 107
k. Inspection During Treatment 107
l. Retentions 108
m. Penetration 108
n. Inspection After Treatment 108
o. Branding 108
p. Conformance 109
q. Records 109
r. Independent Inspections 109
6. Field Treatment of Posts and Blocks 109
7. Rejection for Degrade After Treatment 109
(g) Recreational Applications 110
(h) Preservatives 110

SECTION 912 – CONCRETE CURING MATERIALS AND ADMIXTURES 110
912.01 Curing Materials 110
(a) Burlap Cloth made from Jute or Kenaf 110
(b) Waterproof Paper Blankets 110
(c) White Polyethylene Sheeting, Film 110
(d) White Burlap Polyethylene Sheet 110
(e) Liquid Membrane Forming Compounds 111
(f) Polyethylene Film 111
912.02 Curing-Sealing Materials 111
912.03 Admixtures for Use in Concrete 111
(a) Air Entraining Admixtures 112
(b) Chemical Admixtures for Concrete 112
1. Type A 112
2. Type B 112
3. Type C 112
4. Type D 112
5. Type E 112
6. Type F 112
7. Type G 112
8. High Range Water Reducing Admixture System 112
9. High Range Water Reducing and Retarding Admixture System 113
(c) Test Report 113
912.04 Latex Modifiers 113

SECTION 913 – SOIL TREATMENT MATERIALS 114
913.01 Water 114
913.02 Calcium Chloride 114
913.03 Sodium Chloride 114
913.04 Lime 114
(a) Hydrated Lime for Masonry 114
(b) Lime for Soil Modification 114
1. Hydrated Lime and Quicklime 115
2. Lime By-Products 115

SECTION 914 – ROADSIDE DEVELOPMENT MATERIALS 115
914.01 Special Topsoil for Roadside Development 115
914.02 Temporary Seed 115
914.03 Fertilizer 115
914.04 Grass and Legume Seed 116
914.05 Mulch 119
(a) Mulch for Seeding 119
1. Excelsior Mulch 119
2. Wood Cellulose Fiber 119
3. Excelsior Blanket 119

TABLE OF CONTENTS

SECTION TITLE PAGE

4. Paper Mat....120
5. Straw Mat....120
(b) Mulch for Plants....120
914.06 Leguminous Inoculants....120
914.07 Sod....121
914.08 Plant Materials....121
(a) Quality of Plant Material....121
(b) Plant Names....122
(c) Substitutions....122
(d) Grading Standards....122
(e) Nursery Inspection and Plant Quarantine....122
(f) Balled and Burlapped Plants....122
(g) Container Grown Plants....122
(h) Bare Rooted Plants....123
(i) Collected Plants....123
(j) Forms, Shapes, and Condition of Plants....123
(k) Inspection....123
(l) Shipment....124
(m) Certification....124
914.09 Miscellaneous Material....124
(a) Water....124
(b) Stakes for Bracing and Anchoring....124
(c) Tree Wound Dressing....124
(d) Porous Material....125
(e) Pipe....125
(f) Staples....125
(g) Plastic Net....125

SECTION 915 – BRIDGE PILES AND BEARINGS....125
915.01 Steel Shell Encased Concrete Piles and Epoxy Coated Steel Shell Encased Reinforced Concrete Piles....125
(a) General Requirements....125
(b) Fluted Steel Pile Shells....126
(c) Rounded Steel Pipe Shells....126
(d) Epoxy Coating for Piles....126
1. Prequalification of Organic Coatings for Steel Piles....127
a. Product Data Sheet....127
b. Fingerprint....127
c. Materials Safety Data Sheet....127
d. Laboratory Report....127
(1) Tensile Strength and Elongation....127
(2) Impact Resistance....127
(3) Abrasion Resistance....127
(4) Salt Fog....127
2. Application....128
a. Surface Preparation....128
b. Coating Application....128
(1) Thickness....128
(2) Cure....128
(3) Continuity of Coating....128
3. Certification....128
915.02 Steel H Piles and Epoxy Coated Steel H Piles....129
915.03 Wood Piles....129
915.04 Elastomeric Bearings....129
(a) Description....129
(b) Materials....129
(c) Manufacturing Requirements....131
(d) Appearance and Dimensions....132

TABLE OF CONTENTS

SECTION TITLE PAGE

(e) Quality Assurance 132
(f) Certification 133

SECTION 916 – MATERIALS CERTIFICATIONS 133
916.01 General 133
916.02 Types of Certifications 133
(a) Type A 133
(b) Type B 134
(c) Type C 134
(d) Type D 134
(e) Other Types 134
(f) Requirements for Small Quantities of Materials 134
(g) Buy American Requirement 134
916.03 Sample Forms 134
(a) For Buy American Requirement 134
(b) Sample Type A Certification Form 135
(c) Sample Type B Certification Form 136
(d) Sample Type C Certification Form 137
(e) Sample Type D Certification Form 138
(f) Sample Asbestos Exclusion Letter 139

SECTION 917 – QUALITY ASSURANCE AGGREGATE CERTIFICATION 139
917.01 General Requirements 139
917.02 Quality Control Plan 140
917.03 Source Approval Requirements 140
(a) Step 1 140
(b) Step 2 140
(c) Step 3 141
917.04 Removal from Certified Producer Status 141
917.05 Appeals 141

SECTION 918 – SOIL FABRICS 142
918.01 Fabric for Waterproofing 142
918.02 Geotextile for Use Under Riprap 142
918.03 Geotextile for Use With Underdrains 143
918.04 Geotextile for Silt Fence 144
918.05 Geogrid 144
(a) Type I 145
(b) Type II 145

SECTION 919 – TRAFFIC SIGNS 146
919.01 Traffic Signs 146
(a) Backing Material 146
1. Sheet Signs 147
2. Panel Signs 147
3. Demountable Letters, Numbers, and Symbols 147
(b) Sheeting Material 147
1. Reflective Sheeting 147
2. Non-reflective Sheeting 148
3. Transparent Sheeting 148
(c) Letters, Numbers, Symbols, and Accessories 148
(d) Fasteners 149
1. Sheet Signs 149
2. Panel Signs and Temporary Panel Signs 149
3. Aluminum Rivets 149
(e) Basis for Use 149

SECTION 920 – HIGHWAY ILLUMINATION MATERIALS 149
920.01 Highway Illumination Materials 149
(a) Lighting Standards and Mast Arms, under 80 ft (24.4 m) 150

TABLE OF CONTENTS

SECTION TITLE PAGE

1. General Requirements 150
2. Aluminum Lighting Standards 151
a. Round Seamless 151
b. Single Longitudinal Welded 152
3. Stainless Steel Lighting Standards 152
4. Galvanized Steel Lighting Standards 152
5. Wood Pole Lighting Standards 153
6. Frangible Breakaway Bases 153
a. Cast Aluminum Transformer Base 153
b. Breakaway Coupling 153
7. Anchor Bolts 154
(b) High Mast Standards of 80 ft (24.5 m) and Over 154
1. High Mast Poles 154
2. Welding 155
3. Handholes 155
4. Luminaire Ring Assembly 155
5. Head Frame Assembly 156
6. Winch Assembly 156
7. External Drive System 156
8. Cable Terminator 157
9. Lightening Rod Assembly and Grounding System 157
10. Anchor Bolts 158
(c) Wire and Cable 158
1. Polyethylene Conduit 158
2. Conductors in Cable-Duct 158
3. Lighting Standard Circuit Wiring 159
4. Sign and Underpass Wiring 159
5. Aerial Cable 159
6. High Mast Tower Luminaire Ring Conductors 159
7. Power Cable-High Mast Poles 159
8. Electrical Connectors 159
(d) Luminaires 160
1. General Requirements 160
2. Roadway Lighting Luminaires 160
3. Sign Luminaires 160
4. Underpass Luminaires 161
5. High Mast Luminaires 161
(e) Circuit Breakers and Enclosure 161
1. Circuit Breakers for Type II Service Point 161
2. Circuit Breakers for Sign and Underpass Circuits 161
3. Circuit Breakers for High Mast Poles 161
4. E-Series Magnetic Circuit Breakers 161
(f) Multiple Relay Switches with Photocell Receptacles 162
(g) Shop Drawings 162
(h) Materials Certification 163

SECTION 921 – PAVEMENT MARKING MATERIALS 163
921.01 Traffic Paint 163
921.02 Durable Marking Material 163
(a) Thermoplastic 163
(b) Preformed Plastic 163
1. Material Requirements 164
a. Tensile Strength 164
b. Adhesive Stability Test 164
c. Adhesive Shear Strength 164
d. Bend Test 164
2. Packaging 165
3. Basis For Use 165

TABLE OF CONTENTS

SECTION TITLE PAGE

(c) 100% Solids Epoxy 165
1. Material Requirements 165
a. Glass Beads 165
b. Abrasion Resistance 165
c. Hardness 166
d. Tensile Strength 166
e. Compressive Strength 166
f. Weather Resistance 166
g. Laboratory Drying Time 166
h. Viscosity 166
2. Materials Preparation 167
3. Packaging and Storage 167
4. Basis For Use 167
(d) Raised Pavement Marker 167
1. Snowplowable Raised Pavement Marker 167
a. Prismatic Reflector 167
(1) Optical Performance 168
(2) Seal Test 169
(3) Heat Resistance Test 169
(4) Strength Test 169
(5) Impact Test 169
(6) Temperature Cycling Test 169
(7) Adhesive Tensile Strength Test 170
(8) Basis For Use 170
2. Cast Metal Base 170
a. Epoxy Adhesive 170
b. Basis For Use 170
3. Precast Cement Concrete Base 170
a. Adhesive for Precast Concrete Base 171
b. Packaging 171
c. Basis For Use 171
(e) Glass Beads 171

SECTION 922 – TRAFFIC SIGNALS 172
922.01 Traffic Signal Controller and Cabinet 172
(a) Model Approval 172
(b) Controllers or Control Units Furnished and Installed by the Contractor 172
(c) Blank 173
(d) Bench Testing 173
(e) Pretimed Solid State Digital Controller 173
1. General 174
2. Controller Requirements 175
3. Spare Modules 178
4. Controller Enclosure 178
5. Power Requirements 178
6. Certification of Traffic Control Units 178
7. Warranty 178
(f) Traffic Actuated Solid State Digital Controller 178
1. General 179
2. Controller Requirements 179
3. Spare Modules 180
4. Controller Enclosure 180
5. Power Requirements 181
6. Certification of Traffic Control Units 181
a. Certification of a Production Run Model 181
b. Certification of Environmental Testing 181
7. Warranty 181

TABLE OF CONTENTS

SECTION TITLE PAGE

(g) Cabinet Requirements for Traffic Signal Controllers 182
1. General 182
2. G Cabinet 184
a. Cast Aluminum Pedestal Base 185
b. Pedestal Pole 186
c. Pole Cap 186
3. M Cabinet 186
4. P-1 Cabinet 188
(h) Two Circuit Alternating Flasher 189
1. General 189
2. Cabinet Requirements 189
922.02 Interconnection Equipment 190
(a) Hardwire Interconnection 190
1. Electro-Mechanical Dial Coordination Unit 190
a. General 190
b. Additional Requirements for Master Locations 191
c. Additional Requirements for Secondary Locations 191
922.03 Blank 191
922.04 Signal Head Components 191
(a) Vehicle Signal Face 191
1. General 191
2. Housing, Door, and Visor 192
3. Lens 192
4. Reflector Assembly 192
5. Lamp Receptacle and Wiring 192
6. Section Coupling 192
7. Terminal Block 193
8. Material Requirements 193
a. Polycarbonate Signal Head 193
b. Die-Cast Aluminum Signal Head 193
9. Certification 193
(b) Pedestrian Signal Head 193
1. Housing, Door, and Visor 194
2. Optical Unit 194
3. Lens 194
4. Message 195
5. Reflector Assembly 195
6. Light Distribution 195
7. Electrical 195
(c) Disconnect Hanger Junction Box 195
(d) Signal Bulbs 196
(e) Free Swinging Signal Support Assemblies 197
(f) Mid-Mast Arm Mount Signal Bracket 198
(g) Pedestal Mounted Control Cabinets or Pedestrian Signal Heads 199
922.05 Signal Support 199
(a) Steel Strain Pole 199
(b) Wood Strain Pole 200
(c) Signal Cantilever Structures 200
1. General 201
2. Signal Support 201
3. Combination Signal-Luminaire Support 201
4. Pole Requirements 201
a. General 201
b. Deflection 202
c. Materials 202
d. Hardware 202
e. Anchor Base 202

TABLE OF CONTENTS

SECTION TITLE PAGE

5. Arm Requirements 202
a. Signal Cantilever Arm 203
b. Luminaire Mast Arm for Combination Support 203
c. Materials 203
6. Anchor Bolts 203
7. Finish 204
8. Certification 204
9. Shop Drawings 204
(d) Downguys, Anchors, Rods, and Guards 204
922.06 Traffic Cable 204
(a) Messenger Cable 204
(b) Span, Catenary, and Downguy Cable 204
(c) Tether and Support Cable 205
(d) Cable Hardware 205
1. Messenger Hangers 205
2. Cable Ring 205
3. Clamps 205
4. Servi-Sleeves 205
5. Straight Eye-Bolts 206
6. Hub-Eyes 206
(e) Signal Cable 206
1. Hook-up Wire 206
2. Signal Control Cable 206
3. Integral Messenger Interconnect Cable 206
4. 6 Pair/19 Telemetry Cable 206
5. Fiber Optic Interconnect Cable 206
6. Service Cable 207
7. Detection Wire and Sealant 207
a. Loop Detector Lead-In Cable 207
b. Roadway Loop Wire 207
c. Sealant 207
8. Ground Wire 207
9. Splicing Kit 208
922.07 Ground Rod and Connections 208
922.08 Castings for Handholes 208
922.09 Entrance Switch 208
922.10 Conduit and Fittings 208
(a) Steel Conduit 208
(b) Polyvinyl Chloride Conduit 209
922.11 Detector Housing 209
922.12 Certification 209

SECTION 923 – TEMPORARY TRAFFIC CONTROL DEVICES 209
923.01 Temporary Pavement Marking Tape 209
923.02 Temporary Raised Pavement Marker 210
(a) Optical Requirements 210
(b) Strength Requirements 211
(c) Adhesive 212
(d) Acceptance Evaluation 212
923.03 Construction Warning Lights 213
(a) Flash Requirements 213
1. Flash Rate 213
2. On-Time 213
a. Type A 213
b. Type B 213
(b) Optical Requirements 213
1. Effective Intensity 213
2. Lens Illumination 213

TABLE OF CONTENTS

SECTION TITLE PAGE

3. Reflex-Reflective Performance 214
4. Testing Procedure 214
(c) Lens Requirements 214
1. Size of Lens 214
2. Directional Lenses 214
3. Lens Chromaticity 214
4. Lens Luminous Transmittance 214
5. Lens Material 215
(d) Head and Case 215
1. Swivel Head 215
2. Case 215
(e) Photoelectric Controls 215
923.04 Flashing Arrow Sign 215
(a) Solar Powered 216
(b) Diesel Powered 216
(c) AC Powered 216
923.05 Temporary Worksite Speed Limit Sign Assembly 218
923.06 Tubular Marker 218

SECTION 924 – WELDING SUPPLIES 218
924.01 Welding Supplies 218
(a) Aluminum Alloy Base Metals 218
1. Bare Wire Electrodes and Welding Rods 218
2. Filler Metal 218
3. Shielding Gases 219

SECTION 925 – ITS CONTROLLER CABINET 219
925.01 General Requirements 219
925.02 Model Approval 221
925.03 Warranty 221
925.04 Cabinet Accessories 221
(a) Rack Frame Assembly 221
(b) Equipment Shelves 221
(c) Sunshield 222
(d) Side Panels 222
(e) Data Pocket 222
(f) Equipment Labels 222
(g) Primary Power Terminal Block 222
(h) Ground Lug 222
(i) Ground Bus 222
(j) Transient Voltage Surge Suppression 223
(k) Load Center Main Breaker 223
(l) Load Center Panelboard 223
(m) GFI Duplex Receptacle 223
(n) Duplex Receptacle 223
(o) Terminal Strip Surge Protector 223
(p) Door Open Switches 224
(q) Light Switch 224
(r) Lamp Holders 224
(s) Lamps 224
(t) Circulating Fans 224
(u) Enclosure Heaters 224
(v) Heater Relays 225
(w) Thermostats 225
(x) Detector Card DIN Rail Terminal Blocks 225
(y) I/O Module 225
(z) Detector Card Rack 225
(aa) Padlocks 225

TABLE OF CONTENTS

SECTION TITLE PAGE

(bb) Other Cabinet Equipment 225
925.05 Cabinet Wiring 225
925.06 Drawings 226

SECTION 926 – MISCELLANEOUS MATERIALS 226
926.01 Flexible Delineator Posts 226
926.02 Delineators 227
(a) Acrylic Plastic Delineators 227
(b) Reflective Sheeting Delineators 227
(c) Barrier Delineators 228
(d) Temporary Barrier Delineator 228

SECTION 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.

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACBF	air cooled blast furnace slag
AE	asphalt emulsion
AIA	American Institute of Architects
AMRL	AASHTO Materials Reference Laboratory
ANSI	American Nations Standards Institute
AP	class A aggregate for concrete slabs
ARA	American Railway Association
AREA	American Railway Engineering Association
ARS	asphalt roofing shingles
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 Service Association
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
BBR	bending beam rheometer
BF	blast furnace slag
CCRL	Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology
CFR	Code of Federal Regulations
CMA	cold mix asphalt
CMD	concrete mix design
DBE	disadvantaged business enterprise
DMF	design mix formula
DMTE	District Materials and Tests Engineer
DSR	dynamic shear rheometer
EPA	United States Environmental Protection Agency
ESAL	equivalent single-axle loads
FHWA	Federal Highway Administration, Department of Transportation

FSS	Federal Specifications and Standards, General Services Administration
GBF	granulated blast furnace slag
GGBFS	ground granulated blast furnace slag
HDB	hydrostatic design basis
HFRS	high float seal coat asphalt emulsion
HMA	hot mix asphalt
HRWR	high range water reducing
HRWRR	high range water reducing and retarding
IAC	Indiana Administrative Code
IC	Indiana Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IMSA	International Municipal Signal Association
IOSHA	Indiana Occupation Safety and Health Administration
ITM	Indiana Test Method or Procedure
JMF	job mix formula
MAF	mixture adjustment factor
MC	medium curing asphalt
MCA	medium curing asphalt with additive
MSG	maximum specific gravity
MUTCD	Indiana Manual on Uniform Traffic Control Devices, in accordance with 107.12
NACE	National Association of Corrosion Engineers
NCHRP	National Cooperative Highway Research Program
NEMA	National Electrical Manufacturers Association
NEPCOAT	Northeast Protective Coating Committee
NIST	National Institute of Standards and Technology
OSHA	U.S. Occupational Safety and Health Agency
PAV	pressurized aging vessel
PCC	portland cement concrete
PCCP	portland cement concrete pavement
PG	performance grade asphalt
QC	quality control
QC/QA	quality control/quality assurance
QCP	quality control plan
RAP	recycled asphalt pavement
RCRA	Resource and Conservation Recovery Act
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
SF	steel furnace slag
SHRP	Strategic Highway Research Program
SSD	saturated surface dry
SSPC	The Society for Protective Coatings
TCLP	Toxicity Characteristic Leaching Procedure
TSR	tensile strength ratio

UA	utility asphalt
UL	Underwriter Laboratory
UST	underground storage tank
VFA	voids filled with asphalt
VMA	voids in mineral aggregate
VOC	volatile organic compounds

101.02 Above Normal Inclement Weather Days

The specific 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 chart 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

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

101.05 Bidder

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

101.06 Bridge

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 (6.1 m) 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

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.

101.06.1 Business Day

Monday through Friday except for holidays in accordance with 101.26.

101.07 Calendar Day

Every day shown on the calendar.

101.08 Blank

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 permitted unless otherwise authorized by the Engineer.

101.11 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.

The contract may include, but is not limited to, the Proposal book, Schedule of Pay Items, contract form, bid bond, performance bond, specifications, supplemental 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.

101.12 Contract Information Book

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

101.13 Contract Item (Pay Item)

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

101.14 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 in the Proposal book in lieu of the number of work or calendar days, the contract shall be completed by that date.

101.15 Contractor

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

101.16 Culvert

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

101.17 Department

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

(a) Materials and Tests Division

A division within the Department which has a mailing address of 120 South Shortridge Road, Indianapolis, IN 46219-0389.

(b) Contract Services Section

A section within the Department which has a mailing address of Room N855, 100 North Senate Avenue, Indianapolis, IN 46204-2218.

(c) Procurement and Distribution Division

A division within the Department which has a mailing address of 6400 East 30th Street, Indianapolis, IN 46219-1082.

101.18 Commissioner

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

101.19 Embankment Foundation

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

101.20 Engineer

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

101.21 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.

101.22 Extra Work

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

101.23 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.

101.24 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.

101.25 Frequency Manual

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.

101.26 Holidays

Holidays are considered to be:

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
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.

101.26.1 Indianapolis Traffic Management Center

The location of the Department's ITS Section which has a mailing address of 8620 East 21st Street, Indianapolis, IN 46219.

101.27 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 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.

101.28 Itemized Proposal

The Schedule of Pay Items shown in the Proposal book.

101.29 Laboratory

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

101.30 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.

101.31 Materials

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

101.32 Notice to Proceed

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

101.33 Open to Unrestricted Traffic

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.

101.34 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.

101.35 Performance Bond

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.

101.36 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.

101.37 Professional Engineer

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

101.38 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.

101.39 Project

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

101.40 Proposal

The Schedule of Pay Items shown in the Proposal book.

101.41 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.

101.42 Quality Assurances Adjustments

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

101.43 Reasonably Close Conformance

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.

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 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.

101.44 Right-of-Way

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

101.45 Road

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

101.46 Roadbed

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

101.47 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.

101.48 Roadside Development

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.

101.49 Roadway

The portion of a highway within limits of construction.

101.50 Schedule of Pay Items

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.

101.51 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.

101.52 Sidewalk

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

101.53 Special Provisions

Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.54 Specifications

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

101.55 Specified Completion Date

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

101.56 State

The State of Indiana acting through its authorized representative.

101.57 Street

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

101.58 Structures

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.

101.59 Substantial Completion

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, as a minimum, all of the following criteria must be met: All lanes of the road or bridge may be opened to traffic using its final roadway surface, including shoulders, with all the markings, permanent safety appurtenances, permanent erosion control features, lighting, traffic signals, and signing as shown in the contract documents.

101.60 Blank

101.61 Subcontractor

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

101.62 Subgrade

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

101.63 Substructure

All of that part of the structure below the bearings of simple and continuous spans, skewbacks or arches, and tops of footings of rigid frames together with backwalls, wingwalls, and wing protection railings.

101.64 Superintendent

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

101.65 Superstructure

The entire structure except the substructure.

101.66 Supplemental Specifications

Additions and revisions to the standard specifications that are adopted subsequent to issuance of the Standard Specifications Book.

101.67 Surety

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.

101.68 Technician or Inspector

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

101.69 Titles (Headings)

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.

101.70 Township, Town, City

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

101.71 Traveled Way

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

101.72 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.

101.73 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 permit work on the controlling operations for at least 50% of the day with the normal working force. 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.

101.74 Working Drawings

Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit for approval.

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 Services Section.

If apparent errors, discrepancies, or unclear statements are found in the contract documents prior to letting, the District Construction Engineer for the district shown on the Proposal sheet shall be contacted by telephone or fax.

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 XII, included in the Contract Information book.

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 23.43(a) shall constitute a breach of contract and, after notification, may result in termination of the contract or such remedy as the State deems appropriate.

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 that disadvantaged business enterprises, as defined in 49 CFR Part 23, shall have the maximum opportunity to participate in the performance of contract work financed in whole or in part with Federal funds provided under this contract. Consequently, the disadvantaged business enterprise requirements of 49 CFR Part 23 apply to this contract.

2. The Contractor agrees to ensure that disadvantaged business enterprises certified by the State shall have the maximum opportunity to participate in the performance of contract work or subcontract work financed in whole or in part with Federal funds provided under this contract. In this regard, the Contractor shall take all necessary and reasonable steps, in accordance with 49 CFR Part 23, to ensure that disadvantaged business enterprises have the maximum opportunity to compete for and perform work in this contract. The Contractor shall not discriminate on the basis of race, color national origin, or sex in the award and performance of this contract.

(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

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

A business enterprise which has completed and filed a request for certification with the Indiana Department of Administration, and that the business enterprise has been reviewed and determined to comply with the guidelines established in 49 CFR Part 23. Business enterprises which are determined to be eligible will be certified as DBEs.

(c) Goal

A contract provision goal may be shown on the Proposal sheet. Such goal, if required, has been established as the amount to be contracted to DBEs. The Contractor shall meet or exceed the goal, or demonstrate that it could not be met despite best efforts. Achievement of the contract provision goal does not relieve the Contractor of the requirement for affirmative action on subsequent subcontracting on this contract. Only work with listed DBEs which are certified prior to the date of the letting will count toward the goal.

Contracting may be in the form of subcontract, lease agreement, or material supply. Full credit will be given for subcontracts and lease agreements. Credit for utilization of a DBE material supplier will be limited to those DBEs certified as suppliers prior to the letting at the rate of 60% of the expenditure to the supplier unless the supplier is also the manufacturer. Suppliers that do not manufacture the items shall also perform a commercially useful function in order for credit to be received.

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 permitted 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.

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 not later then 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.

If the Contractor is a certified DBE contractor, the DBE contract goal will be deemed met for the contract. The Affirmative Action Certification, included in the Proposal book, shall not be required. All other requirements pertaining to the DBE utilization will apply.

A written request for changes in utilization of DBEs listed in the Affirmative Action Certification shall be approved prior to start of listed services or purchase of listed materials. Request to reduce or eliminate the services or material provided by a listed DBE that include written approval by the DBE will be considered sufficient justification if the committed DBE utilization after the requested change will meet or exceed the contract goal or a lesser percentage approved prior to execution of the contract. If the committed DBE utilization after the change does not meet or exceed the contact goal or a lesser percentage approved prior to execution of the contract, or the listed DBE does not approve the change, the Contractor shall submit documented evidence that the DBE is unable to perform successfully. Disposition of the request for change will be determined on the basis of the affirmative actions taken as required herein.

(d) Affirmative Actions

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.

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.

(e) Guidelines for Determining Good Faith Efforts

Appendix A of 49 CFR Part 23 has been used as the guideline in preparing the Department procedures to determine the adequacy of good faith efforts. Additional factors consistent with 49 CFR Part 23, and the Department's policies and procedures have also been utilized.

The following factors will be considered in determining good faith efforts. The Contractor shall submit evidence of the factors.

1. The Contractor shall contact a reasonable number of specific DBEs interested in bidding on pay items selected by the Contractor for subcontracting. To effectively participate, the DBE shall have the opportunity to be able to analyze the contract and submit quotations prior to letting. Contacts shall be either by telephone or written notice. Telephone contacts shall be followed up with written confirmation.

2. All other active certified DBEs which perform the type of work to be subcontracted and which perform in the geographic location of the contract shall be notified if efforts taken described above do not result in the Contractor meeting the DBE goal.

3. Information provided by the Contractor to the DBE shall include, at a minimum, the contract number, pay items and quantities for those pay items to be subcontracted, and the date the subcontract bid is desired.

4. The DBE shall be notified at the earliest possible time and at least seven calendar days prior to date the Contractor desires quotes in hand. The efforts as described above shall be accomplished simultaneously, if necessary.

5. The Contractor shall follow up initial written solicitation with telephone contacts to determine if interested DBEs which have not responded had received written notice. Telephone contact shall also be made with DBEs who had indicated through the initial contact that they would submit a bid, but had not by the desired time. These telephone contacts will not be necessary if the Contractor has received satisfactory bids from other DBEs on the pay items in question.

6. 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. The Contractor shall ascertain the prequalification status, including classified limits, from prospective DBE subcontractors.

7. The Contractor shall provide the interested DBEs with complete information about the plans, specifications, and requirements of the contract, noting potential problem areas. 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.

8. The Contractor shall apply affirmative action to its review and award of subcontracts.

   Bids received from DBEs which are within 10% above the low bid of a majority subcontractor shall be utilized by the Contractor in awarding subcontracts in order to meet the goal. The only exception shall be those bids rejected as described below.

   It will be considered unacceptable to avoid subcontracting to DBEs if subcontracting to a DBE results in having to further subcontract remaining work.

9. 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 includes, but is not limited to, hearsay and unsigned documentation.

10. The Contractor shall make efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance required by the State of the Contractor. However, the Contractor shall affirmatively consider waiving requirements it may have in order to assist the DBE.

11. In addition to Department assistance, the Contractor shall effectively use, when feasible, the services of available minority community organizations, minority contractor groups, local State, and Federal minority business assistance offices, and other organizations that provide assistance in the recruitment and placement of DBEs. The Department's certified DBE list is the only accepted list for the Department's DBE Program.

12. If the Contractor has achieved less than the DBE goal but has taken good faith efforts prior to the letting, the Contractor shall take good faith efforts to achieve the DBE goal during the seven calendar days after notification. As a minimum, the Contractor shall re-contact all DBEs including those DBEs listed on the Contractor's Affirmative Action Certificate which submitted quotes or previously expressed interest in quoting to the Contractor. The Contractor shall document, in writing, the contacts that were made.

(f) Affirmative Action Certification

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 DBEs or shall state the reasons DBEs are not listed. 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.

(g) Subcontracts

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.

Requests to subcontract a portion of the work to a firm that is not a DBE shall include Form MBE-2. Documentation shall be submitted evidencing contacts and the results thereof with potential DBEs for the specific work to be subcontracted.

Upon receipt of notification from the Department, a Disadvantaged Business Enterprise Utilization Affidavit, Form MBE-3, shall be completed by the Contractor and returned to the Department. The Contractor and the subcontractor/lessor/supplier shall certify on Form MBE-3 that specific amounts have been paid and received.

(h) Leases and Rentals

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.

In order to perform a commercially useful function, the dollar volume of hauling by a DBE trucking firm that is counted toward the DBE goal is limited to that dollar volume of hauling attributable to a maximum of twice the number of vehicles owned by the DBE, or leased from another DBE, that are utilized on the project. DBE hauling lessors who sublease a portion of their hauling shall take positive affirmative actions to sublease to DBEs and shall provide Form MBE-2 to the Department, evidencing those efforts prior to commencing work.

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.

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

The Contractor shall keep such records as necessary to determine compliance with its DBE utilization obligations and compliance with the Guidelines for Good Faith Efforts for Goal Contracts. 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.

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.

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.

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.

103.03 Blank

103.04 Insurance

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.

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 at Room N855, 100 N. Senate Avenue, Indianapolis, IN 46204-2218 of such impending cancellation.

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

1. Worker's compensation shall be provided according to the provisions of the Indiana Worker's Compensation and Occupation 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

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
   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

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

The named insured in this policy shall be the State of Indiana, c/o Indiana Department of Transportation, 100 N. Senate Avenue, Room N855, Indianapolis, IN 46204-2218. 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.

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.

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:
(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. Not withstanding 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 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

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

These requirements will apply only to a 100% State funded contract. 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, or subcontract.

(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, disability, national origin, or ancestry. Breach of this covenant may be regarded as a material breach of the contract.

(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 be open to the inspection of the Department.

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.

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.

Each employee on the work covered by the contract shall be permitted 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.

(c) Wage Stipulations

No person employed on the contract shall be paid at a rate of less than $8.40/h, as required by IC 8-23-9-22.

1. General Decision Included in Contract Information Book

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.

> "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

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.

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.

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.

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, 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 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 Differing Site Conditions, Suspension of Work, and Significant Changes in the Character of Work

Code of Federal Regulations 23 CFR 635.109 reads as follows:

(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 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 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.

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

(b) Suspensions of Work Ordered by the Engineer

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.

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.

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

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.

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.

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

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% of the actual amount of work performed.

(d) Pre-established Remedies to Changed Conditions

The remedy to the changed condition either eliminates the claim by means of calculations involving existing pay items in the contract or limits the amount to be paid. These requirements will be used in reaching a settlement between the Contractor and the Department, except when either party may demonstrate that this does not result in a just and fair resolution. The Engineer will notify the Contractor of the determination.

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

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. 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 (60 m) intervals where drop-offs of greater than 3 in. (75 mm) 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. 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 permit 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. 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

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 713.07.

(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.

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.

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 competed, shall be maintained in a condition satisfactory for use during the time work is suspended.

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

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 permitted 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. (150 mm) 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.

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.

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.

Regulated materials will consist of those as follows:

(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.

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:

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

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/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.

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.

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.

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

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 have tested those areas so directed by the Department, and shall test for the materials and products so 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.

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:

   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.

      (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.

      (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 have provided written notice to the Contractor which specifies that such hazardous condition and such affected area is, or has been, rendered safe for the resumption of work, or which specifies conditions under which work may be safely resumed.

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.

d. The Department will be listed as the owner/generator on all regulated material manifests or documents.

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.

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

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.

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 if so specified in the Proposal book or 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.

If archaeological artifacts are encountered during excavation operations, these operations shall be ceased in the immediate vicinity and the Engineer shall be notified. An archaeologist will be provided by the Department and a determination will be made as to the significance and the disposition of such findings. In no event shall an employee of the Contractor or the State of Indiana share in such ownership, or profit from salvaged archaeological findings. Unless otherwise agreed to in writing, compliance with this requirement will not be paid for directly. The cost thereof shall be included in the cost of the pay items.

104.08 Final Clean-Up

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.

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 (0.6 m) 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.

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. In the case of such a suspension no additional payment will be made. Work shall not be suspended without written authority from the Engineer.

105.02 Plans and Working Drawings

Road plans shall show in detail structures of up to and including 20 ft (6.1 m) 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. Supplementary bridge plans, shop details, erection and working drawings, falsework and centering plans,

cofferdam plans, or other detailed drawings as may be required and as in accordance with 711.05, shall be furnished. The approval of such drawings will relate only to the requirements for strength and detail. Such approval will not relieve the Contractor from responsibility for errors, adequacy or safety of falsework, cofferdams, or other temporary work.

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.

Plans required for approval and for construction purposes shall be submitted as soon as practicable after contract award, and shall be drawn on vellum or similar material suitable for reproducing copies of working drawings by the white print process. No direct payment will be made for such tracings. When detailed plans for falsework, cofferdams, or other detailed drawings are submitted for approval, they shall be signed by and bear the seal of a registered professional engineer.

105.03 Conformance with Plans and Specifications

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, shown on the plans or indicated in the specifications. Any deviation from the plans or specifications that may be required by the exigencies of construction will be determined by the Engineer and authorized in writing.

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 preponderately of borderline quality or dimension.

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.

If the Engineer finds the materials or the finished product in which the materials are 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 contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as deemed necessary to conform to the determination based on engineering judgement.

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, Supplemental Specifications, and Special Provisions

These specifications, the supplemental 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:	Special Provisions Plans Supplemental Specifications Standard Specifications
Special Provisions	hold over:	Plans Supplemental Specifications Standard Specifications
Plans	hold over:	Supplemental Specifications Standard Specifications
Supplemental Specifications	hold over:	Standard Specifications

In case of discrepancy relative to other contract documents, the list of approved or Prequalified Materials will be regarded the same as supplemental specifications. Notes on the plans which are not 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

Four sets of approved plans and Proposal books will be furnished without charge. Two sets shall be available on the worksite at all times.

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.

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.

105.06 Cooperation with Utilities

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

Water lines, 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 shall have been considered in the bid.

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.

The contract documents in 107.25 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 and/or losses 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 from the documented offending party in accordance with Public Law 35-2005.

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 one project, each contractor shall conduct its work so as to not to 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.

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.

Work shall be arranged and the materials being used shall be placed and disposed of so as to not to 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 bench mark adjacent to the work, and vertical control elevations for flow lines, footings, caps, bridge seats, screed elevations, etc. 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 and the District Traffic Section to locate all existing underground traffic signal and lighting wiring. The District Traffic Section 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, straight-edges, 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 bench marks; running a level circuit to establish elevations on new bench mark 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; and setting vertical control elevations, such as footings, caps, bridge seats, and screed elevations. Construction engineering shall also include documenting the underground wiring as located by the District Traffic Section.

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

The Contractor shall schedule its construction engineering operation, including staking, in a timely fashion so as to assist the utilities in the relocation/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.

A complete cross section shall be taken at each 500 ft (150 m) 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. Interstate routes and other divided lane pavements shall be checked for the vertical clearance under structures to ensure that a minimum of 16 ft (4.9 m) 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 (4.3 m) 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 (30 m) 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 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 Land Surveyors Statutes and Rules.

Bench marks and elevations shall be established on new or rehabilitated bridges. The elevations shall be tied to the United States Geodetic Survey system providing there is an existing monument within a radius of 3 mi (5 km) of the bridge site. If a monument is not within this distance, the elevation of the new bench mark shall be established from the bench marks 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 3 of the Department's Design Manual. Copies of the forms shall be provided to the Engineer for distribution.

All stakes, templates, straight-edges, 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 bench marks shall be run for the full length of the project. Intermediate bench marks shall be established approximately every 500 ft (150 m) through the project. On a bridge contract, the circuit shall include four plan bench marks, if available, two on each side of the structure.

Field notes shall be kept in hard covered bound field note books in a clear, orderly, and neat manner consistent with standard engineering practices and in accordance with the Department's prescribed note book procedure, including titles, number, and indexes. Such note books shall be furnished by the Contractor and shall adequately document all survey information. Copies of field notes 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.

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 in to a permanent plan bench mark. 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.

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 the 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.

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.

(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-or-way, setting slope stakes, referencing points, and preparing grade sheets for rough grading. Rough grade staking will be performed by the Department.

Notes for production staking shall be prepared in standard field note 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 transferral of 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 permit 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 bench mark 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, in no 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.

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.

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.

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

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 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

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 permitted. No loads will be permitted 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.

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 permitted 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

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.

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

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 permitted.

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

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

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

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.

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 Claims for Adjustment and Disputes

If the Contractor deems that additional compensation will be due for work or material not clearly covered in the contract or not ordered as extra work, as defined herein, notification shall be made in writing of the intention to make claim for such additional compensation before the work is begun on which the Contractor bases the claim. If such notification is not given and the Engineer is not afforded proper facilities for keeping strict account of actual cost as required, no claim shall be made for such additional compensation. Such notice, and the fact that the cost as aforesaid has been accounted for, shall not be construed as proving or substantiating the validity to the claim. If the claim, after consideration, is found to be just, it will be paid as provided herein for force account work. Nothing in this subsection shall be construed as establishing a claim contrary to the terms as set out in 104.02.

105.17 Field Office

If a pay item for such is included in the contract, a field office, to be located as mutually agreed, shall be provided for the Department's exclusive use. If there is a building within the limits of the right-of-way that is suitable for a field office, is acceptable, and is scheduled to be removed under the terms of the contract, such building may be equipped and furnished as the field office. If the building is large enough to provide adequate space for a field laboratory, no additional payment will be allowed for a field laboratory as a separate pay item. A building within the right-of-way that is furnished under this specification shall be removed by the time all other pay items have been completed and prior to the date of the last work. Other facilities for the field office shall then be provided.

The field office shall be complete with all utility connections and equipment requirements in place by the start of work unless the Contractor notifies the Engineer in writing that this is not possible. If the Contractor is unable to provide the permanent field office prior to the start of the work, the Contractor and the Engineer shall agree on temporary field office arrangements including which furnishings are necessary, prior to the start of work. A temporary field office shall not be used for more than two months unless otherwise approved.

The office shall be of the type shown on the Schedule of Pay Items. The office shall have a solid level floor with no holes, weatherproof roof, be dust-proof, and wind-tight. It shall be provided with satisfactory lighting, heating, and air-conditioning equipment. It shall be able to sustain a uniform temperature between 68°F and 80°F (20°C and 26°C).

The trailer shall be securely supported by adequate blocking. The blocking shall provide a foundation to prevent settlement.

Each trailer shall be furnished with steps meeting IOSHA/OSHA requirements at each doorway.

The building or trailer furnished for a field office shall be in accordance with all applicable state and local codes and applicable IOSHA/OSHA requirements. The field office shall also contain the following equipment and be in accordance with the following requirements.

	Office Type		
	A	**B**	**C**
Minimum Area	400 sft (37 m^2)	550 sft (51 m^2)	650 sft (60 m^2)
Pencil Sharpener	Yes	Yes	Yes
Broom/Dust Pan	Yes	Yes	Yes
Six-hook Coat Rack	Yes	Yes	Yes
Toilet Facilities	Yes	Yes	Yes
Drinking Water	Yes	Yes	Yes
Fire Extinguishers	1	2	2
First-Aid Kit	1	1	1
Bloodborne Pathogen Kit	1	1	1
Smoke Detector	1	1	2
CO Detector (if applicable)	1	1	1
Doors	2	2	2
Windows	6	8	8
Lockable Storage Area	1	1	1
Shelving	16 lft (4.9 m)	20 lft (6.1 m)	24 lft (7.3 m)
Telephones	2	2	3
Answering Machine/voice mail	1	1	1
Telephones Lines	3	3	4
File Drawers	4	8	12
Desks	2	4	4
Office Folding Tables	1	2	2
Chairs	4	8	12
Drafting Tables	1	1	1
Drafting Stools	1	1	1
Trailer Tie-Down System	Yes	Yes	Yes
Electrical Outlets	Yes	Yes	Yes
Trash Disposal	Yes	Yes	Yes
Waste Paper Baskets	2	4	4
Supplies	Yes	Yes	Yes
Calculators	1	2	2
Copier	1	1	1
Fax Machine	1	1	1
Computers	1	1	2
Electrical Service	100 amp	100 amp	100 amp
Parking Spaces	Yes	Yes	Yes
Microwave Oven/Refrigerator	Yes	Yes	Yes

The office and the equipment shall be furnished in a condition satisfactory to the Department. All mechanical and electrical equipment shall be maintained in good working condition.

The minimum dimensions shall be 8 ft (2.4 m) wide, 7 ft (2.1 m) in height (from floor to ceiling), and have a floor area as specified in the Schedule of Pay Items. For a trailer, the calculation of minimum area will be based on the exterior box dimensions. The Contractor may request to furnish a field office with less than the specified area. If approved, a change order will be executed.

Hand-washing and toilet supplies shall be provided.

Potable drinking water with both hot and cold water capabilities shall be furnished. Drinking cups and paper towels shall be provided.

The fire extinguishers shall be a five-pound, Class ABC or higher rated and shall be maintained in a fully charged and operable condition. They shall be conspicuously located where they will be readily accessible and immediately available. They shall not be obstructed or obscured from view. They shall contain operating instructions and placed in such a manner that the extinguisher operating instructions face outward. Fire extinguishers shall meet all IOSHA/OSHA requirements.

The first-aid kit shall meet the requirements of ANSI Z308.1-1978.

If the field office is heated with fossil fuel, a carbon monoxide detector, in working condition, shall be furnished.

There shall be at least two doors and the appropriate number of windows as previously listed, not including windows that are part of the doors, on office trailers. Each door shall have a satisfactory lock. When the trailer is locked, one door must always be able to be opened from inside the trailer. If a padlock is used to secure the door, it shall be a high security type which is invulnerable to bolt cutters, hacksaws, hammers, or prybars. The padlock shall be mounted in such a manner that locking and unlocking the door is determined to be fast and convenient. Installation of additional hardware to protect the lock or multiple padlocks on the door will not be permitted. However, additional hardware to receive this type lock will be acceptable. The Contractor shall furnish the number of office keys as directed. The Department will maintain a list of all personnel who are given keys.

The windows shall be hinged or sliding and have a minimum area of 5 sft (0.45 m^2) each. Windows shall be provided with locks and satisfactory screens. All windows in the field office, including windows that are part of the doors, shall be covered. This covering may be shades, blinds, or other approved devices.

The office shall contain one lockable storage area suitable to store a nuclear gauge and shall have a minimum storage volume of 48 cu ft (1.3 m^3).

The shelving shall have a minimum width of 10 in. (250 mm).

At least one telephone shall be a cordless phone having a frequency of at least 900 MHz.

The automatic telephone answering machine/voice mail shall be capable of providing both a minimum one minute outgoing message and 30 minute total recording time for incoming calls. It shall have a remote operation feature, which may be used from push-button telephones to retrieve, replay, erase, and save messages.

All filing cabinet drawers shall have a filing depth of 25 in. (635 mm). At a minimum, the files shall be fire resistant steel filing cabinets with a class D or higher classification established by UL or Safe Manufacturers National Association. All files shall have a lock. At least four drawers shall be fire proof.

The desktops shall be at least 48 in. (1220 mm) wide and 25 in. (635 mm) deep. All desks shall contain at least two drawers, one of which shall be provided with a lock.

Each folding table shall be a minimum size of 30 in. x 60 in. (760 mm x 1520 mm).

There shall be a height adjustable chair with castors for each desk. The remaining chairs may be stackable or folding chairs.

The drafting table shall contain a tilt top work table for drafting purposes. Dimensions shall be at least 30 in. x 60 in. (760 mm x 1520 mm). The drafting stool shall be proportional to each drafting table.

The office shall have a minimum of one electrical outlet for each work station (desks, drafting tables, computer stations, etc.).

The Contractor shall be responsible to provide a place or container for trash to be deposited for removal by the Contractor.

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 and have a printer with a minimum 12-digit capacity.

All field offices shall be equipped with a table top dry ink copier machine using plain paper and capable of making full size copies of 11 in. x 17 in. (279 mm x 432 mm) originals. The copier shall be capable of reducing and increasing copy sizes. The copier shall have a self-feeding tray and be capable of producing at least 12 copies per minute.

The fax machine shall be kept in good working condition at all times. If the machine becomes inoperable, requires repair, or is stolen, it shall be repaired or replaced within three business days. The machine shall be provided with a telephone service line dedicated for its use. The machine shall be capable of the following:

a. load a minimum of 10 pages of documents into an automatic document feeder,

b. automatically dial a minimum of 25 preprogrammed fax numbers,

c. handle a document size of 8.5 in (216 mm) in width and 11 in. (279 mm) in length,

d. have the ability to page number,

e. have a standard resolution of 200 x 100, and detail resolution of 200 x 200 (the numbers may vary by ± 5),

f. have a transmission speed of 15 s at 9600 bps, on a 8.5 x 11 in. (216 x 279 mm) document with standard resolution,

g. have automatic reception,

h. have 16 shades of halftones,

i. have a transmit terminal identification and shall automatically add transmit terminal identification to all documents,

j. have the ability to produce reports as follows:

(1) error report,

(2) transaction confirmation report,

(3) transfer result report,

(4) transmission report, and

(5) program list

k. have a transmit and receive counter, a clock, and a monitor speaker,

l. be built in accordance with the international group standards CCITT G3, and

m. be equipped with a handset.

The fully operational multimedia microcomputer system shall include a microcomputer, keyboard, color monitor, and printer. The computer equipment shall be placed on a separate computer work station.

The computer shall be in accordance with the requirements shown below:

1. Desktop System.
   a. Microprocessor: Intel Pentium compatible, 166 MHz, or faster
   b. 32 MB RAM, or larger

c. At least one 1.44 MB 3.5 in. diskette drive. If more than one diskette drive is furnished, the A: drive shall be 1.44 MB 3.5 in.
d. One fixed disk (hard drive), minimum 1.2 GB
e. 6X CD ROM drive, or faster
f. Multimedia sound system with amplified audio speakers
g. An SVGA display adapter, 1Mb video ram minimum
h. MPEG-1 full motion, full screen video
i. A minimum of one serial port
j. One parallel port
k. One mouse port with a 2-button mouse and mouse pad
l. A 101 key enhanced keyboard
m. A 56k V.34 fax/modem board. Port COM2 shall be designated
n. Operating system shall be Windows 95 or Windows 98

2. SVGA Display.
   a. A 15 in. (380 mm) color display, or larger
   b. Graphics 1024 X 768
   c. Dot pitch 0.28 mm
   d. Non-interlaced
   e. A swivel stand

3. An inkjet printer shall be provided meeting or exceeding the following.
   a. HP compatible print codes
   b. Fully compatible with DOS programs. HP Deskjet 600 or 900 series. Other brand printers are acceptable if they are equal to the HP 600 or 900 series.
   c. If settings are required, the printer shall be set for letter quality 10 pitch, IBM extended graphic character set (ASCII 128 thru 255.)
   d. Parallel port interface and connecting cable supplied

4. Software.
   a. Paradox, VER 4.5 for DOS
   b. MS Excel for Windows 95 or newer
   c. MS Word for Windows 95 or newer
   d. McAfee antivirus software for Windows 95. This shall be the latest version and shall be fully installed, with Vshield option activated. The Department will provide periodic updates for the DT and associated files containing new virus names, etc. The Contractor may provide this service if it so desires.

5. Miscellaneous Requirements.
   a. Uninterruptible Power Supply (UPS) minimum 280VA/175W (15 minutes) with full time surge suppression and noise isolation, including RJ-11 connections for modem phone line surge protection. American Power Conversion (APC) model Back-UPS Pro 280 (APC part #BP280), or equivalent
   b. Glare Screen for 15 in. (380 mm) monitor
   c. Printer stand for supplied printer
   d. Dust covers for all equipment

e. Black ink cartridges and 8 1/2 in. by 11 in. sheet paper for inkjet printers shall be supplied and replenished as needed

f. A supplemental phone line in addition to the standard telephone line shall be installed and connected to the PC modem through the UPS surge protection described above. If a supplemental phone line is being installed to accommodate a fax machine, this same line may be used for joint fax and PC communications using a line splitter or other appropriate device.

The requirements shown herein shall be considered as minimum requirements. Equipment or software which exceeds these requirements may be furnished, except where DOS or Windows is specified.

All manuals necessary for operation of the system shall be provided. These shall include manuals for microcomputer operations, DOS and Windows operating system, monitor operation, printer operation and code references, and all other manuals or documentation normally furnished with the equipment or software when purchased.

The microcomputer system in the field office shall be installed, and maintained in good working order. If a portion of the system becomes defective, inoperative, damaged, or stolen, that portion shall be repaired or replaced within five business days, Mondays through Fridays, after the Contractor is notified of such situation.

The Department will be utilizing the hardware and software specified herein to run Construction Management System software applications. These applications are known to run on IBM and fully IBM compatible equipment. If the Department experiences problems running these applications due to requirement compatibility, the Contractor shall, within five business days, Mondays through Fridays, replace and set up appropriate equipment to ensure compatibility to the satisfaction of the Department.

The office shall have 120/240 voltage service with the minimum specified service and breaker amperage.

The office shall have a mutually agreed upon number of all-weather parking spaces. Such parking spaces shall be either paved or surfaced with compacted aggregate, size No. 53, or other acceptable materials.

The microwave oven shall have a minimum 1.0 cu ft capacity with a minimum 1100 watts and shall have digital controls.

The combination refrigerator/freezer shall have a minimum combined capacity of 12 cu ft.

105.18 Method of Measurement

Field office will be measured by the month for the specified type. Partial months will be rounded up to the next half or whole month. The Department will provide two weeks advanced notice of when the office will be vacated.

105.19 Basis of Payment

Field office will be paid for at the contract unit price per month, complete in place until released.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Field Office, _____ type	MOS

The cost of all heating, electrical, telephone, and other miscellaneous utility bills shall be included in the cost of the field office.

If a field office smaller that the specified type is approved, the change order unit price for the smaller field office will be equal to the contract unit price multiplied by the smaller floor area and divided by the specified floor area.

If a temporary field office is provided in accordance with 105.17, payment will be 65% of the unit price.

The cost of materials necessary for the all-weather parking surface shall be included in the cost of the field office.

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.

(a) Approved or Prequalified Materials

Certain materials and equipment require pre-approval by brand name or source of manufacture. The lists of approved materials, equipment and sources are maintained by the Department as provided in the specifications and may be obtained from the Contract Services Section. The Department will review all approved materials lists 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.

The materials used shall be those prescribed for the several 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.

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 not in accordance with the requirements will be rejected. Material tested after incorporation into the work and not in accordance with the requirements will be governed by 105.03.

If a material from a source has a continued approval as shown by five or more consecutive tests, it may, if permitted, be put 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 as not being in accordance with the specifications, the Engineer may, in accordance with 105.03, require its removal from the work or permit it to remain. If permitted 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.

(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

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

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

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 American Requirement

All contracts, whether financed entirely or partially with State or Federal funds, shall comply with IC 5-16-8 and the 23CFR 635.410.

Except for pig iron and processed, pelletized, and reduced iron ore, steel shall be made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer, or other steel making process. Except for pig iron and processed, pelletized, and reduced iron ore, all steel materials and products permanently incorporated in the contract shall be manufactured in the United States. Manufactured products include those which are rolled, formed, shaped, drawn extruded, forged, cast, or fabricated. The United States includes all territories, continental and insular, subject to the jurisdiction of the United States of America.

Except for pig iron and processed, pelletized, and reduced iron ore, no steel products produced in the United States may be modified in a foreign country and still comply with the Buy American Requirement.

A Buy American Certification shall be submitted in accordance with 916.02(g) and 916.03(a).

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.

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.

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 (100 km) 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.

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 and Procedures will be designated as a test method by inserting a T in the ITM number or as a procedure by inserting a P in the ITM number. A test method will become effective immediately upon approval by the ITM Committee. A procedure will become effective on the next September 1, unless approved otherwise by the ITM Committee. 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

An ITM is available on request at the Materials and Tests Division. 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.

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.

106.04 Field Laboratory

If required for the contract work, a shelter or field laboratory consisting of a suitable building or trailer in which to house and use equipment necessary to carry on the required tests shall be provided. It shall be in accordance with 105.17, except for the telephone, adding machine, calculator, telephone answering machine, dry ink copier, and typewriter, and will be paid for as set out therein.

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 with permission unless otherwise approved.

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 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.

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.

106.08 Hazard Communication Program

The Contractor and all subcontractors will be required to furnish the Engineer with Material 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 permitted during construction without written consent. Application for such permission shall be in writing, a 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

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.

Certain counties in the State are considered by the United States Department of Agriculture to be generally infested with various harmful pest 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.

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 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 contact, or debarment of the Contractor from doing further work for the Department for up to three years.

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, cofferdams, etc., 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.

The Department may have acquired environmental 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 included in the Contract Information book. The Contractor shall prosecute the work in accordance with all such restrictions or conditions.

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.

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.

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.

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 who 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 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 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 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 be permitted provided that significant and meaningful training is provided and approved by the Department. Some offsite training is permissible 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 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 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 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.

107.07 Sanitary Conditions Requirements

Accommodations for the use of employees shall be provided and maintained in a neat 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, shall be taken.

(a) Employee Safety

If a trench, 5 ft (1.5 m) 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 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, 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

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 (9 m) from the edge of pavement lanes open to traffic except, storage may be permitted 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 (3 m), if approved.

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.

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 permitted by ordinances, rules, or regulations, or within 5 ft (1.5 m) 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.

(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 permitted. It is the general intent to construct frontage roads, public roads, and private drive approaches, including at least 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.

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.

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

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.

(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.

107.10 Blank

107.11 Bridges over Navigable Waters

All work on navigable waters shall be so conducted 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. 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.

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 105.14, 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.

Pavements and shoulders having an edge drop of more than 3 in. (75 mm) shall be delineated with drums in accordance with 801.09. Delineation shall be at a maximum spacing of 200 ft (60 m). The use of cones in accordance with 801.08 will be permitted during daylight hours in lieu of drums.

At least seven 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.

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 (50 m) 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 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. Flaggers or watchers shall wear a flagger's vest while directing traffic. Official law enforcement officers in uniform will not be required to wear a vest. The vest shall be furnished and be made of a durable fluorescent material, flame orange color, with two vertical reflective stripes on both the front and back. It shall be kept clean and provide maximum visibility at all times. The use of hand signaling flags will not be permitted except for emergency and single flagger 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. (610 mm) wide.

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

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 (305 m) 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 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 108.03.

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 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.

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.

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 permitted, 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.

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, except as set out in 402.12 and 801.18, 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.

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

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.

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 soddings 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

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.

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.

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 of the utility work plans included in the contract documents including some allowance for unexpected minor variation in the anticipated utility work plan and schedule.

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.

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 (cubic meter) 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 as regards 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 permitted to sublet a portion thereof, but shall perform with its own organization, work amounting to not less that 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 deduced 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 permitted to further subcontract their work.

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.

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

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.

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.

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.

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.

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.

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.

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.

An amended Erosion Control Plan shall be submitted in accordance with 327 IAC 15-5 for those areas not included in the Department submittal or as necessary for changes initiated by the Contractor. Items to include consist of sequencing of operations, borrow and disposal areas, and haul roads as well as any revision to the Department's submittal. All appropriate erosion control items shall be in place prior to disturbing the project site. A copy of the amended plan shall be provided to the Engineer.

The Contractor shall designate one or more of its employees to be responsible for the preparation, submittal, and ensuring receipt of the approval of the amended erosion control plan. Such individual(s) shall also be responsible for obtaining all other necessary permits including the wetland inspection and archaeological record check and field survey in accordance with 203.08, and for all environmental inspections. Such individual(s) shall oversee the installation of all erosion control measures and shall conduct regular inspections and completion of all reports in accordance with 205. The name(s) of the designated individual(s) shall be furnished the Engineer at, or prior to, the preconstruction meeting. Should the designated individual(s) need to be replaced during the contract, replacements shall be designated within seven calendar days and notification shall be furnished the Engineer.

Permanent erosion control measures shall be incorporated into the work at the earliest practicable time as the construction progresses to stabilize the site.

In order to minimize pollution to bodies of water, the practices and controls set out below shall be followed.

(a) When work areas are located in or adjacent to bodies of water, such areas shall be separated by a dike or other barrier to keep contained. Sediment disturbance of these bodies of waters shall be minimized during the construction and removal of such barriers.

(b) All waterways shall be cleared as soon as practicable of false-work, temporary piling, debris, or other obstructions placed during construction operations.

(c) Water from aggregate washing or other operations containing sediment shall be treated by filtration, a settling basin, or other means sufficient to reduce the sediment content.

(d) Pollutants such a fuels, lubricants, asphalt, sewage, wash water, or waste from concrete mixing operations, and other harmful materials shall not be discharged into existing bodies of water.

(e) All applicable regulations and statutes relating to the prevention and abatement of pollution shall be complied with in the performance of the contract.

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 (cubic meter) 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.

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

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.

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

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.

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 permitted 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.

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.

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 101.41, 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.

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.

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 nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

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 101.71, 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.

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 number of days for performance permitted 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 permitted 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 permitted.

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 not 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 101.32. 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).

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 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 because of conditions beyond the control and without the fault of the Contractor, such as acts of the public enemy, acts of Government, fires, floods, above normal rainfall, lightning, tornadoes, earthquakes, epidemics, or strikes, it may extend 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 may order the suspension of work, either wholly or in part, for a period of time for certain holidays. For such orders, the contract completion time will be adjusted as follows:

(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 not be extended.

(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.

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.

(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.

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

Not all of the 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.

(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.

(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.

(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.

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.

108.09 Failure to Complete on Time

For each calendar day or work 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. Work days or calendar days will not be charged while waiting for final inspection as defined in 105.15 provided all contract work has been satisfactorily competed. However, five work days will be permitted 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, five calendar days will be permitted 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.

For each calendar day or work 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 to traffic, or safely modified to accommodate traffic, 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. For these purposes, open to traffic will be considered as all pavement lanes open to unrestricted and safe travel. 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.

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 contacts.

Permitting 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 More Than	To and Including	Calendar Day or Fixed Date	Work Day
$0	$500,000	$500.00	$700.00
500.00	1,000,000	1,000.00	800.00
1,000,000	5,000,000	1,500.00	1,100.00
5,000,000	10,000,000	2,000.00	2,000.00
10,000,000	and higher	2,500.00	3,000.00

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

108.10 Default and Termination of Contract

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;

(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;

(g) allows final judgement to stand against it unsatisfied for a period of 10 days;

(h) makes an assignment for the benefit of creditors; or

(i) for other causes whatsoever, fails to carry on the work in an acceptable manner.

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.

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:

(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;

(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;

(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 therefor which do not change the general type of construction or labor.

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 permitted. 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

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.

The standard measures shown in this publication are mostly in the English System of Units such as feet and inches, pounds, gallons, and acres. In this text where the standard measure is given in the English System, metric equivalents are shown in parentheses. The measures shown in parentheses are intended only for those contracts in which they are specified. No guarantee is provided, explicit or implicit, that the units are accurate conversions. Work included in the contract will be accepted on the basis of measures shown in parentheses only when such measures are specified.

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.)

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 (1 m^2) 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 (meter) 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 l 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 gage, when used in connection with the measurement of metal plates or sheets, will mean the U.S. Standard Gage 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 gage refers to the measurement of wire, it will mean the U.S. Steel Wire Gage 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 2000 pounds avoirdupois. (The term megagram will mean 1,000,000 g or 1000 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.

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. (25 mm) of knife-edged bearing shall not exceed 5,000 lb (2270 kg).

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.

If material is weighed on truck scales, weigh tickets showing the net weight (mass) 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 (mass) direct reading if scale is of the direct reading type, tare, net weight (mass), 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. 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.

The weight (mass) of materials weighed outside the State and intended for use on the contact 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 (mass) may be accepted provided payment is made for only the actual weight (mass) of the materials. Car weights (masses) will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight (mass) shall be weighed empty daily at such times as directed. Each truck shall bear a plainly legible identification mark.

(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.

When requested and approved in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed. Such weights (masses) will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight (mass) 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:

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.

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 (megagram). If the Engineer decides that weighing is not feasible, the asphalt material may be measured by volume and converted to tons (megagrams). The conversion will be based on the unit weight as determined in the laboratory.

If asphalt material is to be measured by volume, it will be measured by the gallon (liter) 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.

Tank car deliveries will be measured by volume and converted to tons (megagrams).

Volumes will be measured at 60°F (15°C) or will be corrected to the volume at 60°F (15°C) in accordance with ASTM D 1250 for asphalts or ASTM D 633 for tars.

Net certified scale weights (masses) or weights (masses) 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.

(e) Measurement of PCC

For design and production, PCC will be measured by the cubic yard (cubic meter). 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

Unless otherwise provided, all aggregates for which measurements are obtained by the cubic yard (cubic meter) 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 (cubic meters) by a conversion factor computed at sufficient intervals to ensure correct measurement.

Free water in all aggregates for which payment is made as a separate pay item on a weight (mass) 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 (mass) by drying samples to constant weight (mass) at 110°C ± 55°C. 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:

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

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

The wet weight (mass) will be used for the basis of payment, if the percent 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 (mass) to be paid for will be the gross weight (mass) of aggregate minus the weight (mass) of the excess moisture computed as follows:

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

in which:

G = Gross weight (mass) of material,

M = Percent of moisture in the aggregate to the nearest 0.5% based on oven dry weight (mass),

m = Percent of moisture permitted in the wet aggregate to be paid for based on oven dry weight (mass).

(g) Measurement of Timber or Lumber

Timber or lumber will be measured by the thousand feet board measure or MFBM (cubic meter) 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

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

If standard manufactured materials are specified such as fence, wire, plates, rolled shapes, pipe, or conduit, and such materials are identified by gage, unit weight (mass), or section dimensions, such identification will be considered to be nominal weights (masses) 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

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 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 an 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.

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 therefor 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.

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

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 therefor, 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.

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 of 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

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

(a) Cost Reduction Incentive Proposal Requirements

The proposal shall be submitted with a statement identifying the proposal as Cost Reduction Incentive and shall contain, at a minimum, the following information.

1. A description of the difference between the planned work and the proposed change with a comparison of effects on service life, economy of operation, ease of maintenance, appearance, and safety.

2. Proposed changes in the design. Documents showing such changes shall be signed and bear the seal of a licensed professional engineer.

3. If the Contractor selects a licensed professional engineer other than the design consultant engineer who prepared the plans for the Department, the signed and sealed documents showing the proposed changes shall be submitted directly to the design consultant engineer. The design consultant engineer will review the proposed changes and provide a written recommendation to the Contractor. The design consultant engineer's recommendation shall be included in the cost reduction package submitted for the Department approval. Such recommendation will become an additional cost reduction incentive proposal requirement. Proposed changes to original plans prepared by the Department will be reviewed following submission of the cost reduction package to the Department.

4. The pay items and quantities affected by the change.

5. Complete, detailed cost estimates for performances of the work both as planned and as proposed. Such cost estimates shall be determined in the same manner as if the work were to be paid for on a force account basis in accordance with 109.05, except that lower bid unit prices will be used when applicable.

6. The calendar date required for acceptance and approval of the proposal in order to produce the savings indicated.

7. Locations and situations, including test results, in which similar measures have been successfully used.

8. A statement regarding the effect the proposal will have on the contract completion time.

9. A contract signed by the Contractor and the Contractor's redesign engineer, who prepared and sealed the plans for the cost reduction incentive proposal, shall be submitted to the Department for signature. The contract shall provide for the following:

    a. The Contractor's redesign engineer shall be responsible for all damage to life and property caused by its negligence and the negligence of its subcontractors, agents, or employees in connection

with the services rendered in connection with the plans for the cost reduction incentive proposal. The Contractor's redesign engineer shall indemnify, defend, and hold harmless the Department, its officials and employees, from all liability due to loss, damage, injuries, or other casualties of whatsoever kind, which directly and independently of all other causes, arise out of, or result from the negligence of the Contractor's redesign engineer, its agents or employees, in connection with the services rendered in connection with the plans for the cost reduction incentive proposal.

b. Neither the Department's review, approval, or acceptance of the plans for the cost reduction incentive proposal 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 negligence of the Contractor's redesign engineer.

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. The Contractor's redesign engineer shall have an affirmative duty to advise the Department of all known or obvious errors, omissions, or deficiencies in the designs, drawings, specifications, reports, or other service of the Department or consultants retained by the Department.

e. The Contractor and the redesign engineer may agree to additional terms, as long as such terms do not adversely affect the Department's liability protection.

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.

(b) Approval of Proposal

The Engineer will be the sole judge as to whether a cost reduction 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. Proposed changes in pavement design including materials or pavement type, basic bridge design parameters including structural materials or structure type, or right-of-way will not be approved. Only proposals which result in the Department's portion of the net savings of $2,500.00 or more will be considered. 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.

Contract prices shall not be based on the anticipated approval of a Cost Reduction Incentive proposal. If the proposal is rejected, the contract shall be completed at the original contract prices. If a cost reduction incentive proposal is not approved on or

before the calendar date shown on the proposal, such proposal will be deemed rejected. If a cost reduction incentive proposal is submitted which is subsequently rejected, the Contractor will be required to reimburse the Department for the costs to investigate the proposal as a condition of considering such proposal. In determining the estimated net savings, the contract unit 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.

The cost reduction incentive proposal will not be approved if equivalent options are already available within the contract, if the Department is already considering a change order to the contract which includes the proposed revisions, if certain changes in specifications or standards for general use have been approved and are subsequently used in the Contractor's proposal, or if the proposal substitutes one pay item for another pay item resulting in a decrease.

If the cost reduction incentive proposal is approved, it will be executed by means of a change order, along with the approved cost reduction incentive proposal. The change order will show the changes in the plans and specifications necessary to permit the proposal to be put into effect and the net 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 provision of this specification will apply only to contracts awarded to the lowest bidder in accordance with the Department's competitive bidding requirements.

(c) Method of Measurement

The work, as revised by the cost reduction incentive proposal, will be measured as accomplished, and in accordance with the change order.

(d) Basis of Payment

The work, as revised by the cost reduction incentive proposal, will be paid for as accomplished, and in accordance with the change order. In addition, 50% of the net savings of the cost reduction incentive proposal will be paid for separately upon completion of the revised work. The net savings will be determined by subtracting the cost of the approved change including all design and review cost from the cost of the planned work as bid.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Cost Reduction Incentive No. ____	LS

No additional payment will be made for cost of preparing documents showing the proposed changes by a licensed professional engineer. The Contractor shall directly pay the design consultant engineer for all costs of their review and recommendation. All cost to the Department, including costs for review of changes to plans originally prepared by the Department, will be deducted from the gross savings of the cost reduction incentive.

109.05 Extra Work and Force Account Work

Extra work performed in accordance with 104.03 will be paid for at the unit prices or lump sum prices as approved on the change order. However, the Department may require the Contractor to do such work on a force account basis to be compensated in the following manner:

(a) Labor Costs

For all labor and foremen in direct charge of the specific operations, the 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.

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.

An amount equal to 20% of the sum of the above items will also be paid the Contractor.

(b) 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.

(c) Materials

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.

(d) Equipment

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 Dataquest, Inc. Regardless of the time used, this 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 fuel, lubricant and transportation costs may be added to the rental cost. 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 Contractor will receive payment for the total costs agreed upon to which sum 12% will be added.

(e) Miscellaneous

No additional allowance will be made for general superintendence or other costs for which no specific allowance is herein provided.

(f) Subcontracting

For administration costs in connection with approved subcontract work, the Contractor shall receive an amount equal to 10% of the first $3,000 and 7% thereafter, or the total cost of such work computed as set forth above.

(g) Compensation

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.

(h) 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:

1. name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman;

2. designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment;

3. quantities of materials, prices, and extensions;

4. transportation of materials;

5. cost of property damage, liability and worker's compensation insurance premiums, unemployment insurance contributions, and social security tax.

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 where 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.

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.

(i) Cost Breakdown

In case the work is performed as extra work, the Contractor shall, when directed, furnish a cost breakdown to substantiate a lump sum price or unit price.

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.

A change order will be prepared to reflect these adjustments. The unit price for these adjustments will be one dollar and the quantities will be in units of dollars.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Quality Adjustments, _____ (type)	DOL

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.

(c) Superstructure Concrete, SC

Quality adjustments will be calculated in accordance with 730.19.

(d) Temporary Traffic Control Devices, TTCD

Quality adjustments with respect to non-compliance with the ATSSA brochure titled Quality Standards For Work Zone Traffic Control Devices 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.

(e) Failed Materials, FM

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.

109.06 Eliminated Pay Items

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

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.

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.

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 permitted by Indiana Code 8-23-9-26 through 8-23-9-39.

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.

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

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 no more than 5% of the original total contract price. The exact amount will be a portion of the lump sum price which is an even percentage of the pay item. The balance of the lump sum price will be paid when the contract has been completed and accepted.

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
Mobilization and Demobilization	LS

The cost of all materials, equipment, tools, labor, transportation, operations, and incidentals 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.

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, pavement reinforcing steel, pavement contraction joints, granular

base and subbase materials, aggregates for HMA and concrete pavements, and structural supports for signals, signs, and luminaires.

111.03 Structural Steel and Concrete Structural Members

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 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

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, and the members are acceptable and they are acceptably stored.

111.04 Dowel Bar Assemblies

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

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 shall 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.

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.

Testing shall be provided as directed, during production. Prior to authorizing partial payment, verification will be obtained 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 will be obtained that all required inspections have been made and the joint is acceptable.

(b) Type M

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 will be obtained that all required inspections have been made and the joint is acceptable.

111.07 Structural Supports for Signals, Signs, and Luminaires

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 will be obtained 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.

111.09 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.

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 for in the contract.

Although payment may have been made for materials, the Contractor shall be responsible for loss or damage to the materials. Such materials shall be replaced with no additional payment.

Approval of partial payment for stockpiled materials will not constitute final acceptance of such materials for use in completing the work. Structural steel members and pavement reinforcing steel may be subjected to additional inspection and testing prior to final acceptance and incorporation into the work. All other stockpiled pay items will be subjected to additional inspection and testing prior to final acceptance and incorporation into the work.

Partial payments for stockpiled materials that are a portion of the pay item will be deducted from estimates due the Contractor as the material is incorporated in the work.

111.10 Method of Measurement

No measurement will be made. However, the amount will be substantially verified before authorization for payment.

111.11 Basis of Payment

Stockpiled materials which are authorized for payment in accordance with the requirements herein will be paid for in accordance with 111.03, 111.04, 111.05, 111.06, 111.07, 111.08, and 111.09.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Stockpiled Material, _____ (type of material)	LFT (m)
	EACH
	CYS (m3)
	SYS (m2)
	TON (Mg)
	LBS (kg)
Structural Steel	LS
Structural Members, Concrete	LS
Structural Expansion Joint, _____ (type)	LFT (m)

SECTION 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, except such objects as are designated to remain or are to be removed in accordance with other sections of these specifications, within the construction limits shown on the plans. 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.

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 things 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 (1 m) 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. (100 mm) 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 permits approval 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 at locations off the construction site and outside the limits of view from the traveled roadway. Sod may be disposed of within the right-of-way, but outside the construction limits, if permitted. Written permission shall be obtained from the property owner on whose property the materials and debris are to be placed. All necessary arrangements shall be made with the owner for obtaining suitable disposal locations. The cost involved shall be included in the contract price of pay items.

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.

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 (6.1 m) 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. (100 mm). 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.

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.

(a) Area Basis

The work to be measured will be the number of acres (hectares) 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.

(c) Linear Basis

If a linear unit pay quantity is shown in the Schedule of Pay Items, the length will be measured along the construction centerline in stations.

(d) Individual Unit Basis

1. The diameter of trees will be measured at a height of 24 in. (610 mm) above the ground. Trees of less than 4 in. (100 mm) in diameter will be classified as brush.

2. Stumps will be measured by determining the average diameter at the cutoff location.

3. Hedge rows will be measured by the station.

4. Scalping will be measured by the acre (hectare).

5. 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. (610 mm)	**Pay Diameter**
4 to 8 in. (100 to 200 mm)	6 in. (150 mm)
Over 8 to 12 in. (Over 200 to 300 mm)	10 in. (250 mm)
Over 12 to 24 in. (Over 300 to 610 mm)	18 in. (460 mm)
Over 24 to 36 in. (Over 610 to 910 mm)	30 in. (760 mm)
Over 36 to 60 in. (Over 910 to 1520 mm)	48 in. (1220 mm)
Over 60 in. (Over 1520 mm)	60 in. (1520 mm)

201.07 Basis of Payment

The accepted quantities of clearing and grubbing will be paid for as shown below.

(a) Area Basis

The determined quantities will be paid for at the contract unit price per acre (hectare) respectively for each of the pay items shown in the Schedule of Pay Items.

(b) Lump Sum Basis

If the Schedule of Pay Items show 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 or in the Contract Information book.

(c) Linear Basis

If linear quantities are shown in the Schedule of Pay Items, the quantities will be paid for at the contract unit price for such pay item.

(d) 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.

Payment for tree removal sizes as designated in requirement 5 of 201.06(d), 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.

Payment will be made under:

Pay Item	Pay Unit Symbol
Clearing and Grubbing	ACRE (ha)
	STA
	LS
Clearing Right-of-way	LS
Hedge Rows	STA
Scalping	ACRE (ha)
_____, _____, Remove (name size)	EACH

Except as permitted 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) Clearing Right-of-Way

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 herein 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 or in the Contract Information book.

(f) Exclusions

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

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 permitted 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

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. Designated salvageable material 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. Unless otherwise permitted and except for regulated materials, which are defined in 104.06, and bridge painting debris which is subject to 619, non-salvageable material shall be disposed of in accordance with State, Federal, and local regulations. Unregulated material that may be disposed of on private property, other than approved landfill sites, shall only be done with written approval of the Engineer and the property owner with appropriate permits and shall be outside the limits of view from the traveled roadway. Copies of all agreements with property owners shall be furnished. Unsuitable material shall be removed from cisterns, septic tanks, other tanks, basements, and cavities. The disposition of this material shall be in accordance with all applicable and current State, Federal, and Local Regulations. Cisterns, septic tanks, other 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 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. Each notification form submitted to IDEM may have a maximum of 10 structures listed on the form. For the purposes of this form, a structure includes a building, house, canopy, or a bridge. Fees for this demolition/renovation notification are $50.00 per notification and shall be paid to IDEM by the Contractor.

Copies of the demolition/renovation notification form can be obtained at: www.in.gov/icpr/webfile/formsdiv/44593.pdf. Questions concerning the completion of the demolition/renovation notification should be addressed to IDEM's Office of Air Management's toll free number (888) 547-8150. Office hours are Monday through Friday between the hours of 6:30 a.m. and 4:30 p.m. IDEM will assist in proper completion of the notification.

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 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, salvageable items 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 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 accordance with 202.07. If inspected by the Department, a copy of the findings will be included in the Contract Information book.

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.

Except for tank content waste which is classified in 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 Resource Conservation Recovery Act approved landfill.

(b) Type Z Waste

All waste material that is prohibited from being disposed of in a Resource Conservation Recovery Act approved landfill.

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.

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, which must 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.

(a) Complete

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 (0.3 m) below 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.

Unless otherwise specified, structural steel and salvageable material 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.

If stated in the special provisions, all concrete which is of suitable size for riprap and not needed for such use on the project shall be stockpiled on the project in an approved manner, for use by the Department.

(b) Portions

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.

Pneumatic hammers, up to a maximum of 45 lb (20 kg) may be used for all removal areas to be patched in the deck and all areas within 24 in. (610 mm) of full depth removal lines. Pneumatic hammers up to 69 lb (31 kg) 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 (41 kg) 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 (20 kg) may be used.

Concrete superstructures or deck removal may be accomplished by pneumatic hammers larger than 90 lb (41 kg), 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 (41 kg), provided that the reinforcing steel in the portion to be removed is completely separated from the concrete

that is to remain in place. Alternate methods of removal may be permitted if requested in writing.

Hydro-demolition may be permitted for removal of portions of bridge structures as an alternate method to pneumatic hammers. Hydro-demolition for such removals may be accomplished either by use of a machine or a hand held device. Hydro-demolition shall otherwise be in accordance with 722.05(a)2.

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.

(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. Disposal or placement as riprap will not be paid for directly, but the cost thereof shall be included in the cost of removal.

202.04 Removal of Pipe and Tile Drains

When so provided in the proposal, 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.

202.05 Removal of PCCP, Sidewalks, Curbs, etc.

All PCCP, sidewalks, curbs, gutters, etc., 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 (68 kg), and incorporated into the work as directed; or

(c) otherwise disposed of in accordance with 202.02.

Pavement removal shall consist of the removal and satisfactory disposal of PCCP; PCC resurface with its base; or the total of any combination of HMA base, intermediate, and surface course of any pavement on a PCC base, including the 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 shall be paid for as pavement removal. 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. 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

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 (0.3 m) 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.

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.

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:

(a) In accordance with 202.02 and 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, the IDEM may make a determination of the existence of asbestos materials. Local governmental agencies may have additional regulations that must be followed. The Contractor shall contact IDEM's air management office to determine what local agencies have regulations.

(b) 326 IAC 18-3 which requires the inspector conducting the required inspection to be certified by the 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.

(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

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;

(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) Resource Conservation and Recovery Act and the Indiana Environmental Management Act;

(e) Underground Storage Tank (UST) Notification, Reporting and Closure Requirements as prepared by the IDEM Underground Storage Tank Branch;

(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

(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:

(a) obtain a review of available tank information from the Engineer;

(b) Unless the Department has already done so, provide notification of tank removal operations to appropriate authorities. Notification shall be provided as required to the IDEM, Office of the State Fire Marshall and 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, by telephone, shall be given to the IDEM Underground Storage Tank Branch of intended closure or removal date. Such forms are available from the Indiana Department of Environmental Management;

(c) allow the Engineer to visually inspect tanks after removal;

(d) allow the Engineer to visually inspect the excavation zone for contaminated soils;

(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;

(h) submit a site operation plan for the contaminated area to the Engineer for review and approval 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;

(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;

(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;

(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.

(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.

(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 Resource Conservation and Recovery Act 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.

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;

(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;

(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

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

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:

(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;

(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.

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 measured by the cubic yard (cubic meter).

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 (square meter).

Underground storage tank removal will be measured per each within the size groupings of under 3,000 gal. (11,400 L), from 3,000 through 6,000 gal. (11,400 through 22,800 L), over 6,000 through 10,000 gal. (22,800 through 39,000 L), or over 10,000 gal. (39,000 L). Testing for regulated materials will be measured per each for the type and number of tests required.

The length of pipe removed will be measured by the linear foot (meter), 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.

Pavement removal will be measured by the square yard (square meter) of the area removed.

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 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.

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.

Payment for removal of contaminated soils will be based on the actual cubic yards (cubic meters) removed, or by the number of 55 gal. (210 L) 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.

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. (11,400 L), from 3,000 through

6,000 gal. (11,400 through 22,800 L), over 6,000 through 10,000 gal. (22,800 through 39,000 L), or over 10,000 gal. (39,000 L). Underground storage tank liquid waste disposal will be paid for based on the type of waste and the actual number of gal. (liters) 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. (210 L) drum.

Clearing right-of-way within the construction limits will be paid for at a contract lump sum price. 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 or in the Contract Information book.

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 (cubic meter) for class A concrete in superstructures, class A concrete in substructures, class C concrete in superstructures, or $652.00 per cubic yard ($854.00 per cubic meter), whichever is lowest.

Pavement removal will be paid for at the contract unit price per square yard (square meter).

If there is no pay item for pavement removal and such is encountered, payment will be made for each square yard (square meter) 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.

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 broken down into loading, hauling, and mileage costs.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Clearing Right-of-Way	LS
610 Contaminated Soil, Remove	CYS (m3)
Houses and Buildings, Parcel No. _____, Remove	LS
Pavement Removal	SYS (m2)
Present Structure, Str. No. _____, Remove	LS
Present Structure, Str. No. _____, Remove Portion	LS
_____, Remove	EACH
specific work	LFT (m)
	SYS (m2)
Regulated Asbestos Containing Materials, Remove	SFT (m2)
Regulated Materials, Dispose, _____	GAL. (L)
620 type	CYS (m3)
	TON (Mg)
	DRUM
	EACH
Regulated Materials, Remove, _____	GAL. (L)
type	CYS (m3)
	TON (Mg)
	DRUM
	EACH
Regulated Materials, Transport, _____	GAL. (L)
630 type	CYS (m3)
	TON (Mg)
	DRUM
	EACH
Structures and Obstructions, Remove	LS
Testing for Asbestos, _____ type	EACH
Testing for Wastes, _____ type	EACH
Underground Storage Tank, Liquid Waste	
640 Disposal, _____ type	GAL. (L)
Underground Storage Tank, Remove and Dispose, Under 3,000 Gallons (11 400 Liters) Capacity	EACH
Underground Storage Tank, Remove and Dispose, 3,000 through 6,000 Gallons (11 400 through 22 800 Liters) Capacity	EACH
Underground Storage Tank, Remove and Dispose, 6,000 through 10,000 Gallons (22 800 through 39 000 Liters) Capacity	EACH

Underground Storage Tank, Remove and Dispose,
Over 10,000 Gallons (39 000 Liters) Capacity.....EACH

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.

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.

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.

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 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.

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;

(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.

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 which is not performed in accordance with the specifications, nor that which is not required by the contract.

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.

The cost of clearing right-of-way 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.

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.

All necessary cleanup of spills caused by the Contractor will not be paid for.

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.

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 and all rippable materials.

203.03 Rock Excavation

Rock excavation shall consist of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting; the use of a power shovel of not less than 1 cu yd (0.76 m^3) capacity, properly used, having adequate power and in satisfactory running condition; or the use of other equivalent powered equipment. Rock excavation shall also include all boulders or other detached stones each having a volume of 1/2 cu yd (0.4 m^3) or more.

203.04 Unclassified Excavation

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

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

If there be encountered within the limits of waterway excavation material which can be classified as rock in accordance with 203.03, or material which consists of conglomerate, concrete, masonry, or any similar material which is not part of an existing

structure shown on the plans, shall be defined as class Y excavation. 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 approved 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 the stream or area. Unless otherwise designated in the 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, nor material furnished as B borrow.

Proposed borrow sites and proposed disposal sites for excavated material shall be identified before such material is excavated or disposed of within or outside the right-of-way. Except where a permitted or licensed commercial site is utilized, an inspection of areas outside the construction limits shall be conducted by a qualified wetland professional to determine if wetlands are present on the site. This 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 the IDEM are present. The Contractor shall submit a document, signed by the wetland professional, verifying that the site has been inspected for the presence of wetlands in accordance with the federal manual and for isolated wetlands and, if any are present, specifying the area to be demarcated as jurisdictional waters and/or wetland. Once the area to be used for borrow or for disposal of excavated material has been shown not to contain jurisdictional or isolated wetlands, the boundary of the area cleared shall be demarcated. The methods of demarcation shall be as approved by the Engineer.

The Department will maintain a list of qualified wetland professional consultants. A wetland professional certified by the Society of Wetland Scientists, SWS, as a wetland professional-in-training or professional wetland scientists may also be utilized and a list of such scientists can be located at http://www.wetlandcert.org/search.html.

Previously approved sites may be utilized for borrow or disposal operations if the Contractor furnishes a valid permit or document signed by a wetland professional prior to utilizing the site.

If the Contractor elects to use the site, all required permits shall be obtained. The Contractor shall develop and construct all mitigation measures and fulfill all requirements detailed by such permits. The Contractor shall also obtain written permission from the land owner for Department personnel to access the site for monitoring. No excavation shall occur or no material shall be disposed of beyond the boundaries of the demarcated area.

Before borrow or disposal operations are begun, the Contractor shall submit operation plans for approval. Such plans shall include the following:

(a) a detailed sketch showing the limits relative to property and right-of-way lines;

(b) the grade of all slopes;

(c) an erosion control plan in accordance with the requirements of 327 IAC 15-5;

(d) the encasement, finished grading, and seeding procedures; and

(e) archaeological clearance.

Notice shall be given in advance of opening borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken and the borrow material may be tested before being used.

Except when a commercial source is utilized, a qualified archaeologist shall perform a record check and field survey of borrow or disposal limits to determine if any significant archaeological sites are within the limits. Results of the record check and survey shall be furnished in writing prior to the excavation of any material. If any archaeological sites are identified, the archaeologist shall establish the limits of the site along with a reasonable border. The site shall not be disturbed unless the archaeological site is cleared by established procedures and written authorization to enter the site has been issued. Under no circumstances shall an employee of the Contractor or the State of Indiana share in the ownership or profit from the sale of any archaeological artifacts that may be salvaged. No extension of completion time will be granted due to any delays in securing approval of a borrow or disposal site.

Unless written permission is granted, there shall be no excavation in a borrow area below the elevation of the adjacent properties within 150 ft (45 m) 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 (45 m) 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 (15 m) to an adjacent property line. All excavated slopes of a borrow area shall not be steeper than 3:1 down to 2 ft (0.6 m) below the ground water elevation. All excavated slopes 2 ft (0.6 m) below the ground water elevation shall not be steeper than 2:1.

Top soil from the borrow or disposal area shall be stockpiled for use in restoring the disturbed area. A minimum encasement of 6 in. (150 mm) 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 (45 m) of the nearest right-of-way line shall be well drained. Areas beyond 150 ft (45 m) 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 nor 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 the growth of vegetation is used, such material shall not be placed within 1 ft (0.3 m) 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.

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, and embankment operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with 201. The area of the exposed materials shall be limited by the Contractor's capacity to adequately maintain permanent and temporary erosion and sediment control features.

The Engineer will direct the Contractor to stabilize an area if the disturbed ground has been or will be left bare and unworked for fifteen consecutive calendar days. Once directed, the Contractor shall stabilize these areas within ten calendar days. These methods shall be installed in accordance with 621 or as otherwise directed.

All spongy and yielding material which does not readily compact, and all vegetation shall be removed from within slope-stake limits and to such depths as directed. Soft or unstable materials which are encountered where the proposed embankment will be placed, shall be removed. If groundwater is encountered, backfilling shall be accomplished using B borrow in accordance with 211.02 to an elevation at least 2 ft (0.6 m) above the groundwater level. Compaction of the B borrow placed above the free water level shall be accomplished using heavy vibratory equipment. If groundwater is not encountered during the removal operation, the backfill shall be placed in accordance with the following paragraph. None of the removed materials shall be used in embankment, except if approved, they may be used if aerated such that proper compaction can be achieved.

After the embankment area has been cleared and before embankment is placed, all pronounced depressions left in the original ground shall be refilled with suitable material and compacted in accordance with 203. The upper 6 in. (150 mm) of the original ground

shall be compacted with a roller weighing no less than 10 t (9.1 Mg), or with other approved compacting equipment. Proofrolling of the natural ground surface shall be performed in accordance with 203.26 within all areas where new fill will be placed.

If the original ground cannot be compacted to the required density because of unstable soils, high water table, or other conditions, the use of stabilizing materials consisting of B borrow in accordance with 211.02, or chemical modification in accordance with 215 may be used. The materials shall be 1 to 2 ft (0.3 to 0.6 m) thick, and shall be extended so as to daylight at the toe of slope. B borrow, when exposed, shall be capped with 6 in. (150 mm) of coarse aggregate No. 2.

When B borrow or chemical modification will not satisfactorily stabilize an area, written approval is required prior to the use of alternate methods. When preliminary exploration indicates the need to remove more than 4 ft (1.2 m) or 250 cu yd (200 m^3) of unsuitable material, approval is needed.

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 6 in. (150 mm) in any dimension shall not be left within 6 in (150 mm) 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.

The embankment shall be kept drained at all times by keeping the center higher than the sides and uniformly graded.

Each embankment lift shall extend transversely over the entire area and shall be kept smooth. If a dragline or similar equipment deposits material in large masses onto the embankment, the material shall be spread out in uniform lifts.

The use of hydraulic methods to construct embankments will be permitted 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.

If the same or similar material is being used in the upper lifts of embankment as shall be used in the subbase at that location, these lifts shall be placed in smooth uniform layers for the full width of the embankment.

When grading operations are performed in non-daylight hours, artificial lighting shall be provided and maintained, to permit the construction and inspection of the operations.

All slopes which are to be graded and not stabilized with other erosion control measures shall be roughened as described herein, until permanent erosion control measures are placed. Roughening shall take place each day after work is performed on the slopes, or as directed to re-establish the roughening.

The soil slopes shall be roughened to create a series of ridges and depressions parallel to the roadway making grooves at least 1 in. (25 mm) deep and not more than

15 in. (400 mm) apart. When directed, slopes shall be stabilized using temporary seeding in accordance to 621.

Sufficient quantities of excavated materials suitable for the growth of vegetation shall be preserved from within the planned excavation area and used for the encasement of cut, fill, and shoulder slopes which are deemed not suitable for the growth of vegetation. The depth of encasement shall be 6 in. (150 mm) or more, as directed, measured perpendicular to the face of the slope. No additional compensation will be allowed for this work except payment will be made for the class of excavation involved for authorizing undercutting of back slopes. Encasement of rock embankment and cut slopes will not be required unless otherwise directed.

Material suitable for the growth of vegetation shall be as approved and may consist of sandy loam, sandy clay loam, clay loam, clay, and shall be free from clods, debris, and stones. The material placed on backslopes of cut sections shall be placed in accordance with 203.21.

If sufficient excavation materials suitable for the encasement of cut, full, and shoulder slopes are not available, borrow material shall be furnished. The sources of the borrow material for encasement shall be in accordance with 203.08. Payment for borrow will be made in accordance with 203.28. If the contract does not contain a pay item for borrow, a 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 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 excavated material that cannot be used constructively within the project limits shall be disposed of off the right-of-way in accordance with 201.03 and 203.08.

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 to fill old channels and, if suitable, in embankment, special fill, and approach embankments, or any combination of these, as specified or directed.

A portion of waterway excavation which is unsuitable for the above uses, a portion which is suitable but is in excess of that required for such uses, or if locations for such disposal are not available, the disposal shall be in accordance with 201.03.

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 uniformly spread between the toes of fill slopes and the swamp ditches or beyond, or otherwise disposed of in accordance with 203.08.

203.13 Slides

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.

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.

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.

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.

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.

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.

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. (54 mm) diameter samples. All cores 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 one to one or steeper.

Final breakage of rock excavation shall be in accordance with or closely approximate the slope lines 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 permitted, no rock shall finally project more than 1 ft (0.3 m) 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.

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.

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 (30 m) intervals and shall extend for a depth of 7 ft (2 m) below the proposed grade and have a minimum diameter of 1 1/2 in. (38 mm).

Where cavities are discovered on centerline, additional holes shall be drilled at 25 ft (8 m) intervals along the edge of the proposed pavement, and unless otherwise directed, extend for a depth of 7 ft (2 m) below the proposed grade. Where any cavity is discovered or exposed having a minimum cover of less than 5 ft (1.5 m), the cover shall be removed, and the treatment of such areas shall be in accordance with details in the plans or as otherwise directed.

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 (0.3 m) 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. (50 to 100 mm) in diameter and, unless otherwise directed, be spaced approximately 3 ft (0.9 m) apart. Holes shall be drilled approximately 2 ft (0.6 m) 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 (9 m), unless otherwise directed or permitted. 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 (0.6 m) 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 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 (1.8 m) from the pre-split face, unless otherwise permitted or directed. If additional charges are required, holes shall be placed at half the distance of a full depth hole to a depth such that the bottom of the hole clears the pre-split face approximately 2 ft (0.6 m). The pre-split face shall deviate no more than 6 in. (150 mm) from the front line of drill holes or more than 12 in. (300 mm) 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 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 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

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:

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;

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.

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.

(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.

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 (0.6 m) above free water level. That portion between free water level and this established grade shall be thoroughly watersoaked to secure maximum compaction.

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

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 (3 m), or to a greater or lesser depth, as directed.

If conditions permit, 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 operation are in balance. If conditions permit, 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.

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 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.

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 conduced 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.

Unless otherwise permitted in writing, cased test holes shall be placed by hydraulic boring. The external casing shall be a minimum of 2 in. (50 mm) 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

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.

203.19 Embankment Over and Around Structures

Fill shall not be placed against any new masonry abutment, wingwall, retaining wall, or culvert, nor over any culvert, bridge, or arch until approved. Applicable provisions of 702.23 shall be met.

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.

The embankments around the end bents shall be constructed to approximate subgrade elevation for a distance of no less than 75 ft (23 m). 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, holes to receive the piling shall be cored through the embankment in accordance with 701.09(a). After the piles have been driven, the space between the pile and the cored 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 cored hole would not remain open, the piling shall be driven before the embankment is constructed. No direct payment will be made for excavation of the embankment at the end bents or abutments, or for coring, backfilling holes, or excavating fill, the cost to 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

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 (0.6 m) of the embankment just below the subgrade elevation shall be composed of suitable material placed in layers not exceeding 8 in. (200 mm) loose measurement and compacted to the required density. Shale or shale-like materials will not be permitted in the upper 2 ft (0.6 m) of the embankment.

Where the depth of an embankment exceeds 5 ft (1.5 m) 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 (1.2 m). 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 permitted. 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.

Where the depth of embankment is 5 ft (1.5 m) 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 (0.6 m). Each layer shall be choked thoroughly with broken stone or other suitable material and be compacted to the required density or as directed.

Where a rock fill is to be placed over a structure, the structure shall first be covered with 2 to 4 ft (0.6 to 1.2 m) 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.

(b) Shale, Shale and Soft Rock Mixtures, or Soft Rock

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 (27 Mg). The minimum total compactive effort for the vibratory tamping-foot roller shall be 27.5 t (244 kN). 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. (150 mm). Each tamping-foot on the vibratory tamping-foot roller shall project from the drum a minimum of 4 in. (100 mm). The surface area of the end of each foot on both tamping-foot rollers shall be no less than 5 1/2 sq in. (3550 mm^2).

Shale, shale and soft rock mixtures, or soft rock shall be placed in 8 in. (200 mm) maximum loose lifts, and shall be compacted to at least 95% of maximum dry density. The moisture content shall be controlled within -2 and +1 percentage points of optimum moisture content. The density will be measured with a calibrated nuclear gauge using the direct transmission mode. Excavation and blasting procedures shall 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. (600 mm).

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 (5 km/h) during these passes. The number of passes will be adjusted upward if necessary to obtain 95% of maximum dry density, in accordance with AASHTO T 99. 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.

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 permitted in the construction of embankment, if the following provisions, in addition to those stated in 203.20(b), are observed.

1. The slopes shall be encased with a minimum of 10 ft (3 m) of relatively impervious, non-shale, non-erodable material.

2. The maximum size of limestone which will be permitted in the mixture shall be 6 in. (150 mm) in thickness and 1.5 ft (0.5 m) 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.

If the material is found to be too intermixed with limestone fragments to permit field density tests as required in this section, this requirement may be waived by written permission.

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 to 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 (3 m) 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 (cubic meter) for the class or classes of excavation encountered.

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 (0.3 m) 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.

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 (0.3 m) but less than 3 ft (0.9 m) 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 (1 m^2).

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 (0.3 m) but less than 3 ft (0.9 m) 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.

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 (0.3 m) 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 (0.3 m). This loosened material shall be spread uniformly over the full width of the subgrade plus 1 ft (0.3 m) 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 (0.3 m) but less than 3 ft (0.9 m) 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.

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 (0.3 m) 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 (cubic meter) for the class or classes of excavation encountered.

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 (0.6 m) out from the existing pavement. This material shall be used for widening. Benches, a minimum of 4 ft (1.2 m) 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 and Shale, With Density Control

Unless otherwise specified, all embankments shall be compacted to at least 95% of their maximum dry density. The moisture content shall be controlled within -2 and +1 percentage points of optimum moisture content. Maximum density and optimum moisture content shall be determined in accordance with AASHTO T 99 using method A for soil and method C for granular materials.

When silts or loessial type soils are encountered and used in embankment construction, the moisture content shall be controlled within -3 percentage points of optimum moisture content and optimum moisture content. In no case shall these soils be placed at moisture content in excess of optimum moisture content.

The moisture content for sand soil or a sand and gravel soil, having at least 80% sand and gravel size particles, shall be such that the soils may be compacted to the specified density at a moisture content which is normally several percentage points below optimum or as directed.

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.

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 three-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. (200 mm). 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. (3550 mm^2).

203.24 Method of Making Density Tests

The percent of compaction shall be based on maximum dry densities unless otherwise specified or directed. Field compaction tests will be run on each lift and the required compaction obtained on each lift before the next is placed.

(a) Laboratory

The procedure for determining maximum densities for compaction control shall be in accordance with AASHTO T 99.

(b) Field

The field density determination shall be made in accordance with AASHTO T 191, T 310, or T 272 except as follows:

1. If 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 sieve (850 µm) - 98 to 100%
   Passing the No. 40 sieve (425 µm) - 0 to 35%
   Passing the No. 70 sieve (212 µm) - 0 to 2%

   Sand such as Wedron Silica Sand No. 4075 or Ottawa 2.8 Blasting Sand has been found to be acceptable.

2. If particles larger than those that can pass through a No. 4 (4.75 mm) sieve for soil and a 3/4 in. (19.0 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. (19.0 mm) only. After the densities are determined, the degree of compaction shall be computed by the following formula:

$$\text{Degree of Compaction} = \frac{\text{In Place Density pcf (kg/m}^3\text{)}}{\text{Maximum Density pcf (kg/m}^3\text{)}} \times 100$$

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.

203.25 Embankment Without Density Control

When aggregate is used for embankment construction and has such a large top size as to make it impractical to perform density tests, and if approved, such material may be compacted with crawler-tread equipment or with approved vibratory equipment, or both. The materials shall be placed in lifts not to exceed 6 in. (150 mm), loose measurements, and each lift compacted thoroughly by successive trips back and forth with the tread areas overlapping enough on each trip so that all portions will be compacted uniformly.

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. (100 mm).

203.26 Proofrolling

When proofrolling is specified, the work shall be performed with a pneumatic tire roller in accordance with 409.03(d)3. Other approved equipment such as a fully legally loaded tri-axle dump truck may be substituted for the pneumatic tire roller. There shall be one or two complete coverages as directed. Roller marks, irregularities, or failures shall be corrected.

203.27 Method of Measurement

(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 or revised contract quantities as adjusted by authorized change.

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.

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 preformed on the areas in question and payment will be made for actual quantities.

(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.

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 (1.2 m), 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.

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.

The cubic yards (cubic meters) 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.

Cased test holes and exploratory drilling will be measured by the linear foot (meter); B borrow by the cubic yard (cubic meter), 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 (square meter) in place before breaking.

(c) Measurement on a Linear Basis

When either or both the plans and contract provide for a pay item for linear grading, the measurement for payment will be based on the length of roadway actually constructed to the lines, grades, and typical cross sections specified. All classes of excavation involved, including required borrow, will not be measured for payment, but will be considered as included in the pay item for linear grading per mile (kilometer).

(d) Measurement of Excavation Items on a Weight Basis

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.

When embankment is specified as a separate pay item, the volume so 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 (cubic meters) 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.

If the Contractor chooses the option of coarse aggregate No. 53 as subgrade treatment in accordance with 207.04, the embankment material including the aggregate will be measured in accordance with 203.27(b). The aggregate will also be measured as subgrade treatment in accordance with 207.05.

(f) Measurement of Borrow

Borrow will be measured by the cubic yard (cubic meter). 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 move back into the pit before final sections are taken.

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 yd (382 m^3). 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 yd (3820 m^3), the material may be weighed in accordance with 109.01(b) and converted from pounds (kilograms) shown on the weigh tickets to cubic yards (cubic meters) using a factor of 3,000 lb/yd^3 (1780 kg/m^3).

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.

If the Contractor chooses the option of coarse aggregate No. 53 as subgrade treatment in accordance with 207.04, the borrow material including the aggregate will be measured in accordance with 203.27(b). The aggregate will also be measured as subgrade treatment in accordance with 207.05.

(g) Measurement of Embankment Foundation Soils Treatment

Mechanical treatment of embankment foundation soils will be measured by the square yard (square meter). Chemical treatment of embankment foundation soils will be measured in accordance with 215.10.

(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. (kiloliter) 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

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 (meter) of rock core.

203.28 Basis of Payment

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 cys (12 000 m^3) 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.

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:

If the total quantity exceeds 5,000 cu yd (3800 m^3) at a given location, it will be paid for at $8.00 per cu yd ($10.46 per m^3). If the total quantity exceeds 1,000 cu yd (765 m^3), but does not exceed 5,000 cu yd (3800 m^3) at a given location, it will be paid for at $12.00 per cu yd ($15.69 per m^3). If the total quantity does not exceed 1,000 cu yd (765 m^3) at a given location, it will be paid for at $15.00 per cu yd ($19.61 per m^3).

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.

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 ten times the contract unit price per cubic yard (cubic meter) 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 ($104.60 per m^3).

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 ten times the contract unit price per cubic yard (cubic meter) for common excavation or \$100.00 per cu yd (\$130.80 per m^3) for quantities less than 100 cu yd (76 m^3) or \$80.00 per cu yd (\$104.60 per m^3) for quantities greater than 100 cu yd (76 m^3) but less than 200 cu yd (159 m^3), whichever is greater.

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 (cubic meter) for borrow.

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 ten times the contract unit price per cubic yard (cubic meter) for waterway excavation, or \$100.00 per cu yd (\$130.80 per m^3), 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.

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 yd (8 m^3) or fraction thereof will be paid for at ten times the contract unit price for the class of excavation encountered. The next 40 cu yd (30 m^3) 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 (cubic meter) 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 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 (cubic meter) for common excavation.

Mechanical treatment of embankment foundation soils will be paid for by the square yard (square meter) as embankment foundation soils treatment.

Cased test holes and exploratory drilling will be paid for at the contract unit price per linear foot (meter).

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 nor 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.

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.

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.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Borrow	CYS (m3)
Breaking Pavement	SYS (m2)
Cased Test Holes	LFT (m)
Embankment	CYS (m3)
Embankment Foundation Soils Treatment	SYS (m2)
Excavation, Common	CYS (m3)
Excavation, Peat	CYS (m3)
Excavation, Rock	CYS (m3)
Excavation, Unclassified	CYS (m3)
Excavation, Waterway	CYS (m3)
Excavation, Y	CYS (m3)
Exploratory Cores	LFT (m)
Exploratory Drilling	LFT (m)
Linear Grading	STA
Water for Shale	kGAL. (kL)

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 yardage (cubic meterage) 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.

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.

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.

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.

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 pits, 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.

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

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

Ottawa Sand* ..... AASHTO T 252
Structure Backfill, Size No. 30 904
* Ottawa Sand shall have a minimum permeability of 25.0 ft/day (8.3 m/day).

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 (11.36 kg) of bentonite with 94 lb (42.64 kg) of Portland Cement, type I in accordance with 901.01(b) and a 30 gal. (113.4 L) of water.

CONSTRUCTION REQUIREMENTS

204.03 Settlement Plates

Settlement plates consist of 0.5 in. by 3 ft by 3 ft (13 mm by 1.0 m by 1.0 m) steel plate~~s~~ equipped with sections of 3/4 in. (19 mm) pipe and 2 in. (50 mm) 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 1.0 ft (0.3 m) 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 recorded before starting the first lift of grading operations.

The pipe sections for the settlement plates shall be 3/4 in. (19 mm) steel pipe, 4.0 ft (1.2 m) 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. (50 mm) shall be slipped over and centered on the standpipe, and not welded to plates. The 3/4 in. (19 mm) steel and cover pipes shall extend a minimum of 2.0 ft (0.6 m) or more above the grade of the new embankments at all times during grading operations and monitoring period.

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. (19 mm) by 4.0 ft (1.2 m) steel rods and shall be driven at least 12 in. (300 mm) 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

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 subgrade elevation, additional readings will be taken every seven days until the settlement rate per

week is 1/4 in. (6 mm) or less for four consecutive weeks. The monitoring period may be reduced as directed by the Department's Geotechnical Section.

If the results of any readings indicate that the new embankment has settlement greater than 1/4 in. (6 mm), the monitoring period will be extended until the settlement requirements are met.

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. (6mm). Settlement data will be sent electronically to the Department's Geotechnical Section within one day of the readings for 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 corrective measures taken as directed. Measurements will be made to the nearest 1/4 in. (6 mm).

Settlement plates, extension pipes, cover pipes, and stakes shall be protected during construction operations and during the monitoring period.

204.04 Standpipe Piezometers

The standpipe piezometers shall be installed by a Department approved Geotechnical Consultant prior to placing the first lift of embankment. Piezometer consists of a 1/2 in. (13 mm) 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.

(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. (50 mm) diameter borehole, cased with slotted pipes, drilled to a recommended depth and location or as directed by the Engineer, to establish ground water elevation prior to piezometer installation.

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. (150 mm) 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. (150 mm) by means of jacking or other steady pull operations. The hole shall be filled to the bottom with saturated Ottawa sand and 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.

The auger shall then be pulled or jacked a distance equal to the length of the tip in increments of 6 in. (150 mm). The hole shall be filled with water saturated Ottowa 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. (300 mm) and the hole filled with saturated Ottowa sand in 6 in. (150 mm) increments until the backfilling reaches a minimum of 6 in. (150 mm) below the elevation of the strata change or as directed by the Engineer. In locations where there is no strata change, the Ottowa sand shall be placed a minimum of 12 in. (300 mm) above the top of the tip.

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. (150 mm) lifts. The top of the seal shall be a minimum of 6 in. (150 mm) 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 cement-bentonite 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 Engineers' logs.

If the piezometer location is not in an area of proposed fill, a protective metal cover, about 3 ft (1 m) long shall be installed at the top with about 2 ft (0.6 m) below the surface and 12 in. (300 mm) above the surface. A 6 in. (150 mm) circular pad of course aggregate; 6 in. (150 mm) thick 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. B borrow shall be placed and compacted around the casing without disturbing the casing.

The casing and standpipe shall be extended as the fill is placed, by adding extra lengths not to exceed 5.0 ft (1.5 m). The top of the standpipe shall be at least 12 in. (300 mm) 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. (300 mm) above grade. It shall be filled with structure backfill to within 9 in. (225 mm) of the top of the casing. A 6 in. (150 mm) circular pad of coarse aggregate, 6 in. (150 mm) thick 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 ground water 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. Ground water 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 ground water 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 ground water existing at the time of installation, prior to placement of any fill, will be used as a reference to determine baseline pore pressures. Ground water and pore pressure test results will be made available to the Contractor.

The pore pressure measurement in conjunction with settlement data will be sent electronically to the Department's Geotechnical Section within one day of the readings for 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. (150 mm) 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

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, Ottowa sand, tips, casing, drilling, tubing or PVC pipe, backfilling and measurements will be included in the cost of standpipe piezometers.

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 – TEMPORARY EROSION AND SEDIMENT CONTROL

205.01 Description

This work shall consist of furnishing, installing, maintaining, and removing temporary erosion and sediment control measures in accordance with 105.03.

MATERIALS

205.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate, Class F or Higher.....904
Geotextile for Silt Fence 918.04
Geotextile Under Riprap 918.02
Metal End Sections 908.06
Pipe Drains.....715.02(d)
Revetment Riprap.....904
Stakes .....914.09(b)

Straw bales shall be a minimum of 14 in. by 18 in. by 36 in. (350 mm by 450 mm by 900 mm) and shall not weigh less than 35 lb (16 kg). Bales shall be bound with wire or nylon twine.

CONSTRUCTION REQUIREMENTS

205.03 Control Measures

The installation of temporary erosion and sediment control measures 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 Contractor's vehicles enter and leave public roads, and other locations where erosion or sediment control becomes an issue during the contract. The Contractor's designated individual in accordance with 108.04 shall be responsible for the installation, inspection, and maintenance of these measures.

Adjustments of the erosion and sediment control measures shall be made where appropriate to meet field conditions. These measures shall be constructed as soon as practical and shall be maintained in accordance with the following.

(a) Silt Fence

The manufacturer's recommendations shall be followed with regard to shipping, handling, storage, installation, and protection from direct sunlight. The geotextile 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.

The post spacing shall be as recommended by the manufacturer. The spacing of the posts shall be adjusted such that the posts are located at the low points along the fence line. Joints in fabric shall be avoided at low points along the fence line. At joints, the overlap shall be nailed or similarly fastened to the nearest post with a lath.

The original copies of all necessary current manufacturer's installation manuals shall be provided prior to installation.

(b) Temporary Mulching

Mulching shall be in accordance with 621.05(c) except that the rate of application shall be 2.5 ton/acre (5.5 Mg/ha).

(c) Check Dams

Check dams shall be constructed with revetment riprap or straw bales as shown on the plans.

1. Revetment Riprap

Revetment riprap shall be in accordance with 616 unless otherwise specified.

2. Straw Bales

Straw bales shall be embedded and staked as shown on the plans. Adjacent bales shall be chinked to eliminate gaps between the bales. Bales shall be placed such that the bindings are parallel to and not in contact with the ground.

(d) Interceptor Ditches

Interceptor ditches shall be constructed and graded to drain.

(e) Sediment Traps

Revetment riprap in accordance with 616 shall be used in construction of sediment traps, unless otherwise specified.

(f) Sediment Basins

Embankment construction shall be in accordance with 203. Revetment riprap used for overflow protection shall be in accordance with 616, unless otherwise specified. A manufactured perforated riser may be used when called for on the plans, or as directed.

(g) Ditch Inlet Protection

Ditch inlet protection shall be constructed as shown on the plans.

(h) Slope Drains

Slope drain pipes shall be lengthened as required by the construction of the embankment.

(i) Temporary Seeding

Temporary seeding shall be in accordance with 621.06.

(j) Vegetative Filter Strips

Designated vegetative filter strips shall not be disturbed.

(k) Splashpads

Splashpads shall be constructed with revetment riprap in accordance with 616.

(l) Deck and Curb Inlet Protection

All deck and curb drains shall have sediment control measures when the structure or road is to be used for hauling operations.

(m) Detention Ponds

Excavation shall be in accordance with 203.

(n) Retention Ponds

Excavation shall be in accordance with 203. The soil used in the liner shall be in accordance with AASHTO M 145, classification A-6 or A-7.

The sides and bottom of the retention pond shall be lined with a soil liner of 2 ft (600 mm) minimum thickness. The soil in the liner shall be compacted to 95% of the maximum dry density in accordance with 203.23. The Contractor may use an alternate lining system. Details of the proposed pond lining system shall be submitted to the Department's Geotechnical Section for approval. These details shall include all necessary information such as liner thickness, smooth surface versus textured surface, thickness and type of proposed soil cover, joint construction, material used in the liner, and manufacturer of the liner.

205.04 Maintenance

Temporary erosion and sediment control measures shall be inspected by the Contractor once every seven days and after rain activities. Inspections shall be documented and records shall be maintained by the Contractor, to be made available for review upon request. Records shall include, at a minimum, the date, the inspector's name, the maintenance and corrections needed based on this inspection, and the status of previously identified deficiencies. The temporary protection measures shall be returned to good working conditions within 48 hours after inspection or as directed. Sediment shall be removed as approved and disposed of in accordance with 201.03 and 203.08.

205.05 Removal

Temporary erosion and sediment control measures shall remain in place until directed to be removed. The Contractor shall remove and dispose of all excess silt accumulations, dress the area, and vegetate all bare areas in accordance with the contract requirements. Use or disposal of riprap and straw bales shall be as directed.

205.06 Method of Measurement

Silt fence and straw bale check dams will be measured by the linear foot (meter). Sediment basins will be measured by the units installed complete in place. Revetment

riprap check dams, sediment traps, and splashpads will be measured by the ton (megagram). Measurement of sediment traps will include the riprap and the No. 8 filter stone. Temporary mulching will be measured by the ton (megagram). Temporary seeding will be measured in accordance with 621.13. Removal of sediment will be measured by the cubic yard (cubic meter). Revetment riprap will be measured in accordance with 616.12. Slope drains will be measured in accordance with 715.13. Ditch inlet protection will be measured per each unit installed.

Interceptor ditches, curb inlet protection, deck inlet protection, and the off-site locations designated in 205.03 will not be measured for payment.

Excavation for detention and retention ponds will be measured as common excavation in accordance with 203.27. Retention pond liners will not be measured for payment.

205.07 Basis of Payment

The accepted quantities of silt fence will be paid for at the contract unit price per linear foot (meter), complete in place. Temporary mulching will be paid for by the ton (megagram). Temporary seeding will be paid for in accordance with 621.14. Sediment basins will be paid for at the contract unit price per each unit installed. Check dams, revetment riprap; sediment traps; and splashpads will be paid for by the ton (megagram). Check dams, straw bales will be paid for by the linear foot (meter). Revetment riprap will be paid for in accordance with 616.13. Slope drains will be paid for in accordance with 715.14. Removal of sediment will be paid for at the contract unit price per cubic yard (cubic meter). Ditch inlet protection will be paid for at the contract unit price per each unit installed.

The accepted quantities of excavation for detention or retention ponds will be paid for as common excavation in accordance with 203.28. Retention pond liners will be paid for as a lump sum.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Liner for Retention Pond	LS
Sediment, Remove	CYS (m3)
Splashpad, Riprap	TON (Mg)
Temporary Check Dam, Revetment Riprap	TON (Mg)
Temporary Check Dam, Straw Bales	LFT (m)
Temporary Ditch Inlet Protection	EACH
Temporary Mulching	TON (Mg)
Temporary Sediment Basin	EACH
Temporary Sediment Trap	TON (Mg)
Temporary Silt Fence	LFT (m)
Temporary Slope Drain	LFT (m)

The cost of geotextile fabric shall be included in the cost of the sediment trap.

The cost of geotextile fabric, trenching, backfilling, posts, fencing, and all necessary incidentals shall be included in the cost of silt fence.

The cost for stakes, trenching, backfilling, posts, and all necessary incidentals shall be included in the cost of temporary check dams, straw bales.

The cost of deck and curb inlet protection and interceptor ditches shall be included in the cost of other pay items in this section.

Payment for slope drain will include the standard metal end section, anchors, and all incidentals necessary to perform the work.

The cost of the materials, installation, inspection, maintenance, and removal of the temporary erosion and sediment control measures at off-site locations designated in 205.03 will not be paid for.

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; and for 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.

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

(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.

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 (0.4 m^3) 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.

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 located as directed.

If class X material in accordance with 206.02(a)1 is encountered, the material shall be excavated to allow the foundation to be embedded a distance that is equal to 1/2 of the remaining depth of the foundation before the material was encountered, except for overhead sign structures, strain poles, and high mast lighting foundations.

Overhead sign structure foundations, strain poles, and high mast lighting foundations 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)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 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 (0.3 m) 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

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 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.

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 permit 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.

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

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 is in accordance with 211.02 and if material of this nature is required at the structure or in its approaches, then this material shall be used as special fill and placed in accordance with applicable provisions of 211.

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.

206.08 Preparation of Foundation Surfaces

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.

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.

Before foundations that do not require piling are poured, sufficient test borings shall be made to determine the character of the underlying material for a depth of at least 5 ft (1.5 m) below the bottom of the footing. Also, before pilings are driven in foundations requiring piling, sufficient soundings shall be made to determine the character of the underlying material for a depth of 10 ft (3 m) below the bottom of the footing.

Rock at the bottom of spread footings shall be proof tested. Exploratory holes of 2 in. (50 mm) diameter shall be drilled into the foundation base. Holes shall be drilled into sound rock to a depth of 5 ft (1.5 m) 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
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. (10 or 13 mm) diameter.
6. continuity of bearing material

A professional engineer shall supervise the proof testing work. A report for each hole shall be prepared and submitted for review and approval.

206.09 Cofferdams and Temporary Construction Dikes

Cofferdam 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. Cofferdam construction shall not start before these submitted drawings are approved. Such approval shall be only for insuring the Department against inadequate and insufficient cofferdams and shall not release the Contractor from any risk or responsibility in connection with this part of the work.

Drawings of dikes to be used in lieu of cofferdams or to be used for access to the work shall be submitted, if such dikes are to be constructed within the waterway. Approval of such drawings will not relieve responsibilities as set out elsewhere in the contract documents and will only be given if the probability of stream pollution and stream flow restriction is minimal.

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 permit 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.

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 permitted for 24 h after concrete placement, unless otherwise approved.

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).

Unless otherwise permitted, all cofferdam bracing shall be removed and all sheeting removed or cut off at least 2 ft (0.6 m) 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 (cubic meters) 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.

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.

Additional excavation required for a culvert when the culvert is placed at an elevation that is a least 1 ft (0.3 m) below the elevation shown on the plans shall be measured to include the entire width needed to comply with OSHA or IOSHA requirements.

206.11 Basis of Payment

The accepted quantities of structure excavation will be paid for at the contract unit price per cubic yard (cubic meter) or lump sum.

Unless otherwise provided, excavation for bridges will be paid for at the contract unit price or prices per cubic yard (cubic meter) 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.

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 yardage (cubic meterage) 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.

If class X excavation is encountered at locations other than sign foundations, traffic signal foundations, and highway illumination foundations, and there is no contract unit price for class X excavation, payment will be made at a unit price per cubic yard (cubic meter) as follows:

1. $1000.00 per cu yd ($1300.00 per m^3) if the quantity of class X excavation is less than or equal to 1 cubic yard (1 cubic meter) per foundation.

2. When the quantity of class X excavation is greater than 1 cubic yard (1 cubic meter) per foundation, payment will be made at the lesser of four times the contract unit price for wet excavation or ten times the contract unit price for dry excavation.

If class X excavation is encountered at locations for sign foundations, traffic signal foundations, and highway illumination foundations and there is no contract unit price for class X excavation, payment will be made as follows:

1. $500.00 if the quantity of class X excavation is less than or equal to 1 cubic yard ($660.00 if the quantity of class excavation is less than or equal to 1 cubic meter) per foundation.

2. $500.00 per cu yd ($660.00 per m^3) for all quantities over 1 cubic yard (1 cubic meter).

In addition to the payment for class X excavation at sign foundations, traffic signal foundations, and highway illumination foundations when there is no contract unit price for class X excavation, a mobilization and demobilization payment for class X excavation will be paid in the amount of $1500.00 per occurrence. Multiple mobilization and demobilization payments will be paid if all project foundation locations are not made available in a reasonable time frame while the equipment is on the project. The cost of this work will be included in a change order developed in accordance with 109.05 and paid as class X excavation and a mobilization and demobilization for class X excavation.

If class X excavation is encountered in foundation excavation unclassified and there is no pay item shown in the Schedule of Pay Items, payment will be made at eight times the contract unit price per cubic yard (cubic meter) for foundation excavation unclassified.

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. (0.5 m) 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. (0.5 m) outside the neat lines of footings and parallel thereto. Additional payment will not be made for such excavation outside these limits.

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 (1.2 m) 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 (0.3 m), the factor will be 2.0.

2. For footings or portions thereof lowered more than 1 ft (0.3 m) and not more than 2 ft (0.6 m), the factor will be 2.5.

3. For footings or portions thereof lowered more than 2 ft (0.6 m) and not more than 3 ft (0.9 m), the factor will be 3.5.

4. For footings or portions thereof lowered more than 3 ft (0.9 m) and not more than 4 ft (1.2 m), the factor will be 5.0.

For a footing lowered more than 4 ft (1.2 m) 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.

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 nor require removal of any items, payment will be made in accordance with 203.28.

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:

Pay Item	Pay Unit Symbol
Cofferdam	LS
Excavation, Dry	CYS (m3)
Excavation, Foundation, Unclassified	CYS (m3)
Excavation, Wet	CYS (m3)
Excavation, X	CYS (m3)

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 and Retaining Walls

This requirement will not include pipe culverts. Except as otherwise provided herein, excavation for culverts and retaining walls will not be paid for directly. The cost thereof shall be included in the cost of the class of concrete used therein. 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, relocated, or material of such nature is encountered that additional excavation is necessary over and above that required at the originally planned location, the additional excavation will not be paid for if it is 10 cu yd (8 m^3) or less. Additional excavation in excess of 10 cu yd (8 m^3) will be paid for at three times the contract unit price for the class of excavation involved. However, if the culvert is placed at a depth that is equal to or greater than 1 ft (0.3 m) deeper than the elevation shown on the plans, the additional excavation in excess of 10 cu yd (8 m^3) will be paid at five times the contract unit price for the class of excavation involved.

(b) Bridges

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 shop plans; 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.

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.

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.

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. (0.5 m) outside the neat lines shown on the plans and parallel thereto and above a plane 1 ft (0.3 m) 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 excavation shall be bounded by vertical planes which are 1 ft (0.3 m) 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 (0.3 m) 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.

(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.

SECTON 207 – SUBGRADE

207.01 Description

This work shall consist of the construction of the subgrade in accordance with 105.03.

MATERIALS

207.02 Materials

Materials shall be in accordance with the following.

Chemical Modifiers
- Fly Ash 901.02
- Lime ..... 913.04(b)
- Portland Cement, Type I ..... 901.01(b)

Coarse Aggregate, Class D or Higher, Size No. 11, 12, 53, or 73 904

Geogrid, Type I ..... 918.05(a)

Water 913.01

Recycled concrete pavement meeting the requirements of coarse aggregate size No. 53 may be used when crushed stone size No. 53 is specified.

CONSTRUCTION REQUIREMENTS

207.03 General Requirements

The subgrade shall be constructed uniformly transversely across the width of the pavement including 2 ft (0.6 m) outside the edge of shoulders or curbs unless shown otherwise on the plans, by one of the following methods.

(a) chemical modification in accordance with 215;

(b) aggregate No. 53 in accordance with 301;

(c) geogrid in accordance with 214 placed under aggregate No. 53 in accordance with 301, or

(d) soil compaction to 100% of maximum dry density.

Longitudinally, the treatment may vary depending on the method of construction.

Soils containing greater than 3% by dry weight calcium, magnesium carbonate or organic material, or with a maximum dry density of less than 100 pcf (1600 kg/m^3), or with liquid limit of greater than 50, will not be permitted within the specified thickness of the subgrade. Density shall be determined in accordance with AASHTO T 99 and loss of ignition shall be determined in accordance with AASHTO T 267. Liquid limits shall be determined in accordance with AASHTO T 89.

Coal within the specified thickness of the subgrade shall be excavated if directed, and disposed of in accordance with 202.05. Coal or coal blossoms that are allowed to remain shall be mixed thoroughly with subgrade soils and compacted in accordance with 207.04.

All rock greater than 6 in. (150 mm) shall be removed or broken off at least 6 in. (150 mm) 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.

During subgrade preparation, adequate drainage shall be provided at all times to prevent water from standing on the subgrade.

Even though the subgrade has been previously accepted, the condition of the subgrade at the time paving material is placed shall be in accordance with 105.03 and 207.04. Just prior to placing the base course on the subgrade, proofrolling in accordance with 203.26 shall be completed. Undue distortion of the subgrade shall be avoided. If limits of the work make mechanical preparation of the subgrade impractical, appropriate hand methods may be used.

The grade and cross section of the subgrade shall be finished within a tolerance of 1/2 in. (13 mm) from the true subgrade. It is permissible to finish within this tolerance by blading or other mechanical means without the use of side forms. If these methods do not finish within this tolerance, side forms shall be used.

207.04 Subgrade Treatments

The subgrade treatment type shall be as specified on the contract plans.

Within each of the following subgrade treatment types, the Contractor shall choose from the listed options for each type.

Type I. 16 in. (400 mm) chemical soil modification, 12 in. (300 mm) of the subgrade excavated and replaced with coarse aggregate No. 53, or by 24 in. (600 mm) of soil compacted to density and moisture requirements.

Type IA. 16 in. (400 mm) chemical soil modification or 12 in. (300 mm) of the subgrade excavated and replaced with coarse aggregate No. 53.

Type II. 8 in. (200 mm) chemical soil modification, 6 in. (150 mm) of the subgrade excavated and replaced with coarse aggregate No. 53,or 12 in. (300 mm) of soil compacted to density and moisture requirements.

Type IIA. 8 in. (200 mm) chemical soil modification or 6 in. (150 mm) of the subgrade excavated and replaced with coarse aggregate No. 53.

Type III. 6 in. (150 mm) of soil compacted to the density and moisture requirements, or 6 in. (150 mm) of subgrade excavated and replaced with coarse aggregate No. 53.

Type IIIA. 6 in. (150 mm) of subgrade excavated and replaced with coarse aggregate No. 53.

Type IV. 9 in. (225 mm) of the subgrade excavated and replaced with coarse aggregate No. 53 on geogrid.

Where the 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. (150 mm) compacted in-place to comply with the specified density and moisture requirements. The excavated material shall then be replaced and compacted in 6 in. (150 mm) lifts to comply with the specified density and moisture requirements. Removal of the upper lifts may be waived and only the upper 6 in. (150 mm) treated in accordance with 207.03 when it is determined, through testing in accordance with 203.24, that the lower lifts comply with the specified density and moisture requirements.

In sections where shale or shale and rock mixtures are encountered, these materials shall be undercut 12 in. (300 mm) below the subgrade elevation and replaced with coarse aggregate No. 53 or No. 73 and compacted in accordance with 301.06. All irregularities and holes shall be graded to provide positive drainage. Where necessary, finishing to subgrade elevation shall be accomplished using No. 11 or No. 12 crushed stone.

When conditions are encountered below the specified subgrade treatment depth that prevent achieving the specified subgrade compaction, such conditions shall be treated as directed.

207.05 Method of Measurement

Subgrade treatment will be measured in both cut and fill areas by the square yard (square meter) per type. Chemicals for modification, excavation, aggregates, 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

The accepted quantities of subgrade treatment will be paid for at the contract unit price per square yard (square meter) per type, complete in place.

The undercutting of rock, where encountered, will be measured in accordance with 203.27.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Subgrade Treatment, Type _____	SYS (m2)

The cost of subgrade treatments including testing, sampling, aggregates for cut or at-grade areas, chemicals for modification, geogrid, water, and the excavation required for the methods chosen by the Contractor shall be included in the cost of the pay item for subgrade treatment, type.

Compacted aggregate used for subgrade treatment in fill areas will also be measured and paid for as either embankment or as borrow, as appropriate, in accordance with 203.27 and 203.28.

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.

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

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 (4.5 Mg) 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.

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.

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

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

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

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 hand methods if necessary. Reasonably smooth surfaces shall be obtained and finished at least to within ± 0.1 ft (30 mm) of the required profile and cross sections shown on the plans or as directed.

All rock greater than 6 in. (150 mm) encountered shall be removed or broken off at least 6 in. (150 mm) 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

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

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.

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.

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.

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

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 FILL AND 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

211.02 Materials

Materials shall be in accordance with the following.

B Borrow ..... As Defined*
Geotextile 918.02
Structure Backfill 904

* 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, 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 permitted unless approved.

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 Department's list of approved Geotechnical Consultants For Gradation Control Testing.

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 2000 t (2000 Mg) 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 advise, in writing, the Engineer and the District Materials and Testing Engineer of the plan to measure the material.

When structure backfill is specified, the Contractor may substitute flowable backfill in accordance with 213. However, flowable backfill shall not be placed into or through standing water, unless approved in writing.

CONSTRUCTION REQUIREMENTS

211.03 General Requirements

If B borrow or structure backfill is obtained from borrow areas, the items of obtaining the areas, their 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.

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.

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.

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.

211.04 Mechanical Compaction

Where B borrow or structure backfill is to be compacted by mechanical compaction, it shall, unless otherwise specified, be placed in accordance with the applicable provisions of 203.23 except, if mechanical tamps or vibrators are used, the material shall be deposited in approximately 6 in. (150 mm) lifts, loose measurements, and each lift compacted to density requirements.

211.05 Embankment for Bridges

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. 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 (0.3 m) thick after being compacted into place.

211.06 B Borrow Around Bents

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 Aggregate For End Bent Backfill

When specified, coarse aggregate shall be placed behind end bents as shown on the plans. The material shall be deposited in lifts not to exceed 12 in. (300 mm) loose measurement, and each lift shall be mechanically compacted using a hand held vibratory plate compactor having a plate width of 17 in. (425 mm) or larger that delivers 3000 to 9000 lb (13.3 to 40 kN) per blow. Each lift shall be compacted with two passes of the compactor.

Prior to placing the aggregate, a geotextile shall be installed in accordance with 616.11.

211.08 Spandrel Filling

Unless otherwise specified, spandrel fills for arch structures shall be composed of 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

B borrow, structure backfill, and aggregate for end bent backfill will be measured by the cubic yard (cubic meter) as computed from the neat line limits shown on the plans, or as adjusted. If cubic yards (cubic meters) 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 (cubic meter) 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 (cubic meters) by assuming the weight per cubic foot (mass per cubic meter) 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.

If the material is to be paid for by the ton (megagram), it will be weighed in accordance with 109.01(b).

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 (cubic meter) or per ton (megagram) as specified, complete in place.

Structure backfill will be paid for at the contract unit price per cubic yard (cubic meter), based on the neat line limits shown on the plans or as adjusted for authorized changes, provided the material comes from outside the permanent right-of-way. If the Schedule of Pay Items does not contain a pay item for structure backfill and it is required to backfill pipes or culverts within the project limits, a change order will be generated to establish a unit price.

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 (cubic meter), based on the neat line limits shown on the plans or as adjusted by authorized changes.

Geotextile will be paid for in accordance with 616.13.

Flowable backfill which is substituted for structure backfill will be paid for as structure backfill.

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 (cubic meter) for borrow, unless otherwise provided.

Payment will be made under the following:

Pay Item	**Pay Unit Symbol**
Aggregate For End Bent Backfill	CYS (m3)
B Borrow	CYS (m3) TON (Mg)
Structure Backfill	CYS (m3)

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 MSE wall, and end bent fill will be paid for at the contract unit price of $5.00 per cubic yard ($6.50 per cubic meter) for B borrow/structure backfill handling.

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 excavation 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

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.

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

Stockpiled selected material will be measured in the stockpiles by means of cross sections by the cubic yard (cubic meter), computed by the average end area method. The volume measured as salvaged stockpiled selected material will be the difference in cubic yards (cubic meters) 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.

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 (cubic meter), complete in place.

Payment will be made under:

Pay Item	Pay Unit Symbol
Stockpiled Selected Material	CYS (m3)
Stockpiled Selected Material, Salvaged	CYS (m3)

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 and other work extending under pavement locations, to fill cavities beneath slopewalls and other locations in accordance with 105.03.

MATERIALS

213.02 Materials

Materials shall be in accordance with the following:

Concrete Admixtures	912.03
Fine Aggregate*	904
Fly Ash	901.02
Portland Cement	901.01(b)
Water	913.01

*Except that steel furnace slag shall not be used

If fly ash is used as a filler and not as a pozzolan, the fly ash shall be in accordance with 904.

The supplier may elect to use gradations in accordance with 904 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.

213.03 Flowable Backfill Mix Design

The Contractor shall submit a flowable backfill mix design, FBMD, to the Engineer and arrange a trial batch. The FBMD will be approved based on compliance with 213.04. The FBMD shall be submitted in a format acceptable to the Engineer 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 (mass)
(e) the names of all admixtures
(f) the admixture dosage rates and manufacturer’s recommended range

FBMD's which were used on contracts in the current or previous calendar year, may be submitted to the District Materials and Tests Engineer for approval. Effective January 1, 2004, all FBMD's shall meet the requirements of 213.05.

After the completion of the trial batch and all test results have been reviewed for compliance with the specifications, a mixture number will be assigned by the Engineer.

Mix design changes will not be allowed after the FBMD approval, except for adjustments to compensate for routine moisture fluctuations. All other changes require a new FBMD.

213.04 Flowable Backfill Mix Criteria

The FBMD shall produce a workable mixture with the following properties:

Minimum Unconfined Compressive Strength
at 28-days ..... 50 psi (350 kPa)
Maximum Unconfined Compressive Strength
at 28-days ..... 150 psi (1050 kPa)
Minimum Fill Spread Diameter .....8 in. (200 mm)

213.05 Flowable Backfill Trial Batch

A trial batch shall be produced by the Contractor and tested by the District Materials and Tests Engineer to verify that the FBMD meets the flowable backfill mix criteria. The flowable backfill shall be batched within the proportioning tolerances of 508.02(b). The Engineer will determine and provide the Contractor with test results for the unconfined compressive strength test and the flowable backfill spread diameter. 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 flowable backfill shall not be used for more than one test.

Compressive strength testing shall be conducted in accordance with ITM 588. Flow testing shall be conducted in accordance with ASTM D 6103.

The Contractor shall determine the penetration resistance of the flowable backfill produced during the trial batch in accordance with ITM 213 at one, three, seven, and fourteen days. The results shall be submitted to the Engineer.

FBMD's which were used on contracts in the current or previous calendar year, may be submitted to the District Materials and Tests Engineer for approval.

213.06 Mixing Equipment

The mixing equipment shall be in accordance with the applicable requirements of 702 or 722, except that in lieu of the calibration requirements of 722.11, the mixer operator shall make delivery in a properly calibrated continuous mixer.

CONSTRUCTION REQUIREMENTS

213.07 Placement

The flowable backfill shall not be placed on frozen ground. Flowable backfill shall be protected from freezing until the material has set.

The diameter of the flowable backfill spread shall be at least 8 in. (200 mm) at time of placement.

The flowable backfill shall be brought up uniformly to the fill line as shown on the plans or as directed.

The flowable backfill shall not be subject to load nor disturbed by construction activities until penetration resistance testing in accordance with ITM 213 has been completed. The minimum penetration resistance shall be as follows:

For PCCP ..... 70 psi (500 kPa)
For all Other Applications..... 1200 psi (8000 kPa)

213.08 Method of Measurement

Flowable backfill will be measured by the cubic yard (cubic meter) as computed from the neat line limits shown on the plans, or as adjusted. If neat line limits are not shown on the plans, the volume in cubic yards (cubic meters) 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.

213.09 Basis of Payment

The accepted quantities of flowable backfill will be paid for at the contract unit price per cubic yard (cubic meter) furnished and placed. Holes drilled in the pavement will be paid for at the contract unit price per each.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Drilled Hole for Flowable Backfill	EACH
Flowable Backfill	CYS (m3)

The cost of material placed outside the neat line limits, material placed outside the adjusted limits, and unused or wasted flowable backfill shall be included in the cost of this work.

SECTION 214 – GEOGRID

214.01 Description

This work shall consist of furnishing and installing geogrid as shown on the plans and in accordance with 105.03.

MATERIALS

214.02 Materials

Materials shall be in accordance with 918.05.

CONSTRUCTION REQUIREMENTS

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 soils. Construction activities using equipment which cause pumping and rutting of the embankment foundation soils shall be prevented where possible or otherwise minimized. Fine grading may be waived where impractical. However, when very soft soil is encountered, the embankment foundation shall be cleared of all trash and rubbish materials without disturbing the vegetation cover. The embankment foundation shall be subject to approval prior to placement of geogrid. Proofrolling of the embankment foundation will not be required.

214.04 Geogrid Placement

The geogrid shall be installed in accordance with the manufacturer's recommendations with excess geogrid being removed. The Contractor may turn the excess portion of the geogrid into the fill layer as an alternative to removal, provided an acceptable installation is obtained. The geogrid shall be kept taut during placement of the initial lift of backfill. Installation may require the use of stakes to hold the geogrid in place.

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 Contractor. A copy of the manual for the installation shall be furnished to the Engineer.

Geogrid shall be overlapped a minimum of 2.0 ft (0.6 m) side to side and end to end for type I and only end-to-end for type II. The geogrids shall be overlapped 3.0 ft (1 m) in areas where foundation conditions cannot support foot traffic or where 2.0 ft (0.6 m) is found to be inadequate during fill placement. Overlaps shall be oriented, or shingled, to prevent advancing fill from lifting the geogrid. Overlaps shall be further secured to prevent separation during fill placement. Damaged geogrid shall be patched. Patching shall include placement of a minimum of 3.0 ft (1 m) 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.

Geogrid shall be covered with fill within three calendar days after placement. Only that amount of geogrid required for pending work shall be placed to minimize exposure of the geogrid.

214.05 Fill Placement

Construction vehicles shall not be permitted on the geogrid. The placement of the fill shall proceed forward along the roadway centerline and outward to the embankment

edges and compacted in accordance with 203.23. The Engineer may waive density requirements for the first lift if the fill is determined to be too soft to support compaction equipment.

214.06 Method of Measurement

Geogrid will be measured by the square yard (square meter), for the type specified. The quantity will be computed based on the total area of geogrid shown on the plans, exclusive of the area of overlaps. The portion of geogrid cut off or turned up into the backfill layer will not be measured for payment.

214.07 Basis of Payment

The accepted quantities of geogrid will be paid for at the contract unit price per square yard (square meter) per type of geogrid.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Geogrid, _____ type	SYS (m2)

The cost of furnishing the materials, manufacturer's representative, all labor and equipment required for furnishing and placing the geogrid, all work necessary to establish grades, geogrid splices, overlaps, stakes or pins, supplemental product test data, and patching or replacement of damaged geogrid shall be included in the cost of this work.

SECTION 215 – CHEMICAL MODIFICATION OF SOILS

215.01 Description

This work shall consist of the modification of soils by uniformly mixing dry portland cement, fly ash, lime, or a combination of the materials with soil to aid in achieving the workability of soils having an excessive moisture content.

MATERIALS

215.02 Materials

Materials shall be in accordance with the following:

Fly Ash	901.02
Lime	913.04(b)
Portland Cement, Type I	901.01(b)
Water	913.01

CONSTRUCTION REQUIREMENTS

215.03 Testing and Mix Design

The Contractor shall be responsible for all tests required to determine the chemical modifier type and optimum chemical modifier content for modification of the soils. The modifier selection, laboratory testing, and mix design shall be performed by an

approved geotechnical consultant in accordance with the Department's Design Procedures for Soil Modification or Stabilization.

The quantities for hydrated lime, quicklime, or portland cement shall be based on 4.0 ± 0.5% by dry unit weight (mass) of the soils. The quantities for lime by-products shall be based on 5.0 ± 1.0% by dry unit weight (mass) of the soils. The quantities for fly ash class C shall be based on 12.0 ± 2.0% by dry unit weight (mass) of the soils. Class F fly ash shall not be used except in combination with lime or cement.

If hydrated lime, quick lime, or cement are used, test results, recommendations, and a type A certification for the chemical modifiers, except for cement, shall be submitted to the Engineer prior to use. If fly ash, lime, lime by-products, or any combination of chemical modifiers are used, test results, recommendations, and type A certifications for the chemical modifiers shall be submitted to the Engineer and to the Materials and Tests Division for approval at least five business days prior to use. Cement, if used, shall be from the Department's list of approved Cement Sources.

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.

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 (7°C), measured 4 in. (100 mm) below the surface, and with the air temperature rising. The chemical modifier shall not be mixed with frozen soils or with soil containing frost.

215.06 Preparation of Soils

The soils shall be prepared in accordance with 207.03. All aggregates which are larger than approximately 3 in. (75 mm) 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 or disked to the specified depth prior to distribution of the chemical modifier. If a combination of modifiers are used, it shall be mixed mechanically prior to being incorporated. The chemical modifier shall be distributed uniformly by a cyclone, screw-type, or pressure manifold type distributor. 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 or a disc harrow. 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 16 in. (400 mm).

215.09 Compaction

Compaction of the mixture shall begin as soon as practicable after mixing. Compaction after mixing shall be as follows:

(a) For cement modified soils, mixing shall be completed within 30 min of cement placement and 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.

Compactive efforts shall be in accordance with 203 or 207.03 as applicable.

Maximum dry densities will be determined in accordance with AASHTO T 272 at the same time and location as each in-place density test is performed when in-place densities do not meet AASHTO T 99. The field in-place dry density shall be in accordance with AASHTO T 191 or AASHTO T 310.

The moisture content of the mixture shall be between the optimum moisture and the optimum moisture plus 2.0%. Aeration or drying by further mixing, or the addition of water and further mixing, may be required to obtain the optimum moisture content.

Construction traffic or equipment shall not be on the treated soils within 72 h after compaction.

215.10 Method of Measurement

The accepted quantity of chemically modified soils will be measured by the square yard (square meter), complete in place. All excavation required to modify the soils below the specified depth will be measured in accordance with 203.27(b).

215.11 Basis of Payment

The accepted quantity of chemically modified soils will be paid for by the square yard (square meter), complete in place. All excavation required to modify the soils below the specified depth will be paid for in accordance with 203.28.

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 hydrated lime, quicklime, lime by-products, or fly ash are not appropriate and moisture density compaction can not be achieved, a price adjustment will be made for the use of cement. The price adjustment will be calculated at a cost equal to the difference in the invoice cost of the cement and

the invoice cost of the hydrated lime. This adjustment will be included in a change order and will be paid for as chemical modifier adjustments. Payment for chemical modifier adjustments will be made for direct material costs incurred by the Contractor and shall not include any other markups.

Payment will be made under:

Pay Item	Pay Unit Symbol
Chemical Modification, Soils	SYS (m2)

The cost of performing the laboratory tests, providing an approved geotechnical consultant, scarification of the subgrade, spreading and mixing of the chemical modifier and soil, compaction of the resultant mixture, shaping the subgrade, 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 subgrade trimming, 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, CCF

216.01 Description

This work shall consist of furnishing and placing a light weight, low absorbability cellular concrete fill in accordance with 105.03.

MATERIALS

216.02 Materials

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.

A foam liquid concentrate in accordance with ASTM C 796 shall be used to produce the CCF properties in accordance with 216.04. The concentrate shall be chosen from those shown on the Department's list of approved CCF Manufacturers/Installers.

CONSTRUCTION REQUIREMENTS

216.03 Mix Design

A mix design prepared in accordance with the geotechnical report shall be submitted to the Materials and Tests Division for approval at least five work days before the CCF operations begin. A cellular concrete manufacturer shall be chosen from those shown on the Department's list of approved CCF Manufacturers/Installers.

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/cyd (480 kg/m^3)	972 lb/cyd (580 kg/m^3)	1134 lb/cyd (670 kg/m^3)
Minimum Compressive Strength, ASTM C 495*	40 psi (375 kPa)	80 psi (550 kPa)	120 psi (825 kPa)
Freeze-thaw resistance minimum at relative E = 70%, ASTM C 666 Modified		80 cycles	300 cycles
Water Absorption Maximum**	20%	16%	14%
Shear Modulus, G ASTM D 4015	25,000 psi (172 000 kPa)	34,000 psi (231 000 kPa)	
Young Modulus, E, ASTM D 4015	67,000 psi (469 000 kPa)	102,000 psi (772 000 kPa)	

* 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 C 796.

(a) CCF Cast Density

The density shall be monitored at the point of placement at hourly intervals during placement. Adjustments shall be made as necessary to maintain the specified cast density, ± 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.

216.06 Weather Limitations

CCF shall be placed when the ambient temperature is 32°F (0°C) or above. CCF shall not be placed on frozen subsoil. The installation procedure shall not begin if a temperature of less than 32°F (0°C) 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.

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 nor disturbed by construction activities until a minimum compressive strength of 25 psi (175 kPa) has been achieved.

The final surface finish shall be within ± 0.1 ft (30 mm) of the plan elevation.

216.09 Lots

Lots will be defined as 300 cyd (250 m^3) of CCF placed. A partial lot equal to or less than 60 cyd (50 m^3) shall be included in the previous lot. A partial lot greater than 60 cyd (50 m^3) but less than 300 cyd (250 m^3), will be considered a full lot.

216.10 Testing

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 C 495, 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 (cubic meter) for each class as computed from the neat lines shown on the plans, or as adjusted.

216.12 Basis of Payment

CCF will be paid for at the contract unit price per cubic yard (cubic meter) of the class specified.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Cellular Concrete Fill, _____ class	CYS (m3)

Water, curing, molds, equipment, materials, and other incidentals necessary for finishing CCF specimens shall be included in the cost of CCF.

No payment will be made for replacement of damaged CCF.

SECTION 300 – AGGREGATE PAVEMENT AND BASES

SECTION 301 – AGGREGATE BASE

301.01 Description

This work shall consist of placing a dense-graded compacted aggregate on a prepared subgrade in accordance with 105.03.

MATERIALS

301.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher, Size No. 53 904

CONSTRUCTION REQUIREMENTS

301.03 Preparation of Subgrade

Subgrade shall be compacted in accordance with 207.04. In areas of 500 ft (150 m) or less in length, or for temporary runarounds, proofrolling will not be required. Proofrolling will not be required in trench sections where proofrolling equipment cannot be used.

301.04 Temperature Limitations

Aggregate shall not be placed when the air temperature is less than 35°F (2°C). Aggregate shall not be placed on a frozen subgrade. Frozen aggregates shall not be placed.

301.05 Spreading

The 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. (75 mm) and a maximum of 6 in. (150 mm). The 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.

301.06 Compacting

Aggregates shall be immediately compacted to a minimum of 100% of the maximum dry densities in accordance with AASHTO T 99. Compaction equipment shall be in accordance with 409.03(d). Density of the compacted aggregate will be determined in accordance with 203.24(b). The aggregate shall meet the compaction requirements at the time subsequent courses are placed. In areas inaccessible to compaction equipment such as private drives, mailbox approaches, and temporary runarounds, the compaction requirements may be accepted by visual inspection.

All displacement or rutting of the aggregates 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. (13 mm) 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.

301.09 Method of Measurement

Compacted aggregate base will be measured by the ton (megagram) in accordance with 109.01(b).

301.10 Basis of Payment

The accepted quantities of compacted aggregate base will be paid for at the contract unit price per ton (megagram), complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Compacted Aggregate, No. 53, Base	TON (Mg)

The cost of placing, compacting, water, and necessary incidentals shall be included in the cost of the pay item.

Payment will not be made for material placed outside of a one to one slope from the planned typical section.

Replacement of pavement damaged by the Contractor's operations shall be at no additional payment.

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 3 in. (75 mm) of coarse aggregate No. 8 as the aggregate drainage layer placed over a 6 in. (150 mm) coarse aggregate No. 53 as the separation layer. Dense graded subbase shall consist of a 6 in. (150 mm) coarse aggregate 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

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 (2°C). Aggregate shall not be placed on a frozen subgrade. Frozen aggregates shall not be placed.

302.05 Spreading

The 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. (75 mm) and a maximum of 6 in. (150 mm). The 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.

302.06 Compacting

Subbases shall be compacted as follows:

(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 Layers

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 1000 vibrations per min. 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 submitted for approval. All 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)6 shall be used.

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. (13 mm) shall be corrected. If additional aggregate is required, the course shall be remixed and recompacted.

302.08 Method of Measurement

Subbase for PCCP or dense graded subbase will be measured by the cubic yard (cubic meter) 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% than 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 (cubic meter), complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Dense Graded Subbase	CYS (m3)
Subbase for PCCP	CYS (m3)

The cost of compacting, water, aggregates 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

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 REQUIRMENTS

303.03 Preparation of Subgrade

Subgrade shall be compacted in accordance with 207.04. In areas of 500 ft (150 m) or less in length, or for temporary runarounds, proofrolling will not be required. Proofrolling will not be required in trench sections where proofrolling equipment cannot be used.

303.04 Temperature Limitations

Aggregate shall not be placed when the air temperature is less than 35°F (2°C). Aggregate shall not be placed on a frozen subgrade. Frozen aggregates shall not be placed.

303.05 Spreading

The 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. (75 mm) and a maximum of 6 in. (150 mm). The 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.

303.06 Compacting

Aggregates shall be immediately compacted to a minimum of 100% of the maximum dry densities in accordance with AASHTO T 99. Compaction equipment shall be in accordance with 409.03(d). Density of the compacted aggregate will be determined in accordance with 203.24(b). The aggregate shall meet the compaction requirements at the time subsequent courses are placed. In areas inaccessible to compaction equipment such as private drives, mailbox approaches, and temporary runarounds, the compaction requirements may be accepted by visual inspection.

All displacement or rutting of the compacted aggregate shall be repaired prior to placing subsequent material.

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. (13 mm) shall be corrected. If additional aggregate is required, the course shall be remixed and re-compacted.

303.08 Dust Palative

A dust palative, if required, shall be in accordance with 407.

303.09 Method of Measurement

Compacted aggregate will be measured by the ton (megagram) 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 (megagram), for the type specified, complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Compacted Aggregate, No. 53	TON (Mg)
Compacted Aggregate, No. 73	TON (Mg)

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 one to one slope from the planned typical section.

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

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 Patching

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. (50 mm) 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.

Subgrade of aggregate base under 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. (150 mm) 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.

The excavated patch areas shall be filled with HMA for patching of the type specified in the pay item. Partial depth patches shall use HMA intermediate mixture and full depth patches shall use HMA base mixture in accordance with 402. A 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).

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 base, intermediate, or surface mixtures may 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 of daily operations shall be backfilled, compacted, and a temporary surface placed to carry traffic, unless otherwise permitted.

304.05 Widening

The outside face of the excavated area shall be left as nearly vertical as the nature of the material will permit and not wider than the outside limits of the widening section. The subgrade in the widened area shall be compacted in accordance with 207.

Widening mixtures shall be HMA mixtures in accordance with 402 and as shown on the typical section or as directed.

For widening 3.0 ft (1 m) or less and 330 lb/syd (180 kg/m^2) or less, six passes of trench rollers in accordance with 409.03(d)5 shall be used. For widening 3.0 ft (1 m) or less and greater than 330 lb/syd (180 kg/m^2), twelve passes of trench rollers in accordance with 409.03(d)5 shall be used.

For widening greater than 3.0 ft (1 m) and 330 lb/syd (180 kg/m^2) or less, six passes of rollers with a compaction wheel bearing of no less than 300 lb/in (5.3 kg/mm) shall be used. For widening greater than 3.0 ft (1 m) and greater than 330 lb/syd (180 kg/m^2), twelve passes of rollers with a compaction wheel bearing of no less than 300 lb/in. (5.3 kg/mm) shall be used.

Except for surface mixtures, the course flush with the top of the existing surface shall be compacted with equipment entirely on the widening.

A MAF in accordance with 401.05 or 402.05 will not apply. HMA mixtures will be accepted in accordance with 402.09.

304.06 Method of Measurement

Widening and patching will be measured by the ton (megagram) of the type of HMA specified, in accordance with 109.01(b). Compacted aggregates for base will be measured by the ton (megagram) in accordance with 109.01(b).

304.07 Basis of Payment

The accepted quantities for widening and patching will be paid for at the contract unit price per ton (megagram), of the type of HMA specified, complete in place. Compacted aggregates for base will be paid for in accordance with 301.10.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
HMA Patching, Type __*__	TON (Mg)
Widening with HMA, Type __*__	TON (Mg)

* Mixture type in accordance with 402.04

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.

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

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

Construction of new PCC bases shall be in accordance with 502, except for 502.14 and 502.20. The surface shall be finished with wet burlap or by wood floats. Smoothness of the base will be controlled with a 16 ft (4.9 m) long straightedge longitudinally and a 10 ft (3 m) 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;

(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

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 306.07.

(c) Retrofit Load Transfer

Retrofit load transfer shall be in accordance with 507.08.

(d) Rubblizing Existing PCCP

The existing pavement shall be rubblized with a self-contained, self-propelled, resonant frequency pavement breaking unit capable of producing low amplitude, 2000 lbf (8900 N) blows at a rate of not less than 44 per s 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.

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. (150 mm) in the largest dimension, the majority being a nominal 1 to 2 in. (25 to 50 mm) in size. The concrete from the surface to the top of the reinforcement shall be reduced to the 1 to 2 in. (25 to 50 mm) 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.

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. (150 mm) 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.

The vibratory roller shall be operated in the vibration mode at a speed not to exceed 6 ft (1.8 m) per s. All depressions 1 in. (25 mm) 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.

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.

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.

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.

Materials and construction requirements shall be in accordance with the applicable requirements of 502, except the following.

(a) coarse aggregate shall be Class A or higher;

(b) joints shall be sawed in one pass and not sealed. Transverse joints constructed in the widening shall be aligned with existing transverse joints or cracks;

(c) tining is not required;

(d) shoulder corrugations are not required; and

(e) pavement smoothness shall be controlled by a 16 ft (4.9 m) straightedge.

When the widening is not open to traffic prior to placing an overlay, liquid membrane compounds shall not be used and an alternative curing option shall be used. AE-T in accordance with 406 may be used as a curing option.

305.06 Method of Measurement

Compacted aggregate will be measured by the ton (megagram) in accordance with 109.01(b) for the type specified. Retrofit load transfer will be measured in accordance with 507.09. Surface milling will be measured in accordance with 306.09. PCC base, PCC base patching, and widening with PCC base will be measured by the square yard (square meter) of the thickness specified. The area of PCC will be the planned width of the base, patching or widening multiplied by the measured length or as directed in writing. The planned width of the base, patching and widening will be as shown on the typical cross section of the plans.

Rubblized PCCP will be measured by the square yard (square meter) of rubblized pavement.

305.07 Basis of Payment

The accepted quantities of compacted aggregate will be paid for in accordance with 303.10, for the type specified, complete in place. Retrofit load transfer will be paid for in accordance with 507.10. Surface milling will be paid for in accordance with 306.10. PCC base, PCC base patching, and widening with PCC base will be paid for at the contract unit price by the square yard (square meter) of the thickness specified.

Rubblized PCCP will be paid for at the contract unit price per square yard (square meter) for rubblized pavement.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
PCC Base, _____ in. (mm) thickness	SYS (m2)
PCC Base Patching, _____ in. (mm) thickness	SYS (m2)
Rubblizing PCCP	SYS (m2)
Widening With PCC Base, _____ in. (mm) thickness	SYS (m2)

If PCC base is found to be deficient in thickness, price adjustments in accordance with 502.23 will be determined.

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.

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

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 vertical or near vertical face exceeding 1.5 in. (38 mm) 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. (75 mm) 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. (25 mm) that are exposed to traffic shall be transitioned in an approved manner.

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.

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. Sufficient cutting teeth shall be on the cutting drum to produce cuttings such that 90% of the conglomerate particles pass a 2 in. (50 mm) sieve.

(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

1. Straightedge – 16 ft (4.9 m)

A 16 ft (4.9 m) straightedge shall be a rigid beam mounted on two solid wheels on axles 16 ft (4.875 m) 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 (3 m)

A 10 ft (3 m) straightedge is the same as a 16 ft (4.9 m) straightedge except that the wheels are mounted 10 ft (3.048 m) apart. A handheld rigid beam may be substituted.

306.04 Asphalt Scarification and Profile Preparation

Asphalt scarification and profile preparation shall consist of preparing a base for resurfacing by removing existing asphalt material. The entire existing asphalt surface shall be roughened by the operations. The existing pavement shall be milled to the cross-slope as shown on the plans, and shall have a surface finish that does not vary longitudinally more than 1/4 in. (6 mm) from a 16 ft (4.9 m) straightedge or as described in the QCP in accordance with 401.02. The milled surface shall have macrotexture equal to or greater than 2.2 for single course overlays and 1.8 for multiple course overlays in accordance with ITM 812. 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. (3 mm) when measured with a 10 ft (3 m) straightedge.

Milled mainline areas left open to traffic for longer than 5 work days will be assessed $1600 per day per lane mile ($1000.00 per day per lane kilometer), 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-mainline areas such as auxiliary lanes left open to traffic for longer than 10 work days will be assessed $800 per day per lane mile ($500.00 per day per lane kilometer), 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.

306.04.1 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. (6 mm) to accommodate the approach pavement. The approach milling shall be completed to provide a smooth transition from the mainline pavement to the termini of the approach. The existing approach pavement shall be cut to provide a vertical face of 1.5 in. (38 mm) for the termini of surface.

Mailbox approaches to be resurfaced shall be milled to maintain the mainline 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.

The transverse vertical cut face for commercial or public road approaches shall be transitioned at a rate of 24:1 or as approved.

306.05 Asphalt Milling

Asphalt milling shall consist of preparing a base for resurfacing by removing the existing asphalt material at a specified average depth. The existing pavement shall be milled to the cross-slope as shown on the plans, and shall have a surface finish that does not vary longitudinally more than 1/4 in. (6 mm) from a 16 ft (4.9 m) straightedge or as described in the QCP in accordance with 401.02. The milled surface shall have macrotexture equal to or greater than 2.2 for single course overlays and 1.8 for multiple course overlays in accordance with ITM 812. 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. (3 mm) when measured with a 10 ft (3 m) 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.

Milled mainline areas left open to traffic for longer than 5 work days will be assessed $1600 per day per lane mile ($1000.00 per day per lane kilometer), 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-mainline areas such as auxiliary lanes left open to traffic for longer than 10 work days will be assessed $800 per day per lane mile ($500.00 per day per lane kilometer), 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.

The transverse vertical cut face shall be transitioned by HMA, CMA or prefabricated materials at a rate of 24:1 or as approved.

306.06 Asphalt Removal

Asphalt removal shall consist of complete removal of asphalt 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 approved.

306.07 PCCP Milling

PCCP milling shall consist of preparing a base for resurfacing by removing the existing PCCP material at a specified average depth. The existing pavement shall be milled to the cross-slope as specified in the plans, and shall have a surface finish that does not vary longitudinally more than 1/4 in. (6 mm) from a 16 ft (4.9 m) straightedge or as described in the QCP in accordance with 401.02. The milled surface shall have macrotexture equal to or greater than 1.8 in accordance with ITM 812. 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. (3 mm) when measured with a 10 ft (3 m) straightedge or as directed by the Engineer.

A milled surface shall not be left open to traffic for longer than 14 calendar days. If the milled surface is not overlaid after 14 calendar days, $1600 per day per lane mile (1000.00 per day per lane kilometer), or portion thereof, will be assessed as liquidated damages, not as a penalty, but as damages sustained for each calendar day that the milled area remains left open to traffic.

Milled non-mainline areas such as auxiliary lanes left open to traffic for longer than 10 work days will be assessed $100 per day per transition as liquidated damages, not as a penalty, but as damages sustained for each work day that the milled area remains open to traffic.

The transverse vertical cut face shall be transitioned by HMA, CMA or prefabricated materials at a rate of 24:1 or as approved.

306.08 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 vertical face of 1.5 in. (38 mm) for the termini of each overlay lift of base, intermediate, or 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 approved.

Automatic control devices will not be required on surface milling equipment used for transitions cut off the mainline. Cutting shall not damage any pavement that is to remain in place.

306.09 Method of Measurement

Approach milling, asphalt milling, asphalt removal, PCCP milling, scarification/profile milling, and transition milling will be measured by the square yard (square meter) of the milled area.

306.10 Basis of Payment

Approach milling, asphalt milling, asphalt removal, PCCP milling, scarification and profile milling, and transition milling will be paid for at the contract unit price per square yard (square meter).

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Milling, Approach	SYS (m2)
Milling, Asphalt, _____ in. (mm) thickness	SYS (m2)
Milling, Asphalt Removal	SYS (m2)
Milling, PCCP	SYS (m2)
Milling, Scarification/Profile	SYS (m2)
Milling, Transition	SYS (m2)

The cost for castings removed and replaced at the Contractor's option in accordance with 306.02 shall be included in the cost of the milling.

Any portion of the pavement that is damaged or removed outside the milling limits shall be replaced with no additional payment.

The cost of tapering of vertical faces and removal of milled material from the project site shall be included in the cost of milling.

The cost of cutting of the surface course shall be included in the milling.

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SECTION 400 – ASPHALT PAVEMENTS

SECTION 401 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HOT MIX ASPHALT, 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

The HMA shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Volumetric 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.

MATERIALS

401.03 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

Fibers.....AASHTO MP 8

Fine Aggregates 904

*Surface aggregate requirements are listed in 904.03(d).

401.04 Design Mix Formula

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 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, and a Mixture Adjustment Factor (MAF). The DMF shall state the source, type, and dosage rate of any stabilizing additives. Approval of the DMF will be based on the ESAL and mixture designation. A mixture number will be assigned by the Engineer. No mixture will be accepted until the DMF has been approved.

The ESAL category identified in the pay item correlates to the following ESAL ranges.

ESAL CATEGORY	ESAL
1	< 300,000
2	300,000 to < 3,000,000
3	3,000,000 to < 10,000,000
4	10,000,000 to < 30,000,000
5	≥ 30,000,000

401.05 Volumetric Mix Design

The DMF shall be determined for each mixture from a volumetric mix design by a design laboratory selected from the Department's list of approved Mix Design Laboratories. A volumetric mixture shall be designed in accordance with the respective AASHTO and ASTM references as listed below.

Standard Specification for Superpave Volumetric Mix Design ..... AASHTO M 323

Standard Specification for Designing Stone Matrix Asphalt (SMA) ..... AASHTO MP 8

Standard Practice for Mixture Conditioning of Hot Mix Asphalt (HMA) ..... AASHTO R 30

Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA) ..... AASHTO PP 28

Maximum Specific Gravity and Density of Bituminous Paving Mixtures ..... AASHTO T 209

Resistance of Compacted Asphalt Mixture to Moisture Induced Damage ..... AASHTO T 283

Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor ..... AASHTO T 312

Bulk Specific Gravity of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing ..... ASTM D 6752

The single percentage of aggregate passing each required sieve shall be within the limits of the following gradation tables.

	Dense Graded, Mixture Designation – Control Point (Percent Passing)				
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm
Sieve Size					
50.0 mm					
37.5 mm	100.0				
25.0 mm	90.0 - 100.0	100.0			
19.0 mm	< 90.0	90.0 - 100.0	100.0		
12.5 mm		< 90.0	90.0 - 100.0	100.0	100.0
9.5 mm			< 90.0	90.0 - 100.0	95.0 -100.0
4.75 mm				< 90.0	90.0 - 100.0
2.36 mm	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0	
1.18 mm					30.0 - 60.0
600 µm					
300 µm					
75 µm	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	6.0 - 12.0

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
Primary Control Sieve	4.75 mm	4.75 mm	2.36 mm	2.36 mm	NA
PCS Control Point	40	47	39	47	NA

Open Graded, Mixture Designation – Control Point (Percent Passing)		
	OG19.0	OG25.0
Sieve Size		
37.5 mm		100.0
25.0 mm	100.0	70.0 – 98.0
19.0 mm	70.0 – 98.0	50.0 – 85.0
12.5 mm	40.0 – 68.0	28.0 – 62.0
9.5 mm	20.0 – 52.0	15.0 – 50.0
4.75 mm	10.0 – 30.0	6.0 – 30.0
2.36 mm	15.0 ± 8.0	15.0 ± 8.0
1.18 mm	2.0 – 18.0	2.0 – 18.0
600 µm	1.0 – 13.0	1.0 – 13.0
300 µm	0.0 – 10.0	0.0 – 10.0
150 µm	0.0 – 9.0	0.0 – 9.0
75 µm	0.0 – 8.0	0.0 – 8.0
Percent of Binder	> 3.0	> 3.0

Dust/Calculated Effective Binder Ratio shall be taken from 0.6 to 1.2, when the aggregate gradation passes above the primary control sieve (PCS) control point and 0.8 to 1.6 when the aggregate gradation is less than or equal to the PCS. The Dust/Calculated Effective Binder Ratio for 4.75 mm mixtures shall be 0.9 to 2.0.

90 The optimum binder content for dense graded mixtures shall produce 4.0% air voids at N_{des} and for open graded mixtures shall produce 15.0% – 20.0% air voids at N_{des}. 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 of the uncompressed mixture shall be determined in accordance with AASHTO T 209.

The percent draindown of open graded mixtures shall not exceed 0.30% in accordance with AASHTO T 305. Open graded mixtures may incorporate fibers.

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 2 h in accordance with AASHTO R 30. The minimum tensile strength ratio, TSR, shall be 80%. The 6 in. (150 mm) 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.

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 $0.980 \leq MAF \leq 1.020$, then the MAF shall be considered to be 1.000. If the calculated MAF is outside of the above range, then the actual calculated value shall be used. The MAF does not apply to OG mixtures.

Changes in the source or types of aggregates shall require a new DMF. A new DMF shall be submitted to the District Materials and Tests Engineer for approval one week prior to use.

Changes in the source of specified binders, except for PG 58-28 or PG 64-22, shall require a new DMF. Changes in the grade of a specified binder shall require a new DMF.

The mixture design compaction temperature for the specimens shall be 300 ± 9°F (150 ± 5°C) for dense graded mixtures and 260°F (125°C) for open graded mixtures.

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					
< 300,000	6	50	75	91.5	98.0
300,000 to < 3,000,000	7	75	115	90.5	98.0
3,000,000 to < 10,000,000	8	100	160	89.0	98.0
10,000,000 to < 30,000,000	8	100	160	89.0	98.0
≥ 30,000,000	9	125	205	89.0	98.0
OPEN GRADED					
ALL ESAL	NA	20	NA	NA	NA

* N_{ini} , N_{des} , N_{max} , - definitions are included in AASHTO PP 28

VOIDS IN MINERAL AGGREGATE (VMA) CRITERIA @ N_{des}	
Mixture Designation	Minimum VMA, Percent
4.75 mm	16.0
9.5 mm	15.0
12.5 mm	14.0
19.0 mm	13.0
25.0 mm	12.0
OG19.0 mm	NA
OG25.0 mm	NA

VOIDS FILLED WITH ASPHALT (VFA) CRITERIA @ N_{des}	
ESAL	VFA, Percent
< 300,000	70 – 80
300,000 to < 3,000,000	65 – 78
3,000,000 to < 10,000,000	65 – 75
10,000,000 to < 30,000,000	65 – 75
≥ 30,000,000	65 – 75

Note 1: For 9.5 mm mixtures, the specified VFA range shall be 73% to 76% for design traffic levels ≥ 3 million ESALs.

Note 2: For 25.0 mm mixtures, the specified lower limit of the VFA shall be 67% for design traffic levels < 0.3 million ESALs.

Note 3: For 4.75 mm mixtures, the specified VFA range shall be 75% to 78% for design traffic levels ≥ 3 million ESALs.

Note 4: For OG19.0 mm and OG25.0 mm mixtures, VFA is not applicable.

401.06 Recycled Materials

Recycled materials may consist of reclaimed asphalt pavement, RAP, or asphalt roofing shingles, ARS, or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve when entering the HMA plant. ARS shall consist of waste from a shingle manufacturing facility. No tear-off materials from roofs will be allowed. ARS shall be stockpiled separately from other materials. The coarse aggregate in the recycled materials shall pass the maximum size sieve for the mixture being produced.

Recycled materials may be used as a substitute for a portion of the new materials required to produce HMA mixtures. When only RAP is used in the mixture, the RAP shall not exceed 25.0% by weight (mass) of the total mixture. When only ARS is used in the mixture, the ARS shall not exceed 5.0% by weight (mass) of the total mixture. For substitution or use, 1.0% of ARS is considered equal to 5.0% RAP. The percentages of recycled materials shall be as specified on the DMF.

Recycled materials shall not be used in ESAL Category 3, 4, or 5 surface mixtures or open graded mixtures.

The combined aggregate properties of a mixture with recycled materials shall be determined in accordance with ITM 584 and shall be in accordance with 904. Gradations of the combined aggregates shall be in accordance with 401.05.

Mixtures containing 15.0% or less RAP shall use the same grade of binder as specified. The binder for mixtures containing greater than 15.0% and up to 25.0% RAP shall be reduced by one temperature classification, 6°C, for both the upper and lower temperature classifications.

401.07 Lots and Sublots

Lots will be defined as 4000 t (4000 Mg) of base or intermediate mixtures or 2400 t (2400 Mg) of surface mixture. Lots will be further sub-divided into sublots not to exceed 1000 t (1000 Mg) of base or intermediate mixtures or 600 t (600 Mg) of surface mixture. Partial sublots or 100 t (100 Mg) or less will be added to the previous sublot. Partial sublots greater than 100 t (100 Mg) constitute a full sublot.

401.08 Job Mix Formula

A job mix formula, JMF, shall be developed by a certified HMA producer. A JMF used in the current or previous calendar year that was developed to N_{des} will be allowed. The mixture compaction temperature shall be 300 ± 9°F (150 ± 5°C) for dense graded mixtures and 260 ± 9°F (125 ± 5°C) for open graded mixtures. The JMF for each mixture shall be submitted to the Engineer and shall use the same MAF as the DMF.

401.09 Acceptance of Mixtures

Acceptance of mixtures for binder content, VMA at N_{des}, and air voids at N_{des} for each lot will be based on tests performed by the Engineer. Acceptance testing for surface mixtures will include tests for moisture content. The Engineer will randomly select the location(s) within each sublot for sampling in accordance with ITM 802. An acceptance sample will consist of two plate samples with the first being at the random location and the second 2 ft (0.6 m) ahead station. A backup sample consisting of two plate samples shall be located 2 ft (0.6 m) towards the center of the mat from the acceptance sample. For surface mixtures, an additional sample shall be located 2 ft (0.6 m) back station from the random sample location.

Samples from each location shall be obtained from each sublot from the pavement in accordance with ITM 580.

The binder content will be determined in accordance with ITM 586 or ITM 571 as directed by the Engineer. The maximum specific gravity will be determined in accordance with AASHTO T 209. The air voids will be determined in accordance with AASHTO PP 28 based on the average bulk specific gravity from two gyratory specimens and the MSG for the sublot. The VMA will be determined in accordance with AASHTO PP 28 based on the average bulk specific gravity from two gyratory specimens, the percent aggregate in the mixture from the sublot and the BSG of the aggregate blend from the DMF/JMF as applicable. The gyratory pills will be prepared in accordance with AASHTO T 312.

The bulk specific gravity of gyratory specimens for dense graded mixtures will be determined in accordance with AASHTO T 166 except samples are not required to be dried overnight. The bulk specific gravity of gyratory specimens for open graded mixtures, OG19.0, OG25.0 will be determined in accordance with ASTM D 6752, except as follows. The duration of the test from initiating the vacuum extraction to weighing the specimen after the water bath will not exceed five minutes. The mass of water absorbed

by the specimen while in the water bath will be subtracted from the mass of the specimen obtained in the water bath. Any test in which the mass of water absorbed by the specimen exceeds 5 g is invalid.

The mixture properties for each sublot shall meet the requirements for the tolerances from the JMF as shown in the table as follows.

ACCEPTANCE TOLERANCES	
MIXTURE PROPERTIES	TOLERANCES FROM THE JMF
DENSE GRADED	
Air Voids	JMF ± 1.0%
Binder Content	JMF ± 0.5%
VMA	JMF ±1.0%
OPEN GRADED	
Air Voids*	JMF ± 3.0%
Binder Content	JMF ± 0.5%

* Gmb will be determined in accordance with ASTM D 6752

The maximum percent of moisture in the mixture shall not exceed 0.10 from plate samples.

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%.

The Engineer's acceptance test results for each sublot will be available after the sublot and testing are complete.

Air voids, binder content and VMA values will be reported to the nearest 0.1%. Moisture and draindown test results will be rounded to the nearest 0.01%. Rounding will be in accordance with 109.01(a).

Pay factors will be determined in accordance with 401.19(a).

The Contractor may request an appeal of the Engineer's test results in accordance with 401.20.

Fibers incorporated into the mixture will be accepted on the basis of a type A certification for the specified material properties for each shipment of fibers. Fibers from different manufacturers and different types of fibers shall not be intermixed.

In the event that an acceptance sample is not available to represent a sublot(s), all test results of the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

CONSTRUCTION REQUIRMENTS

401.10 General

Equipment for HMA operations shall be in accordance with 409. The Contractor shall submit to the Engineer a written Certificate of Compliance that includes the manufacturer's make, model, serial number, manufactured year, and the manufacturer's literature with pictures. The Certificate of Compliance shall be submitted prior to use and shall certify that the paving equipment proposed for the project is new and includes the modifications or have been modified in accordance with the following.

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:

1. Blaw-Knox HMA pavers shall be equipped with the Blaw-Knox Materials Management Kit, MMK.

2. Cedarrapids 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}".

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 accomplished on the pavement or shoulder areas.

Segregation or flushing or bleeding of HMA mixtures will not be permitted. Corrective action shall be taken to prevent continuation of these conditions. Segregated or flushed or bleeding HMA mixtures shall be removed if directed. All areas showing an excess or deficiency of binder shall be removed and replaced.

All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

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.

Compacted aggregate bases and rubblized 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.

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/syd (75 kg/m^2) shall be placed when the ambient temperature and the temperature of the surface on which it is to be placed is 45°F (7°C) 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 or JMF 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 not be more than 18°F (10°C) below the minimum mixing temperature as shown on the JMF for mixtures compacted in accordance with 402.15.

Planned HMA courses greater than 165 lb/syd (90 kg/m^2) 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 165 lb/syd (90 kg/m^2) 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 permitted 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 vary. Hydraulic extensions may be used in tapers and added lanes less than 250 ft (75 m) in length.

Automatic slope and grade controls shall be used as outlined in the QCP.

HMA mainline and HMA shoulders which are 8.0 ft (2.4 m) or more in width shall be placed with paving equipment in accordance with 409.03(c)1.

When laying mixtures with density not controlled by cores, the speed of the paver shall not exceed 50 ft (15 m) per min. Rollers shall be operated to avoid shoving of the HMA and at speeds not to exceed 3 mph (4.5 km/h). However, vibratory rollers will be limited to 2.5 mph (4 km/h).

The finished thickness of any course shall be at least two times but not more than four times the maximum particle size as shown on the DMF.

401.15 Joints

Longitudinal joints in the surface shall be at the lanelines of the pavement. Longitudinal joints below the surface shall be offset from previously constructed joints by approximately 6 in. (150 mm), and be located within 12 in. (300 mm) of the lane line.

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.

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/syd (210 kg/m^2); or

(b) the first lift of material placed at less than 385 lb/syd (210 kg/m^2) over a shoulder existing prior to the contract award.

Density of any random core location(s) in these areas will be assigned a value of 92.0 %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% of MSG. Vibratory rollers shall not be used on open graded mixtures.

Density acceptance by cores will be based on samples obtained from two random locations selected by the Engineer within each sublot 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. (75 mm) from a confined edge or 6 in. (150 mm) 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 in. (150 mm) diameter pavement sample. Coring shall be completed prior to the random location being covered by the next course. Surface courses shall be cored within two work days of placement. Damaged core(s) shall be discarded and replaced with a core from a location selected by adding 1.0 ft (0.3 m) 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.

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 1.0 ft (0.3 m) from the random location using the same transverse offset.

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 sublot, times 100. The Engineer will determine the BSG of the cores in accordance with AASHTO T 166. The maximum specific gravity will be determined in accordance with AASHTO T 209 from samples prepared in accordance with ITM 572. The target value for density of dense graded mixtures of each sublot shall be 92.0%.

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 test results for each sublot shall meet the requirements for the tolerances as shown in the table below.

DENSE GRADED ACCEPTANCE TOLERANCE	
Core Density	94.0 ± 2.0 %MSG

Pay factors will be determined in accordance with 401.19(b).

The Engineer's acceptance test results for each sublot will be available when the sublot testing is complete. Acceptance of the pavement for density (%MSG) will be reported to the nearest 0.1%. Rounding will be in accordance with 109.01(a).

401.17 Shoulder Corrugations

Shoulder corrugations shall be in accordance with 606.

401.18 Pavement Smoothness

The pavement smoothness will be accepted by means of a profilograph, a 16 ft (4.9 m) long straightedge, or a 10 ft (3 m) long straightedge.

The profilograph shall be used where all of the following conditions are met:

(a) the design speed is greater than 45 mph (70 km/h)

(b) the pavement lanes are full width and 0.1 mi (0.16 km) or longer, and

(c) the HMA is placed on a milled surface or the total combined planned lay rate of surface, intermediate, and base is 385 lb/syd (210 kg/m^2) or greater.

If a pay item, Profilograph, HMA, is included in the contract and the above conditions are met, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 912. The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor. When a profilograph, HMA, is not included as a pay item, and the above conditions are met, the Department will furnish, calibrate, and operate the profilograph or the Department will develop a change order in accordance with 109.05 to include profilograph, HMA as a pay item.

Within the limits of a smoothness section where the posted speed is 40 mph (65 km/h) or less, smoothness of that section may be measured by a profilograph or a 16 ft (4.9 m) long straightedge. The Contractor shall notify the Engineer of the selected process prior to placement of the HMA. Smoothness pay adjustments are only applicable when measured by a profilograph.

The 16 ft (4.9 m) long straightedge shall be used on overlays where the profilograph is not specified. The 16 ft (4.9 m) long straightedge shall be used on all full width pavement lanes shorter than 0.1 mi (0.16 km), on tapers, within 50 ft (15 m) of a reinforced concrete bridge approach, and within 50 ft (15 m) of an existing pavement, which is being joined.

The 10 ft (3 m) long straightedge shall be used for transverse slopes, approaches, and crossovers.

All wavelike irregularities and abrupt changes in profile caused by paving operations shall be corrected.

Each finished course of base and intermediate shall be subject to approval. The pavement smoothness shall be checked on any new intermediate course located immediately below a surface course and the surface course at the locations as designated in ITM 912.

If grinding of the 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.

When the 16 ft (4.9 m) straightedge is used on a surface course, the pavement variations shall be corrected to 1/4 in. (6 mm) or less. When the 10 ft (3 m) straightedge is used, the pavement variations shall be corrected to 1/8 in. (3 mm) or less.

When the profilograph is being used on a surface course, in addition to the requirements for the profile index, all areas having a high or low point deviation in excess of 0.3 in. (8 mm) shall be corrected. Courses underlying the surface courses that are exposed by corrective actions shall be milled to 1 1/2 in. (38 mm) and replaced with the same type surface materials. The initial profile index shall be determined prior to any corrective action. The final profile index will be determined after all corrective action has been completed.

When the profilograph is being used on an intermediate course, all areas having a high or low point deviation in excess of 0.3 in. (8 mm) shall be corrected. When the 16 ft (4.9 mm) or 10 ft (3 m) straightedge is being used on an intermediate course, all areas having a high or low point deviation in excess of 1/4 in. (6 mm) shall be corrected.

401.19 Pay Factors

A composite pay factor for each sublot based on test results for mixture properties and density is determined in a weighted formula as follows:

$$SCPF = 0.20(PF_{BINDER}) + 0.35(PF_{VOIDS}) + 0.10(PF_{VMA}) + 0.35(PF_{DENSITY})$$

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_{VMA}	=	Sublot Pay Factor for VMA at N_{des}
$PF_{DENSITY}$	=	Sublot Pay Factor for Density

If the SCPF for a sublot is less than 0.85, the Materials and Tests Division will evaluate the pavement. If the Contractor is not required to remove the mixture, quality assurance adjustments of the lot will be assessed or other corrective actions taken as determined by the Materials and Tests Division.

The sublot quality assurance adjustment for mixture properties and density is calculated as follows.

$$q = L \times U \times (SCPF - 1.00)/MAF$$

where:

q	=	quality assurance adjustment for the sublot
L	=	sublot quantity
U	=	unit price for the material \$/TON (\$/Mg)
SCPF	=	sublot composite pay factor

(a) Mixture

Sublot test results for mixture properties will be assigned pay factors in accordance with the following.

BINDER CONTENT		
DENSE GRADED	OPEN GRADED	PAY FACTOR
Deviation from JMF (± %)	Deviation from JMF (± %)	Pay Factor
≤ 0.2	≤ 0.2	1.05
0.3	0.3	1.04
0.4	0.4	1.02
0.5	0.5	1.00
0.6	0.6	0.90
0.7	0.7	0.80
0.8	0.8	0.60
0.9	0.9	0.30
1.0	1.0	0.00
> 1.0	> 1.0	Submitted to the Materials and Tests Division*

* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

530

VMA		
DENSE GRADED	OPEN GRADED	PAY FACTOR
Deviation from JMF (± %)	Deviation from JMF (± %)	Pay Factor
≤ 0.5		1.05
> 0.5 and ≤ 1.0	All	1.00
> 1.0 and ≤ 1.5		0.90
>1.5 and ≤ 2.0		0.70
> 2.0 and ≤ 2.5		0.30
> 2.5		Submitted to the Materials and Tests Division*

* 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 JMF (± %)	Deviation from JMF (± %)	Pay Factor
≤ 0.5	≤ 1.0	1.05
> 0.5 and ≤ 1.0	> 1.0 and ≤ 3.0	1.00
1.1	3.1	0.98
1.2	3.2	0.96
1.3	3.3	0.94
1.4	3.4	0.92
1.5	3.5	0.90
1.6	3.6	0.84
1.7	3.7	0.78
1.8	3.8	0.72
1.9	3.9	0.66
2.0	4.0	0.60
> 2.0	> 4.0	Submitted to the Materials and Tests Division

* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

For mixtures produced during a plant's adjustment period, pay factors based on the JMF with the above tolerances will be used to compute quality assurance adjustments.

540 **(b) Density**

Sublot test results for density will be assigned pay factors in accordance with the following.

DENSITY		
Percentages are based on %MSG	Pay Factors – Percent	
Dense Graded	Open Graded	
≥ 97.0		Submitted to the Materials and Tests Division*
95.6 - 96.9		1.05 - 0.01 for each 0.1% above 95.5
94.0 - 95.5		1.05
93.1 - 93.9		1.00 + 0.005 for each 0.1% above 93.0
92.0 - 93.0	84.0	1.00
91.0 - 91.9		1.00 - 0.005 for each 0.1% below 92.0
90.0 - 90.9		0.95 - 0.010 for each 0.1% below 91.0
89.0 - 89.9		0.85 - 0.030 for each 0.1% below 90.0
≤ 88.9		Submitted to the Materials and Tests Division*

* 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 shall be rounded to the nearest 0.01.

(c) Smoothness

When the pavement smoothness is tested with a profilograph, payment will be based on a zero blanking band on the final profile index in accordance with the following table. A Quality Assurance Pay Factor, PFs, for smoothness will apply to the planned typical section including the aggregate base, and the HMA base, intermediate, and surface courses. The quality assurance adjustment for each section will include the total area of each pavement lane excluding shoulders for 0.1 mi (0.16 km) long section represented by the profile index calculated by 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, syd (m^2)
S = planned spread rate for material, lb/syd (kg/m^2)
T = conversion factor: 2000 lb/ton (1000 kg/Mg)
U = unit price for the material, \$/ton (\$/Mg)

The quality assurance adjustment for smoothness, Qs, for the contract will be the total of the quality assurance adjustments for smoothness, qs, on each section by the following formula.

$$Q_s = \sum q_s$$

ADJUSTMENT FOR SMOOTHNESS ($PI_{0.0}$) ZERO BLANKING BAND	
Design Speed Greater Than 45 mph (70 km/hr)	
Profile Index in./0.1 mi. (mm per 0.16 km)	Pay Factor
Over 0.00 to 0.80 in. (Over 0 to 20 mm)	1.06
Over 0.80 to 1.00 in. (Over 20 to 25 mm)	1.05
Over 1.00 to 1.20 in. (Over 25 to 30 mm)	1.04
Over 1.20 to 1.40 in. (Over 30 to 35 mm)	1.03
Over 1.40 to 1.60 in. (Over 35 to 40 mm)	1.02
Over 1.60 to 2.00 in. (Over 40 to 50 mm)	1.01
Over 2.00 to 2.40 in. (Over 50 to 60 mm)	1.00
Over 2.40 to 2.60 in. (Over 60 to 65 mm)	0.96
Over 2.60 to 2.80 in. (Over 65 to 70 mm)	0.92
All pavement with a profile index ($PI_{0.0}$) greater than 2.80 in. (70 mm) shall be corrected.	

Quality assurance pay factors greater than 1.00 will be applicable only to the initial measured profile index, prior to any corrective work. Quality assurance pay factors of 1.00 or less will be applied to pavement sections where corrective work has been completed.

The total quality assurance adjustments is to be calculated as follows:

$$Q = Q_s + (\sum q)$$

where

Q = total quality assurance adjustment
Q_s = quality assurance adjustment for smoothness
q = sublot quality assurance adjustment

401.20 Appeals

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. The appeal sample will be analyzed in a lab different than the lab that analyzed the original sample when requested by the Contractor. Additional testing may be requested for one or more of the

following tests: MSG, BSG of the gyratory specimens, binder content, or BSG of the density cores. The request for the appeal for MSG, BSG of gyratory specimens, binder content or BSG of the density cores shall be submitted within seven calendar days of receipt of the Department's written results for that sublot. The sublot and specific test(s) shall be specified at the time of the appeal request. Only one appeal request per sublot is permitted. Upon approval of the appeal, the Engineer will perform additional testing as follows.

The backup or new sample(s) will be tested in accordance with the applicable test method for the test requested.

(a) MSG

The backup MSG sample will be dried in accordance with ITM 572 and tested in accordance with AASHTO T 209, Section 9.5.1.

(b) BSG of the Gyratory Specimen

New gyratory specimens will be prepared and tested in accordance with AASHTO T 312 from the backup sample.

(c) Binder Content

The backup binder content sample will be prepared and tested in accordance with the test method that was used for acceptance.

(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 1.0 ft (0.3 m) longitudinally of the cores tested using the same transverse offset. The appeal density cores will be tested in accordance with AASHTO T 166.

The appeal results will replace all previous test result(s) 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 (megagram) of the type specified, in accordance with 109.01(b). The measured quantity will be divided by the MAF to determine the pay quantity.

Milled shoulder corrugations will be measured in accordance with 606.02.

401.22 Basis of Payment

The accepted quantities for this work will be paid for at the contract unit price per ton (megagram) for QC/QA-HMA, of the type 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, HMA.

Adjustments to the contract payment with respect to mixture, density, and smoothness for mixture produced will be included in a quality assurance adjustment pay item in accordance with 109.05.1.

Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Profilograph, HMA	LS
QC/QA-HMA, _____, _____, _____, _____mm (ESAL[1])(PG[2])(Course[3])(Mix[4])	TON (Mg)

(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

Preparation of surfaces to be overlaid shall be included in the cost of other pay items.

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.

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.

If QC/QA-HMA intermediate over QC/QA-HMA base mixtures are specified, QC/QA-HMA intermediate mixture may be permitted as a substitute for the QC/QA-HMA intermediate and QC/QA-HMA base 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 intermediate mixture. The quantity and amount for QC/QA-HMA intermediate mixture shall equal the sum of the contract quantities and amounts shown for QC/QA-HMA intermediate and QC/QA-HMA base mixtures. The unit price for QC/QA-HMA intermediate mixture shall be equal to the sum of contract amounts divided by the sum of contract quantities. Payment for the QC/QA-HMA intermediate mixture will be made at the unit price per ton (megagram) for QC/QA-HMA intermediate mixture. No payment will be made for additional work or costs which may result due to this change.

SECTION 402 – HOT MIX ASPHALT, HMA, PAVEMENT

402.01 Description

This work shall consist of one or more courses of HMA base, intermediate, or surface mixtures, and miscellaneous courses for rumble strips, and wedge and leveling constructed on prepared foundations in accordance with 105.03.

402.02 Quality Control

The HMA shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Volumetric 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.

MATERIALS

402.03 Materials

Materials shall be in accordance with the following:

Asphalt Materials
PG Binder, PG 58-28*, PG 64-22,
PG 64-28*, PG 70-22, PG 76-22 .....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

* Only for use in mixtures containing greater than 15% RAP. Refer to 402.05.
** Surface aggregate requirements are listed in 904.03(d).

402.04 Design Mix Formula

A DMF shall be prepared in accordance with 402.05 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 calibration factor and test temperature to be used for the determination of binder content using ITM 586 or ITM 571, and a MAF. Approval of the DMF will be based on the ESAL and mixture designation as follows.

Mixture Type	Type A	Type B	Type C	Type D
Design ESAL	200,000	2,000,000	9,000,000	11,000,000
Surface	9.5 mm	9.5 mm	9.5 mm	9.5 mm
Surface – PG Binder	64-22	64-22	70-22	70-22
Intermediate	19.0 mm	19.0 mm	19.0 mm	19.0 mm
Intermediate – PG Binder	64-22	64-22	64-22	70-22
Base	25.0 mm	25.0 mm	25.0 mm	25.0 mm
Base – PG Binder	64-22	64-22	64-22	64-22

The Engineer will assign a mixture number. No mixture will be accepted until the DMF has been approved.

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 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 $0.980 \leq MAF \leq 1.020$, then the MAF shall be considered to be 1.000. If the calculated MAF is outside of the above range, then the actual calculated value shall be used.

402.06 Job Mix Formula

The job mix formula, JMF, shall be an approved JMF in accordance with 401.08 of the same gyratory compaction effort ESAL category or higher, and submitted in a format acceptable to the Engineer and shall use the same MAF as the DMF. The JMF shall state the maximum particle size in the mixture and the calibration factor and test temperature to be used for the determination of binder content using the ignition oven. Approval of the JMF will be based on the ESAL and mixture designation. No mixture will be accepted until the JMF has been approved.

All changes in the type or source of aggregate shall require the submittal of a new DMF for approval.

For mixtures containing 0.0% to 15.0% RAP, changes in the source and grade of specified binders will be permitted; however, the high temperature grade shall meet the minimum requirements of 402.04.

402.07 Mix Criteria

(a) Composition Limits for HMA Rumble Strip Mixtures

Rumble strip mixtures shall be type A 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

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 type B in accordance with 402.04. A MAF in accordance with 402.05 will not apply.

(d) Composition Limits for HMA Curbing Mixes

The mixture shall be HMA surface type A 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 Sieves
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 calibration factor and test temperature to be used for the determination of binder content using ITM 586 or ITM 571.

402.08 Recycled Materials

Recycled materials may consist of reclaimed asphalt pavement, RAP, or asphalt roofing shingles, ARS, or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve when entering the HMA plant. ARS shall consist of waste from a shingle manufacturing facility. No tear-off materials from roofs will be allowed. ARS shall be stockpiled separately from other materials. The coarse aggregate in the recycled materials shall pass the maximum size sieve for the mixture being produced.

Recycled materials may be used as a substitute for a portion of the new materials required to produce HMA mixtures. When only RAP is used in the mixture, the RAP shall not exceed 25.0% by weight (mass) of the total mixture. When only ARS is used in the mixture, the ARS shall not exceed 5.0% by weight (mass) of the total mixture. For substitution or use, 1.0% of ARS is considered equal to 5.0% RAP. The percentages of recycled materials shall be as specified on the JMF.

Recycled materials may be used in all mixtures except type C and type D surface mixtures.

The combined aggregate properties of a mixture with recycled materials shall be determined in accordance with ITM 584 and shall be in accordance with 904. Gradations of the combined aggregates shall be in accordance with 402.03.

The binder low temperature classification for mixtures containing greater than 15.0% and up to 25.0% RAP shall be -28°C, and the binder high temperature classification may be reduced by 6°C.

402.09 Acceptance of Mixtures

Acceptance of mixtures will be in accordance with the Frequency Manual on the basis of a type D certification in accordance with 916. 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 ±1.5% and binder content tolerance shall be ±0.7% from DMF or JMF.

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

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 accomplished on the pavement or shoulder areas.

Segregation, flushing or bleeding of HMA mixtures will not be permitted. Corrective action shall be taken to prevent continuation of these conditions. Areas of 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 is in any way defective 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 permitted.

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.

Compacted aggregate bases and rubblized bases 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

HMA courses less than 110 lb/syd (60 kg/m^2) are to be placed when the ambient and surface temperatures are 60°F (16°C) or above. HMA courses equal to or greater than 110 lb/syd (60 kg/m^2) but less than 220 lb/syd (120 kg/m^2) are to be placed when the

ambient and surface temperatures are 45°F (7°C) or above. HMA courses equal to or greater than 220 lb/syd (120 kg/m^2) and HMA curbing are to be placed when the ambient and surface temperatures are 32°F (0°C) 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.

All partially completed sections of roadway that are 8 in. (200 mm) or less in thickness shall be proofrolled prior to the placement of additional materials the following spring. Proofrolling shall be accomplished in accordance with 203.26. The contact pressure shall be 70 to 80 psi (480 to 550 kPa). 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 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. Mixtures in areas inaccessible to laydown equipment or mechanical devices may be placed by other methods.

The temperature of each mixture at the time of spreading shall not be more than 18°F (10°C) below the minimum mixing temperature as shown on the DMF or JMF.

Planned HMA courses greater than 165 lb/syd (90 kg/m^2) 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 165 lb/syd (90 kg/m^2) 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 permitted 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 (75 m) in length.

HMA shoulders which are 8.0 ft (2.4 m) 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 (7°C).

The speed of the paver shall not exceed 50 ft (15 m) per min when spreading mixtures.

Automatic slope and grade controls shall be required except when placing mixtures on roadway approaches which are less than 200 ft (60 m) 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 four times the maximum particle size as shown on the DMF or JMF. The finished thickness of wedge and level mixtures shall be at least 1.5 times but not more than six times the maximum particle size as shown on the DMF or JMF. Feathering may be less than the minimum thickness requirements.

Rumble strips shall be placed to ensure uniformity of depth, 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.

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. (150 mm), and be located within 12 in. (300 mm) 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/syd (240 kg/m^2)				Courses > 440 lb/syd (240 kg/m^2)	
	Option 1	Option 2	Option 3	Option 4	Option 1	Option 2
Three Wheel	2		4		4	
Pneumatic Tire	2	4			4	
Tandem	2	2	2		4	
Vibratory Roller				6		8

A reduced number of applications on a course may be approved if detrimental results are being observed.

Compaction equipment shall be operated with the drive roll or wheels nearest the paver and at speeds not to exceed 3 mph (4.5 km/h). However, vibratory rollers will be

limited to 2.5 mph (4 km/h). 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. (150 mm).

Longitudinal joints shall be compacted in accordance with the following:

(a) For confined edges, the first pass adjacent to the confined edge, the compaction equipment shall be entirely on the hot mat 6 in. (150 mm) from the confined edge.

(b) For unconfined edges, the compaction equipment shall extend 6 in. (150 mm) beyond the edge of the hot mat.

All displacement of the HMA mixture shall be corrected at once by the use of lutes and/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.

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)6 to achieve the required compaction. A trench roller, in accordance with 409.03(d)5, 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.

Vehicular traffic will not be permitted on a course until the mixture has cooled sufficiently to prevent distortions.

Rumble strips shall be compacted with vibratory compacting equipment in accordance with 409.03(d)6 unless otherwise stated.

402.16 Low Temperature Compaction Requirements

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 no closer than 3 in. (75 mm) from a confined edge or 6 in. (150 mm) from a non-confined edge of the course being placed.

For compaction of HMA during low temperature periods with quantities less than 100 t (100 Mg) per day, acceptance may be visual.

The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 6 in. (150 mm) 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 1.0 ft (0.3 m) 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.

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 1.0 ft (0.3 m) from the random location using the same transverse offset.

The density for the mixture shall be expressed as:

Density = 100 x BSG/MSG

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. The maximum specific gravity will be determined in accordance with AASHTO T 209. Density shall not be less than 92.0%.

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.

402.17 Shoulder Corrugations

Shoulder 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

HMA mixtures will be measured by the ton (megagram) 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 (meter) of each transverse strip, complete in place.

Milled shoulder corrugations will be measured in accordance with 606.02.

402.20 Basis of Payment

The accepted quantities for this work will be paid for at the contract unit price per ton (megagram) for HMA, of the type specified complete in place.

HMA rumble strips will be paid for at the contract unit price per linear foot (meter), of each transverse strip complete in place.

Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
HMA Surface, Type __*__	TON (Mg)
HMA Intermediate, Type __*__	TON (Mg)
HMA Base, Type __*__	TON (Mg)
HMA Rumble Strips	LFT (m)
HMA for Temporary Pavement	TON (Mg)
HMA Wedge and Level, Type __*__	TON (Mg)

* Mixture type

Preparation of surfaces to be overlaid shall be included in the cost of other pay items in this section.

No payment will be made for additional anti-stripping additives.

The cost of removing and replacing soft yielding areas discovered by proofrolling 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.

If HMA intermediate over HMA base mixtures are specified, HMA intermediate may be permitted as a substitute for the HMA intermediate and HMA base 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 HMA intermediate. The quantity and amount for HMA intermediate shall equal the sum of the contract quantities and amounts shown for HMA intermediate and HMA base mixtures. The unit price for HMA intermediate shall be equal to the sum of contract amounts divided by the sum of contract quantities. Payment for the HMA intermediate will be made at the unit price per ton (megagram) for HMA intermediate. No payment will be made for additional work or cost which may result due to this change.

SECTION 403 – COLD MIX ASPHALT, 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

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)

Course Aggregates 904
- Base, Class D or Higher
- Intermediate, Class C or Higher
- Surface, Class B or Higher

Fine Aggregates 904

Acceptance of the mixture will be in accordance with the Frequency Manual on the basis of a type D certification in accordance with 916.

CONSTRUCTION REQUIREMENTS

403.03 Weather Limitations

CMA pavements shall not be placed on a wet surface, when the ambient temperature is below 40°F (4°C), 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. The gradations and percent of asphalt shall be as follows.

Composition Limits for CMA Mixtures						
Sieve Size	Total Percent of Aggregates Passing Sieves Based on Total Weight (Mass) of Aggregates					
	Size 2	Size 5	Size 8	Size 9	Size 11	Size 5D
2.5 in. (63 mm)	100					
2 in. (50 mm)	95-100					
1.5 in. (37.5 mm)		100				100
1 in. (25 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 Percent Crushed	95	95	95	95	95	95
Percent 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 (mass) 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 (80°C).

403.06 Preparation of Subgrade or Base

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.

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.

403.09 Compaction

Compaction shall be in accordance with 402.15. Satisfactory means to confine the mixture within the required limits shall be in place during the compaction operation.

403.10 Surface Tolerances

The smoothness requirements for CMA pavements shall be in accordance with 402.18.

403.11 Method of Measurement

CMA pavement will be measured by the ton (megagram), of the type and size specified, in accordance with 109.01(b).

403.12 Basis of Payment

The accepted quantities of CMA pavement will be paid for at the contract unit price per ton (megagram), of the type and size specified, for the mixture.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
CMA Base _____ size	TON (Mg)
CMA Intermediate _____ size	TON (Mg)
CMA Surface _____ size	TON (Mg)

The cost of repairing damaged areas of mixture allowed to cure under traffic shall be included in the cost of the pay items in this section.

SECTION 404 – SEAL COAT

404.01 Description

This work shall consist of one or more applications of asphalt material, each followed by an application of cover aggregate in accordance with 105.03.

MATERIALS

404.02 Asphalt Material

The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, RS-2, AE-90, AE-90S, or HFRS-2.....902.01(b)

404.03 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, or 12 904
Fine Aggregate
Size No. 23 or 24 904

The types of seal coats shall be as follows:

TYPE	APPLICATION	COVER AGGREGATE SIZE NO. AND COURSE	RATES OF APPLICATION PER SQUARE YARD (SQUARE METER)	
			AGGREGATE lb (kg)	ASPHALT MATERIAL GALLON (LITER) AT 60°F (16°C)
1*	Single	23, 24	12-15 (5.4-6.8)	0.12-0.16 (0.45-0.61)
2	Single	12	14-17 (6.4-7.7)	0.29-0.33 (1.09-1.25)
3	Single	11	16-20 (7.3-9.1)	0.36-0.40 (1.36-1.51)
4	Single	9	28-32 (12.7-14.5)	0.63-0.68 (2.38-2.57)
5	Double	Top – 12 Bottom – 11	16-19 (7.3-8.6) 16-20 (7.3-9.1)	0.33-0.37 (1.25-1.40) 0.36-0.40 (1.36-1.51)
6	Double	Top – 11 Bottom – 9	18-22 (8.2-10.0) 28-32 (12.7-14.5)	0.41-0.46 (1.55-1.74) 0.63-0.68 (2.38-2.57)
7	Double	Top – 11 Bottom – 8	18-22 (8.2-10.0) 28-32 (12.7-14.5)	0.41-0.46 (1.55-1.74) 0.63-0.68 (2.38-2.57)

* Only AE-90 or AE-150 shall be used for seal coat, type 1.

CONSTRUCTION REQUIREMENTS

404.04 Weather Limitations

Asphalt material shall not be applied on a wet surface, or when other weather conditions would adversely affect the seal coats. Seal coats shall not be placed when the ambient or base temperature is below 40°F (4°C). If seal coats are placed when the ambient or base temperature is between 40°F (4°C) and 60°F (16°C), the cover aggregate shall be heated to between 120°F (49°C) and 150°F (66°C).

404.05 Equipment

A distributor, rotary power broom, pneumatic tire roller, and aggregate spreader in accordance with 409.03 shall be used.

404.06 Preparation of Surface

Surfaces to be sealed shall be brought to proper section and grade, compacted, cleaned as required, and approved.

404.07 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 (square meter) shall be as directed.

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. It shall not be spread more than 500 ft (150 m) ahead of the aggregate spreader.

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.

404.08 Application of Cover Aggregate

Immediately following the application of the asphalt material, cover aggregate shall be spread in quantities as directed. Spreading shall be accomplished such that the tires of the trucks or aggregate spreader do not contact the uncovered and newly applied asphalt material.

Rolling shall consist of at least three complete roller coverages and be completed within 30 min after the cover aggregate is applied. The rollers shall not be operated at speeds that will displace the cover aggregate from the asphalt material.

The seal coat shall be protected by the restriction of traffic or by controlling traffic speed until the asphalt material has cured or set sufficiently to hold the cover aggregate without displacement.

Excess cover aggregate shall be removed from the pavement surface by light brooming on the day following placement of the seal coat. The brooming shall not displace the imbedded aggregate.

404.09 Method of Measurement

Asphalt material and cover aggregate will be measured by the ton (megagram). Seal coat will be measured by the square yard (square meter).

If measurement of seal coat is made by the square yard (square meter), the quantity for each day's placement will be the least of the following:

(a) the measured square yards (square meters) within the specified limits;

(b) the calculated square yards (square meters) based on the amount of aggregate used, divided by the minimum amount of aggregate per square yard (square meter) specified in 404.03; or

(c) the calculated square yards (square meters) based on the amount of asphalt material used, divided by the minimum amount of asphalt material per square yard (square meter) specified in 404.03.

404.10 Basis of Payment

The accepted quantities of asphalt material and cover aggregate will be paid for at the contract unit price per ton (megagram). Seal coat will be paid for at the contract unit price per square yard (square meter) complete in place. If slag is used as a cover aggregate, and payment will be made per ton (megagram), the pay quantity will be adjusted in accordance with 904.01.

If seal coat is paid for by the square yard (square meter) and if so directed, asphalt material in excess of the limits set out in 404.03 will be paid for at the Contractor's invoice price, plus 20%.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Asphalt for Seal Coat	TON (Mg)
Cover Aggregate, Seal Coat	TON (Mg)
Seal Coat, _____ type	SYS (m2)

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

The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-PMP .....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
Fine Aggregate, Size No. 23 or 24.....904

CONSTRUCTION REQUIREMENTS

405.04 Weather Limitations

Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 50°F (10°C), 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.

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-PMP shall be uniformly applied at the rate of 0.50 to 0.75 gal./syd (2.2 to 3.3 L/m^2) placed in a single application. When placing material on a rubblized base, a carpet drag shall be utilized behind the distributor.

When traffic is to be maintained within the limits of the section, approximately 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

Asphalt for prime coat will be measured by the ton (megagram), or by the square yard (square meter). Cover aggregate will be measured by the ton (megagram).

405.10 Basis of Payment

The accepted quantities of prime coat will be paid for at the contract unit price per ton (megagram), or per square yard (square meter) for asphalt for prime coat. The accepted quantities of cover aggregate will be paid for at the contract unit price per ton (megagram), complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Asphalt for Prime Coat	TON (Mg) SYS (m2)
Cover Aggregate, Prime Coat	TON (Mg)

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

The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-T, AE-PMT .....902.01(b)
PG Asphalt Binder, PG 64-22 .....902.01(a)

CONSTRUCTION REQUIRMENTS

406.03 Equipment

A distributor in accordance with 409.03(a) shall be used.

406.04 Preparation of Surface

The existing surface to be treated shall be free of foreign materials deemed detrimental by the Engineer.

406.05 Application of Asphalt Material

The asphalt material shall be uniformly applied at the rate of from 0.03 to 0.08 gal./syd (0.14 to 0.36 L/m^2), or as otherwise specified or directed.

Tack coat shall not be applied to a wet surface. The rate of application, temperature, and areas to be treated shall be approved prior to application. Excessive tack coat shall be corrected to obtain an even distribution.

406.06 Method of Measurement

Asphalt for tack coat will be measured by the ton (megagram) or by the square yard (square meter).

406.07 Basis of Payment

The accepted quantities of tack coat will be paid for at the contract unit price per ton (megagram), or per square yard (square meter) for asphalt for tack coat, complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Asphalt for Tack Coat	TON (Mg) SYS (m2)

SECTION 407 – DUST PALATIVE

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

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 (10°C), or when other unsuitable conditions exist, unless approved by the Engineer.

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

The asphalt material shall be uniformly applied at the rate of 0.25 to 1.00 gal./syd (1.5 to 5 L/m^2) 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 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

Asphalt for dust palative will be measured by the ton (megagram).

407.08 Basis of Payment

The accepted quantities of this work will be paid for at the contract unit price per ton (megagram) for asphalt for dust palative, complete in place.

Payment will be under:

Pay Item	**Pay Unit Symbol**
Asphalt for Dust Palative	TON (Mg)

SECTION 408 – SEALING CRACKS AND JOINTS

408.01 Description

This work shall consist of sealing longitudinal and transverse cracks and joints in existing asphalt pavement in accordance with 105.03.

MATERIALS

408.02 Materials

Materials shall be in accordance with the following:

Asphalt Emulsion for
Crack Sealing, AE-90, AE-90S, AE-150.....902.01(b)
Fine Aggregates, No. 23 or 24 904
Joint Sealing Materials.....906.02

CONSTRUCTION REQUIREMENTS

408.03 Equipment

A distributor in accordance with 409.03 shall be used when crack sealing and an indirect-heat double boiler kettle with mechanical agitator shall be used when routing and filling. Air compressors shall be capable of producing a minimum air pressure of 100 psi (690 kPa).

408.04 Weather Limitations

Sealing or filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F (4°C), or when other unsuitable conditions exist, unless approved by the Engineer.

408.05 Routing and Filling Cracks and Joints

Cracks and joints shall be routed when specified, with a vertical-spindle router with carbide-tipped or diamond router bits to form a reservoir not exceeding 0.5 in. (13 mm) wide with a minimum depth of 0.75 in. (19 mm). 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 filled with asphalt rubber to within 0.25 in. (7 mm) of the surface in accordance with the manufacturer's recommendations.

408.06 Sealing Cracks and Joints

Cracks and joints 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 and joints. The cracks and joints shall be completely filled or overbanded not to exceed 5 in. (125 mm), or as required. All excess asphalt material shall be removed from the pavement. The sealed cracks and joints shall be covered with sufficient fine aggregate to prevent tracking of the asphalt materials. All excess cover material shall be removed from the pavement.

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 (megagram) 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 (megagram) 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 and Joints in Asphalt Pavement, Seal	TON (Mg)
Cracks and Joints in Asphalt Pavement, Rout and Seal	TON (Mg)

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.

(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.

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.

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.

Truck beds may be treated with approved anti-adhesive agents. 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 list of approved 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.

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 backlashing. 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 (mass) of 10 t (9 Mg).

2. Three Wheel Roller

A roller having three wheels with a minimum bearing of 300 lb/in. (5.3 kg/mm) on the rear wheels. The crown of the wheels shall not exceed 2.5 in. (63 mm) in 18 ft (5.5 m).

A tandem roller which has a drive wheel bearing of no less than 300 lb/in. (5.3 kg/mm) 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 (1.65 m). 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 (345 to 620 kPa) uniformly over the pavement by adjusting ballast and tire inflation pressures. 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 be equipped with a variable amplitude system, a speed control device, and have a minimum vibration frequency of 2000 vibrations per min. A reed tachometer shall be provided for verifying the frequency of vibrations.

5. Trench Roller

A trench roller shall have a compaction wheel bearing of no less than 300 lb/in. (5.3 kg/mm).

6. Specialty Roller/Compactor

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

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 (4.9 m)

A 16 ft (4.9 m) straightedge shall be a rigid beam mounted on two solid wheels on axles 16 ft (4.875 m) 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 (3 m)

A 10 ft (3 m) straightedge is the same as a 16 ft (4.9 m) straightedge except that the wheels are mounted 10 ft (3.048 m) apart. A handheld rigid beam may be substituted.

SECTION 410 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HMA SURFACE – SMA PAVEMENT

410.01 Description

This work shall consist of one course of QC/QA HMA Surface – SMA mixture constructed on prepared foundations in accordance with 105.03.

410.02 Quality Control

The SMA mixture shall be supplied from a certified HMA plant in accordance with ITM 583; Certified Volumetric 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 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 SMA paving operations.

MATERIAL

410.03 Materials

Materials shall be in accordance with the following:

Asphalt Materials
PG Binder, PG 76-22, PG 70-22.....902.01(a)
Coarse Aggregates, Class AS.....904
Stabilizing Additive .....AASHTO MP 8
Fine Aggregates (sand, mineral filler) 904

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, and a Mixture Adjustment Factor (MAF). The DMF shall state the source, type dosage rate of any stabilizing additives. Approval of the DMF will be based on the ESAL and mixture designation. A mixture number will be assigned by the Engineer. No mixture will be accepted until the DMF has been approved.

The ESAL category identified in the pay item correlates to the following ESAL ranges:

ESAL CATEGORY	ESAL
1	< 300,000
2	300,000 to < 3,000,000
3	3,000,000 to < 10,000,000
4	10,000,000 to < 30,000,000
5	≥ 30,000,000

410.05 SMA Mix Design

The DMF shall be determined for each mixture from a SMA mix design by a design laboratory selected from the Department's list of approved Mix Design Laboratories. A SMA mixture shall be designed in accordance with the respective AASHTO references as listed below.

Standard Practice for Designing
Stone Matrix Asphalt (SMA).....AASHTO PP 41

Standard Practice for Mixture Conditioning
of Hot-Mix Asphalt (HMA).....AASHTO R 30

Standard Specification for Designing
Stone Matrix Asphalt (SMA).....AASHTO MP 8

Determining the Plastic Limit and Plasticity
Index of Soils.....AASHTO T 90

Maximum Specific Gravity and Density of Bituminous
Paving Mixtures.....AASHTO T 209

Resistance of Compacted Asphalt Mixture to
Moisture Induced Damage.....AASHTO T 283

Determination of Draindown Characteristics
in Uncompacted Asphalt Mixtures .....AASHTO T 305

Method for Preparing and Determining the Density
of Hot Mix Asphalt (HMA) Specimens by
Means of the Superpave Gyratory Compactor.....AASHTO T 312

Method for Viscosity Determination of Asphalt Binder
Using Rotational Viscometer.....AASHTO T 316

The single percentage of aggregate passing each required sieve shall be within the limits of the following gradation table.

SMA Gradation Control Limits (Percent Passing by Volume)				
	Mixture Designation			
	9.5 mm		12.5 mm	
Sieve Size	Lower	Upper	Lower	Upper
25.0 mm				
19.0 mm			100.0	100.0
12.5 mm	100.0	100.0	90.0	99.0
9.5 mm	70.0	95.0	50.0	85.0
4.75 mm	30.0	50.0	20.0	40.0
2.36 mm	20.0	30.0	16.0	28.0
1.18 mm	---	21.0	---	---
600 µm	---	18.0	---	---
300 µm	---	15.0	---	---
75 µm	8.0	12.0	8.0	11.0

The optimum binder and aggregate gradation content shall produce 4.0% air voids. The maximum specific gravity of the uncompacted mixture shall be determined in accordance with AASHTO T 209. The percent draindown for SMA surface mixture shall not exceed 0.30% in accordance with AASHTO T 305.

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 mixtures. If the MAF calculation results in a value where $0.980 \leq MAF \leq 1.020$, then the MAF shall be considered to be 1.000. If the calculated MAF is outside of the above range, then the actual calculated value shall be used.

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 2 h in accordance with AASHTO R 30. The minimum tensile strength ratio, TSR, shall be 70%. The 6 in. (150 mm) mixture specimens shall be compacted to 6.0 ± 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, change in source or type of stabilizing additives, or a change in the source of the specified binder shall require a new DMF. A new DMF shall be submitted to the District Materials and Tests Engineer for approval one week prior to use.

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 Materials and Tests Engineer. A new DMF is not required for this adjustment.

The mixture design compaction temperature for the specimens shall be 300 ± 9°F (150 ± 5°C).

VOIDS IN MINERAL AGGREGATE (VMA) CRITERIA	
Mixture Designation	Minimum VMA, Percent
12.5 mm	17.0
9.5 mm	17.0

410.06 Recycled Materials

Mainline surface shall not contain recycled materials.

410.07 Lots and Sublots

Lots will be defined as 2400 t (2400 Mg) of SMA surface mixture. Lots will be further sub-divided into sublots not to exceed 600 t (600 Mg) of SMA surface mixture. Partial sublots of 100 t (100 Mg) or less will be added to the previous sublot. Partial sublots greater than 100 t (100 Mg) constitute a full sublot.

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 the current or previous calendar year will be allowed. The mixture compaction temperature shall be 300 ± 9°F (150 ± 5°C). The JMF for each mixture shall be submitted to the Engineer.

410.09 Acceptance of Mixtures

Acceptance of mixtures for binder content, moisture, and gradation for each lot will be based on tests performed by the Engineer. The Engineer will randomly select the location(s) within each sublot for sampling in accordance with ITM 802.

Samples from each location shall be obtained from each sublot from the pavement in accordance with ITM 580. The second sample shall be located from the random sample by offsetting 1 ft (0.3 m) transversely towards the center of the mat and will be used for the moisture sample. 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.

The maximum percent of moisture in the mixture shall not exceed 0.10 from plate samples.

The Engineer's acceptance test results for each sublot will be available after the sublot and testing are complete. During the adjustment period the test results will be made available after testing is complete.

ACCEPTANCE TOLERANCE FOR MIXTURES (% Percent Mass)							
MIXTURE	NUMBER OF TESTS	SIEVE SIZE					
		*12.5 mm	*9.5 mm	*4.75 mm	2.36 µm	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

* 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 sublot 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 (± Percent Mass)	
SIEVE SIZE & BINDER CONTENT	PERCENTAGE POINTS
	SURFACE
2.36 mm	12.0
600 µm	6.0
75 µm	2.0
% BINDER	1.0

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 sublot. The range of binder shall be the difference between the highest sublot binder content and the lowest sublot binder content in one lot. The range of gradation shall be the difference between the highest sublot percent passing and the lowest sublot percent passing each required sieve in one lot.

Single test values and averages will be reported to the nearest 0.1% except moisture will be reported to the nearest 0.01%. Rounding will be in accordance with 109.01(a).

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%.

Stabilizing additives incorporated into the mixture will be accepted on the basis of a type A certification for the specified material properties for each shipment of fibers. 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 sublot(s), all test results of the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

CONSTRUCTION REQUIREMENTS

410.10 General

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 accomplished on the pavement or shoulder areas.

Segregation, flushing or bleeding of SMA mixtures will not be permitted. Corrective action shall be taken to prevent continuation of these conditions. Segregated, flushed or bleeding of SMA mixtures shall be removed if directed. All areas showing an excess or deficiency of binder shall be removed and replaced.

All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

410.11 Preparation of Surfaces to be Overlaid

Milling of an existing pavement surface shall be in accordance with 306.05. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

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

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 (7°C) or above.

410.14 Spreading and Finishing

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.

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.

Planned SMA courses greater than 165 lb/syd (90 kg/m^2) 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 165 lb/syd (90 kg/m^2) 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 permitted 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 (75 m) in length.

Automatic slope and grade controls will be required and shall be outlined in the QCP.

SMA mainline and SMA shoulders which are 8.0 ft (2.4 m) or more in width shall be placed with automatic paving equipment.

The rollers shall be operated to avoid shoving of the SMA and at speeds not to exceed 3 mph (4.5 km/h). Rollers shall be in accordance with 409.03(d)1, 2, or 6. Vibratory rollers meeting the requirements of 409.03(d)4 may be used but shall not be operated in vibratory mode, except the vibratory mode may be used on the first pass to the paver.

The finished thickness of any course shall be at least two times but not more than four times the maximum particle size as shown on the DMF.

410.15 Joints

Longitudinal joints in the surface shall be at the lane lines of the pavement.

Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course. For areas inaccessible to rollers, other mechanical devises 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.

410.16 Density

Acceptance will be based on lots and sublots in accordance with 410.07.

The Engineer's acceptance test results for each sublot will be available after the sublot 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).

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

sublot for coring. The transverse core location will be located so that the edge of the core will be no closer than 3 in. (75 mm) from a confined edge or 6 in. (150 mm) 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 in. (150 mm) diameter pavement sample. Surface courses shall be cored within one work day of placement. Damaged core(s) shall be discarded and replaced with a core from a location selected by adding 1.0 ft (0.3 m) 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.

The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific sublot or sublots will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 1.0 ft (0.3 m) 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 the maximum specific gravity for the sublot, times 100. The Engineer will determine the BSG of the cores in accordance with AASHTO T 166. The maximum specific gravity will be determined in accordance with AASHTO T 209 from plant produced materials prepared in accordance with ITM 572. The target value for density of SMA mixtures of each sublot shall be 93.0%.

The densities of the sublots will be averaged to determine the density of the lot.

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 Shoulder Corrugations

Shoulder 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

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, $/TON ($/Mg)
P = total adjustment points

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

If the total adjustment points for a lot are greater than 15, the pavement will be evaluated by the Materials and Tests Division. 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 Materials and Tests Division.

(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					
	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	0.2	0.3
For Each 0.1% > 1.0% Out of Tolerance	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 tan 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)
2.36 mm	0.1
600 µm	0.1
75 µm	0.1
% Binder	1.0

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.

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

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 – Percent
> 97.0	Submitted to the Materials and Tests Division*
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 Materials and Tests Division*

* 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

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. The basis of the appeal shall include applicable QC test results showing acceptable quality results and shall be submitted within seven calendar days of receipt of the Department's written results for that sublot. Acceptable QC test results are defined as QC test results resulting in less pay adjustment to the contract than that determined by the Department. If an appeal is granted, appeal cores shall be taken within seven calendar days after written notification unless otherwise directed. Within one work day of appeal coring operations

the Contractor shall clean, dry, and refill the core holes with SMA or HMA surface materials.

The results of the appeal cores will replace the initial test results for a sublot(s) or lot and be used as the basis for acceptance.

(a) Mixture

Upon approval for the additional testing, the Contractor shall take cores in accordance with ITM 580. The core location will be within 1.0 ft (0.3 m) longitudinally of the sample tested using the same transverse offset.

(b) Density

Additional core locations will be determined by adding 1.0 ft (0.3 m) longitudinally of the cores tested using the same transverse offset. Each sublot density will be calculated using the average bulk specific gravity of the cores obtained for that sublot and the average MSG of the lot.

410.21 Method of Measurement

SMA mixtures will be measured by the ton (megagram) of the type specified, in accordance with 109.01(b). The measured quantity will be divided by the MAF to determine the pay quantity.

410.22 Basis of Payment

The accepted quantities for this work will be paid for at the contract unit price per ton (megagram) for QC/QA-HMA, of the type specified, - SMA, complete in place.

Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made in accordance with 401.22.

Adjustments to the contract payment with respect to mixture, density, and smoothness for mixture produced will be included in a quality assurance adjustment pay item. The unit price for this pay item will be one dollar ($1.00) and the quantity will be in units of dollars. The quantity is the total calculated in accordance with 410.19. A change order developed in accordance with 109.05 will be prepared to reflect contract adjustments.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
QC/QA HMA, _____, _____, _____, _____ mm (ESAL[1]) (PG[2]) (Course[3]) (Mix[4])	TON (Mg)
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
(4) Mixture Designation

Preparation of surfaces to be overlaid shall be included in the cost of other pay items within this section.

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.

The price for profilograph, HMA will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

SECTION 500 – CONCRETE PAVEMENT

SECTION 501 – QUALITY CONTROL/QUALITY ASSURANCE, 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 ITM 405, transported, and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803, for PCCP. The QCP shall be submitted to the Engineer at least 15 days prior to commencing PCCP paving operations.

An American Concrete Institute certified concrete field testing technician, grade 1, 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

501.03 Materials

Materials shall be in accordance with the following:

Admixtures	912.03
Coarse Aggregate, Class AP, Size No. 8	904
Fine Aggregate, Size No. 23*	904
Fly Ash	901.02
Ground Granulated Blast Furnace Slag	901.03
Portland Cement	901.01(b)
Rapid Set Patching Materials	901.07
Water	913.01

*Or gradation as identified in the QCP

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 DMTE. 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:

(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 pozzolan
(h) the batch weights (mass)
(i) the names of all admixtures
(j) the admixture dosage rates and the manufacturer's recommended range

The CMDS is used to conduct a trial batch in accordance with 501.06. Upon completion of the trial batch, the Contractor shall document the adjustments to the CMDS and submit the concrete mix design trial, CMDT, to the DMTE for approval. The CMDT shall be submitted a minimum of three work days prior to production to the DMTE utilizing the Department furnished spreadsheet. Production shall not commence without an approved CMDT. Both the Contractor's and the Engineer's tests will be included in the CMDT submittal.

The CMDT is used to start production. The CMDT can be adjusted in accordance with 501.17 and will be documented as a concrete mix design for production, CMDP. The CMDP shall be submitted by the end of the second lot to the DMTE utilizing the Department's spreadsheet. Production shall stop upon the end of the first sublot of the third lot if the CMDP is not received by the DMTE.

(a) Change in Materials

A change in a CMDP to any of the following requires a new CMDS.

1. cement source, except for type I
2. cement types for IA, IIIA, ISA, IP-A, IS, II, III, IP, ISM
3. admixture type
4. pozzolan source or type
5. aggregate material

(b) Change in Source

A change in a CMDP to any of the following requires a new CMDT.

1. cement source, type I
2. admixture source utilizing the same type
3. aggregate source

When changes in the CMDP are in accordance with 501.04(b), the new CMDT shall be verified on the first sublot of production in accordance with 501.06, except the DMTE will use the acceptance test results for verification. The CMDT will be documented as a CMDP after verification. Production may continue until flexural strength tests are completed as long as all other properties are in accordance with 501.05. If the flexural strength is not in accordance with 501.05, production shall stop. All PCCP constructed with the new CMDT will be adjudicated as a failed material in accordance with normal Department practice in accordance with 105.03. No CMDT adjustments in accordance with 501.17 will be allowed. The CMDP shall be submitted to the DMTE utilizing the Department furnished spreadsheet by the end of the second lot. Production shall stop upon the end of the first sublot of the third lot if the CMDP is not received by the DMTE.

A CMDP from a previous contract may be submitted for use on additional contracts.

501.05 Concrete Mix Criteria

The CMD shall produce workable concrete mixtures having the following properties:

Minimum portland cement content ..... 440 lbs/yd^3 (260 kg/m^3)
Maximum water/cementitious ratio 0.450
Minimum portland cement/fly ash ratio.....3.2 by weight (mass)
Minimum portland cement/GGBFS ratio.....2.3 by weight (mass)
Target air content 6.5%
Minimum flexural strength, third
point loading .....570 psi (4000 kPa) at 7 days

The Contractor may elect to use fine and coarse aggregates in accordance with 904, or may propose the use of alternate gradations. If alternate gradations are proposed, the QCP shall specify the tolerances of material passing each sieve. In either case, 100% of the coarse aggregate shall pass the 1 in. (25 mm) sieve. The combined amount of fine and coarse aggregates passing the No. 200 (75 µm) sieve shall be from 0% to 2.0% for fine aggregate and gravel, and from 0% to 2.5% for fine aggregate and crushed stone or crushed slag.

The fine aggregate shall be at least 35% but not more than 50% of the total weight (mass) of the aggregate in each cubic yard (cubic meter). Proportions will be based upon saturated surface dry aggregates.

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.

Fly ash or GGBFS used as an additive, or blended portland cements may only be incorporated in the concrete mix between April 1 and October 15 of the same calendar year. 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 500 lbs/yd^3 (300 kg/m^3). The use of fly ash or GGBFS as an additive will not be permitted when blended portland cements are used.

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 or CMDT meets the concrete mix criteria. The concrete shall be batched within the proportioning tolerances of 508.02(b). 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 (mass) may be used to conduct the air content test.

The target unit weight (mass) and water/cementitious ratio of the plastic concrete shall be determined by the trial batch. The flexural strength shall be determined by averaging a minimum of two beam breaks.

Test results shall be added to the CMDS or CMDT and submitted to the DMTE in accordance with 501.04.

501.07 Lots and Sublots

Lots will be defined as 7,200 syd (6000 m^2) of PCCP. Lots will be further subdivided into sublots of 2,400 syd (2000 m^2) of PCCP within a lot. Partial sublots of 480 syd (400 m^2) or less will be added to the previous sublot. Partial sublots greater than 480 syd (400 m^2) constitute a full sublot. Partial lots of one or two sublots constitute a full lot.

Lots and sublots will be tested on the CMD's for a given pay item. Lots and sublots will be closed out at the end of the paving season.

501.08 Acceptance

Acceptance of PCCP for flexural strength, air content, unit weight (mass), water/cementitious ratio, and thickness will be determined on the basis of tests performed by the Engineer in accordance with 505. The Engineer will randomly select the location within each sublot for sampling in accordance with ITM 802.

The random sample(s) per sublot shall be of sufficient quantity to perform all required tests and obtained in accordance with AASHTO T 141. 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 sublot	AASHTO T 97	1 psi (10 kPa)
Air Content	One per sublot	AASHTO T 152 or ASTM C 173	0.1
Unit Weight	One per sublot	AASHTO T 121	1
Water/Cementitious Ratio	Once per week	ITM 403	0.001
Thickness	Two per sublot	ITM 404	0.1

Rounding will be in accordance with 109.01(a).

In the event that an acceptance sample is not available to represent a sublot(s), all test results of the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

CONSTRUCTION REQUIREMENTS

501.09 General

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

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. Dowel bars shall be coated with a bond breaking material and the coating shall be evident at the time of placement.

501.13 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.

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.

(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.

The batch ticket for contract dedicated plants and delivery tickets for ready mix plants shall include the approved CMDT or CMDP number. The tickets shall be delivered to the Engineer.

Discharge from non-agitating equipment shall be completed within 30 min of mixing the water, cement, and aggregates. Discharge from a truck agitator or a truck mixer shall be completed within 90 min of mixing the water, cement, and aggregates.

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. (25 mm) when the average slump is 3 in. (75 mm) or less, or by more than 2 in. (50 mm) when the average slump is greater than 3 in. (75 mm), 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 min 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.

501.15 Weather Limitations

PCCP shall not be placed on frozen subgrade or subbase. PCCP shall be placed when the ambient temperature is 35°F (2°C) and above, unless procedures outlined in the QCP for lower temperatures are followed. 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

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 contract with a dowel bar assembly, subgrade, subbase, or forms.

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.

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 CMDT Adjustments

The target water/cementitious ratio and target unit weight may be adjusted during the first lot of each year's production or as a result of fluctuations in fine or coarse aggregate specific gravities.

Adjustments to the dosage amount of admixtures will be permitted; however, a new CMDS will be required for the addition or deletion of an admixture.

The fine aggregate to total aggregate ratio may be adjusted by ±3% within the limits of 501.05.

501.18 Joints

Joints shall be in accordance with 503.

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.

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 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.

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.

(a) Construction

Construction vehicles or equipment will be allowed on the PCCP after 10 days or when flexural tests indicate a modulus of rupture of 550 psi (3800 kPa) or greater. ITM 402 may be used as an alternate method to determine the flexural strength. All construction vehicles or equipment that may damage the PCCP shall not be used on the

PCCP unless adequate protection is provided. Approved joint cutting saws may be operated on the PCCP.

(b) Non-Construction

PCCP may be opened to traffic after 14 days. The PCCP may be opened earlier if test beams or ITM 402 indicate a modulus of rupture of 550 psi (3800 kPa) or greater. If adequate strengths are not met within 14 days, an investigation by the Engineer and 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 Shoulder Corrugations

Shoulder corrugations shall be in accordance with 606.

501.25 Pavement Smoothness

The pavement smoothness will be accepted by means of a profilograph, a 16 ft (4.9 m) long straightedge, or a 10 ft (3 m) long straightedge.

The profilograph shall be used where all of the following conditions are met:

(a) the design speed is greater than 45 mph (70 km/h), and

(b) the pavement lanes excluding shoulders are full width and 0.1 mi (0.16 km) or longer

If a pay item, profilograph, PCCP, is included in the contract, and the above conditions are met, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 912. The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor. When a profilograph, PCCP is not included as a pay item, and the above conditions are met, the Department will furnish, calibrate, and operate the profilograph or the Department will develop a change order in accordance with 109.05 to include profilograph, PCCP as a pay item.

The 16 ft (4.9 m) long straightedge shall be used on all full-width pavement lanes shorter that 0.1 mi (0.16 km), on tapers, within 50 ft (15 m) of a reinforced concrete bridge approach, and within 50 ft (15 m) of an existing pavement which is being joined, and shoulders greater than 10 ft (3 m) wide.

The 10 ft (3 m) long straightedge shall be used for transverse slopes, approaches, and crossovers.

As soon as the PCCP has cured sufficiently, the smoothness may be checked. Profile testing shall be completed prior to opening the pavement to traffic. 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. An initial profile index will be determined from the profilogram of this profile. The initial profile

index for areas requiring replacement will be adjusted to include the results of a profilogram of all replaced areas.

Pavement smoothness variations outside specified tolerances shall be corrected by grinding with a groove type cutter or by replacement. Grinding will not be permitted until the PCCP is 10 days old or the flexural strength test is 550 psi (3800 kPa) 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 after grinding shall be uniform. If the grinding operation reduces the tining grooves to a depth of less than 1/16 in. (1.5 mm) and the longitudinal length of the removal area exceeds 15 ft (4.5 m), or two or more areas are within 30 ft (9.0 m) of each other, the PCCP shall be re-textured in accordance with 504.03.

When the 16 ft (4.9 m) straightedge is used, the pavement variations shall be corrected to 1/4 in. (6 mm) or less. When the 10 ft (3 m) straightedge is used, the pavement variations shall be corrected to 1/8 in. (3 mm) or less.

When the profilograph is being used, the pavement variations shall be corrected to a profile index of 12.0 in./0.1 mi (30 mm/0.16 km) or less. In addition to the requirements for the profile index, all areas having a high or low points deviation in excess of 0.3 in. (8 mm) shall be corrected. Verifying profilograph measurements will be taken only in the 0.1 mi (0.16 km) length where corrections have been performed.

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. (100 mm) 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 6 in. (150 mm) of the edge of pavement, within 3 in. (75 mm) of longitudinal joints, within 2 ft (0.6 m) of D-1 contraction joints, or within 5 ft (1.5 m) 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 sublot shall be the average lengths of both cores from the sublot. Calculations shall be to the nearest 0.1 in. (2.5 mm).

501.27 Tolerance

Plastic unit weight, water/cementitious ratio, flexural beam, and air content tests will be performed during PCCP operations.

(a) Plastic Unit Weight

Sublots shall not vary by more than ±3.0% from the target unit weight. A stop paving order will be issued if the plastic unit weight exceeds ±3.0% from the target plastic unit weight (mass). Paving operations shall not resume until satisfactory changes are made or an alternate CMDT or CMDP is used.

Calculations for the plastic unit in lbs/yd^3 will be made and reported to the nearest figure in the tenth (calculations in kg/m^3 will be made and reported to the nearest whole unit).

(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 0.450. 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 CMDT or 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 of 570 psi (4000 kPa) and above shall be achieved. Price adjustments for values outside the tolerance limits will be in accordance with 501.28.

Calculations for flexural strength in psi will be made and reported to the nearest whole unit (kPa to the nearest 10 kPa).

(d) Air Content

The average lot air content values shall not vary more than -0.8% to +2.4% from the 6.5% target air content. The range of sublot 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 test results for flexural strength, air content, air content range, 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 flexural strength, air content, air content range, thickness, and smoothness will be calculated as follows:

$$q = L \times U \times (P - 1.00)$$

where:

q = quality assurance adjustment quantity
L = lot quantity
U = unit price for QC/QA-PCCP, \$/yd^2 (\$/m^2)
P = pay factor

For sublot thickness determination:

$$q_T = l_T \times U \times (P - 1.00)$$

where:

q_T = quality assurance adjustment quantity
l_T = sublot quantity for thickness
U = unit price for QC/QA-PCCP, \$/yd^2 (\$/m^2)
P = pay factor

The quality assurance adjustment points for smoothness, Qs, 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 flexural strength
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

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 Materials and Tests Division.

(a) Flexural Strength

When test results for flexural strength exceed the allowable tolerance, a pay factor will be assessed as follows:

1. Lots

Lot Average Flexural Strength	
Psi (kPa)	Pay Factors
570 (3927) and Above	1.00
565 – 569 (3893 – 3926)	0.98
560 – 564 (3858 – 3892)	0.96
555 – 559 (3824 – 3857)	0.94
550 – 554 (3789 – 3823)	0.92
545 – 549 (3755 – 3788)	0.89
540 – 544 (3720 – 3754)	0.86
535 – 539 (3686 – 3719)	0.83
525 – 534 (3617 – 3685)	0.78
515 – 524 (3548 – 3616)	0.72
514 (3547) 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

If a sublot value is less than 500 psi (3500 kPa), the PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. For a sublot completely removed, the sublot test value from the replacement sublot 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
> 10.0	*
10.0	0.80
9.7 – 9.9	0.85
9.5 – 9.6	0.91
9.3 – 9.4	0.96
9.0 – 9.2	0.98
5.7 – 8.9	1.00
5.0 – 5.6	0.99
4.7 – 4.9	0.98
4.6	0.88
4.5	0.80
< 4.5	*

* 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.

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.

2. Sublots

If a sublot value is less than 4.0% 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 sublot completely removed, the sublot test value from the replacement sublot 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:

Sublot Pay Factors For Thickness	
Average Core depth (ACD) Design Depth (DD)	
ACD Minus DD	Pay Factor
> + 0.5 in. (> + 13 mm)	1.05
+ 0.3 in. to 0.5 in. (+ 7 mm to + 13 mm)	1.02
± 0.2 in. (6 mm)	1.00
- 0.3 in. to - 0.5 in. (- 6 mm to - 13 mm)	0.96
- 0.6 in. to - 0.7 in. (- 14 mm to - 19 mm)	0.90
- 0.8 in. to - 1.0 in. - 20 mm to - 25 mm)	0.80
< - 1.00 in. (< - 25 mm)	*

* 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 after corrective action. A Quality Assurance Pay Factor (PFs) 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 excluding shoulders for 0.1 mi (0.16 km) long section represented by the profile index calculated by the following formula:

$$q_s = (PF_s - 1.00) \times A \times U$$

where:

q_s = quality assurance adjustment for smoothness for one section
PF_s = pay factor for smoothness
A = area of the section, SYS (m^2)
U = unit price for the material \$/SYS (\$/m^2)

The quality assurance adjustment for smoothness, Qs, for the contract will be the total of the quality assurance adjustments for smoothness, qs, on each section by the following formula:

$$Q_s = \Sigma\, q_s$$

SECTION PAY FACTORS FOR SMOOTHNESS ($PI_{0.0}$) ZERO BLANKING BANK	
Design Speed Greater Than 45 mph (70 km/hr)	
Profile Index in./0.1 mi. (mm/0.16 km)	Pay Factor
Over 0.00 to 1.00 in. (Over 0 to 25 mm)	1.06
Over 1.00 to 1.20 in. (Over 25 to 30 mm)	1.05
Over 1.20 to 1.40 in. (Over 30 to 35 mm)	1.04
Over 1.40 to 1.60 in. (Over 35 to 40 mm)	1.03
Over 1.60 to 1.80 in. (Over 40 to 45 mm)	1.02
Over 1.80 to 2.20 in. (Over 45 to 55 mm)	1.01
Over 2.20 to 2.60 in. (Over 55 to 65 mm)	1.00
Over 2.60 to 2.80 in. (Over 65 to 70 mm)	0.96
Over 2.80 to 3.00 in. (Over 70 to 75 mm)	0.92
All pavementS with a Profile Index ($PI_{0.0}$) greater than 3.00 in. (75 mm) shall be corrected.	

501.29 Appeals

If the Contractor does not agree with the acceptance test results, a request may be made in writing for additional tests for a sublot(s) 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) Flexural Strength

Appeals will not be considered unless QC test results indicate greater than a 50 psi (350 kPa) difference between the Department's and the Contractor's tests. Upon approval for the additional testing, the Contractor shall obtain cores, as directed, in the presence of the Engineer.

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 (1.5 m) of a header. Two cores shall be taken in each sublot for the full depth of pavement and shall be 4 in. (100 mm) 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 C 496. 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. Flexural strength will be calculated as follows:

$$F_D = S_D \text{ x } \left[\frac{F_{A1}}{2S_{A1}} + \frac{F_{A2}}{2S_{A2}} \right]$$

where:

F_D = flexural strength of the appealed sublot
F_{A1} = flexural strength of the previous adjacent sublot
F_{A2} = flexural strength of the subsequent adjacent sublot
S_D = split tensile strength of the appealed sublot
S_{A1} = split tensile strength of the previous adjacent sublot
S_{A2} = split tensile strength of the subsequent adjacent sublot

(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(s) as directed in the presence of the Engineer.

The Engineer will determine the location of the core(s) within the appealed sublot(s). 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 (1.5 m) of a header. One 4 in. (100 mm) diameter full depth core shall be taken from the pavement for each sublot appealed. All core holes shall be filled with PCC or rapid setting patch material within 24 h of drilling.

The air content for a sublot 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 C 457.

501.30 Method of Measurement

QC/QA-PCCP will be measured by the square yard (square meter) 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 shoulder corrugations will be measured in accordance with 606.02.

501.31 Basis of Payment

The accepted quantities of QC/QA-PCCP will be paid for at the contract unit price per square yard (square meter) 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.

Adjustments to the contract payment with respect to flexural strength, thickness, air content, range and smoothness will be included in a quality assurance adjustment pay item in accordance with 109.05.1.

Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment for pavement thickness determinations will be made at the contract lump sum price for coring, PCCP. A change order in accordance with 109.05 will be developed to adjust the cost of coring when the final QC/QA-PCCP quantity differs from the bid quantity by more than 2400 syd (2000 m^2). This adjustment covers the cost of cores for the adjusted quantity of QC/QA-PCCP. The adjustment, plus or minus, will be based on the difference in the number of sublots, rounded to the nearest full sublots, times $100.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Coring, PCCP	LS
Profilograph, PCCP	LS
QC/QA-PCCP, _____ in. (mm) thickness	SYS (m2)

The cost of trial batch demonstrations shall be included in the cost of PCCP.

The price of profilograph, PCCP will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

The cost of corrections for pavement smoothness and re-texturing shall be included in the cost of QC/QA-PCCP.

The cost of coring and refilling of the pavement holes for appeals shall be included in the cost of QC/QA-PCCP.

Traffic control for appeals shall be supplied with no additional payment.

Removal and replacement of QC/QA-PCCP damaged by freezing shall be with no additional payment.

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

Materials shall be in accordance with the following:

Admixtures	912.03
Coarse Aggregate, Class AP, Size No. 8	904
Fine Aggregate, Size No. 23	904
Fly Ash	901.02
Ground Granulated Blast Furnace Slag	901.03
Portland Cement	901.01(b)
Rapid Set Patching Materials	901.07
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 one week prior to production and approved by the DMTE. The CMDS shall be submitted utilizing the Department provided spreadsheet and shall include the following:

(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 (mass)
(h) the names of all admixtures
(i) the admixture dosage rates and the manufacturer's recommended range

Production may commence once the DMTE approves the submission as a CMDP.

(a) Change in Materials

A change in a CMDP to any of the following requires a new CMDS.

1. cement type
2. admixture type
3. pozzolan type
4. aggregate material

(b) Change in Source

A change in a CMDP to any of the following requires a new CMDS.

1. cement source
2. admixture source
3. pozzolan source
4. aggregate source

(c) Change in Mixture

A change in a CMDP to any of the following requires a new CMDS.

1. proportions of aggregates by weight (mass) exceeding ± 2%
2. addition or deletion of an admixture

A CMDP in accordance with 501.05 may be used upon the approval of the DMTE. A CMDP in accordance with 502.04 from a previous contract may be submitted for use upon the approval of the DMTE.

502.04 Concrete Mix Criteria

The fine aggregate shall be at least 35% but not more than 45% of the total weight (mass) of the aggregate in each cubic yard (cubic meter). Proportions will be based upon saturated surface dry aggregates.

(a) Portland Cement Concrete

The CMD shall produce workable concrete mixtures, with the minimum amount of water, and having the following properties.

Portland cement content	564 lbs/yd^3 (335 kg/m^3)
Maximum water/cementitious ratio	0.487
Maximum substitution of fly ash for portland cement	20%
Fly Ash/portland cement substitution ratio	1.25 by weight (mass)
Maximum substitution of GGBFS for portland cement	30%
GGBFS/portland cement substitution ratio	1.00 by weight (mass)
Slump, formed	2 in. (50 mm) to 4 in. (100 mm)
Slump, slipformed	1.25 in. (30 mm) to 3 in. (75 mm)
Air	5.0% to 8.0%

Minimum flexural strength, third point loading,
with fly ash.....550 psi (3800 kPa) at 28 days
Relative yield ..... 0.98 to 1.02

Class C concrete in accordance with 702 using Class AP coarse aggregate may be substituted in PCCP.

Chemical admixtures type A, type B, type C, type D, and type E may be permitted with prior written approval.

Fly ash or GGBFS used as an additive, or blended portland cements may only be incorporated in the concrete mix between April 1 and October 15 of the same calendar year. If type IP, type IP-A, type IS or type IS-A cements are to be used, the portland cement content shall be increased to 598 lbs/yd^3 (355 kg/m^3). The use of fly ash or GGBFS as an additive will not be permitted when blended portland cements are used.

(b) High-Early Strength Concrete

The Contractor shall submit, along with the CMDS, all supporting test results for approval to the DMTE prior to placing concrete. Testing shall be conducted by an American Concrete Institute, ACI, certified concrete field testing technician, grade 1. The supporting test results shall be signed by the technician and include air content, slump, relative yield, water cement ratio, and the flexural strengths at one day, two days, and seven days.

The CMD shall produce workable concrete mixtures, with the minimum amount of water, and having the following properties.

Minimum portland cement content (type I or III)..... 564 lbs/yd^3 (335 kg/m^3)
Maximum fly ash addition .....10% of cement content
Maximum water/cementitious ratio (type I) 0.42
Maximum water/cementitious ratio (type III).....0.45
Maximum GGBFS addition .....15% of cement content
Slump, formed..... 2 in. (50 mm) to 4 in. (100 mm)
Slump, slipformed..... 1.25 in. (30 mm) to 3 in. (75 mm)
Air content.....5.0% to 8.0%
Minimum flexural strength, third point
loading.....550 psi (3800 kPa) at 2 days
Relative yield ..... 0.98 to 1.02

Fly ash or GGBFS used as an additive may only be incorporated in the concrete mix between April 1 and October 15 of the same calendar year.

Chemical admixtures type A, type B, type C, type D, and type E may be permitted with prior written approval.

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.

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.

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 (2 m). 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.

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

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. Dowel bars shall be coated with a bond breaking material and the coating shall be evident at the time of placement.

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. (6 mm).

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.

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. (6 mm) 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 (3 m) 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.

Forms shall be kept a minimum of 500 ft (150 m) ahead of concrete placement when distance permits. 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

Concrete mixing and transportation shall be completed by central mixed, shrink mixed, or transit mixed methods. The minimum batch of concrete shall be 2 yd^3 (1.5 m^3). Discharge from non-agitating equipment shall be completed within 30 min of mixing the water, cement, and aggregates. Discharge from a truck agitator or a truck mixer shall be completed within 90 min of mixing the water, cement, and aggregates.

Concrete shall be uniformly mixed when delivered to the job site. Batch tickets for each load of PCC shall indicate the weight (mass) of cement, pozzolan, and aggregates, volume or weight (mass) of water, and the type and volume of admixtures. The weight (mass) of the cement shall be within 1% of the CMDP, the saturated surface dry weight (mass) of the aggregates shall be within 2% of the CMDP, and the volume or weight (mass) of water shall be within 1% of the required amount.

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. (25 mm) when the average slump is 3 in. (75 mm) or less, or by more than 2 in. (50 mm) when the average slump is greater than 3 in. (75 mm), 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 min 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. A maximum overload of 10% may be permitted provided strength and consistency remain satisfactory and no spillage of concrete takes place.

(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.

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.

(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 competed prior to 300 revolutions of the drum.

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 (2°C) and rising. PCCP operations shall be discontinued when the ambient temperature is descending and is 40°F (4°C) 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 502.18. 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 (10°C) and not more than 80°F (27°C) at the time of placement.

When the water or the aggregates are heated, they shall be a minimum of 70°F (21°C) or a maximum of 150°F (66°C). When either aggregates or water are heated to above 100°F (38°C), 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.

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.

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.

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

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

The Contractor and 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

When fly ash, GGBFS, or cement type IP, type IS, type IP-A, or type IS-A is incorporated into the PCCP, traffic shall not be allowed on the PCCP until the test beams indicate a modulus of rupture of 550 psi (3800 kPa) or greater. Opening to traffic of PCCP not containing the above additives shall be based on the following.

(a) Construction

Construction vehicles or equipment may be allowed on the PCCP after 10 days or when the test beams indicate a modulus of rupture of 550 psi (3800 kPa) or greater. Any construction vehicle or equipment that may damage the PCCP shall not be used on the PCCP unless adequate protection is provided. Approved joint cutting saws may be operated on the PCCP as determined by the Contractor.

(b) Non-Construction

PCCP may be opened to traffic after 14 days or when test beams indicate a modulus of rupture of 550 psi (3800 kPa) or greater. Prior to opening to traffic, cracks and joints shall be sealed in accordance with 503.05 and the PCCP shall be cleaned.

502.19 Shoulder Corrugations

Shoulder corrugations shall be in accordance with 606.

502.20 Pavement Smoothness

Pavement smoothness will be in accordance with 501.25 except profilograph requirements will not apply.

502.21 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. (100 mm) 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 (0.6 m) of the edge of PCCP, over dowels, or within 5 ft (1.5 m) 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. (13 mm) deficient in thickness, additional cores shall be drilled at 20 ft (6.0 m) 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 (6.0 m) intervals until two successive cores indicate a thickness deficiency of 1/2 in. (13 mm) or less, or where cores can no longer be drilled in the new PCCP.

If a core indicates a thickness deficiency of more than 1.0 in. (25 mm) and two cores drilled adjacent at 20 ft (6.0 m) intervals indicate a thickness deficiency of not more than 1.0 in. (25 mm), additional cores shall be drilled at 5 ft (1.5 m) intervals on each side of the initial core. The drilling shall continue in both directions at 20 ft (6.0 m) intervals until two successive cores indicate a thickness deficiency of 1/2 in. (13 mm) or less, or where cores can no longer be drilled in the new PCCP.

When a single core indicates a thickness deficiency of more than 1.0 in. (25 mm), or if two or more adjacent cores indicate a thickness deficiency of more than 1/2 in. (13 mm), 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 a 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

The quantity of PCCP for each pay item will be defined as a section. The section will be divided into subsections of 1200 syd (1000 m^2). Sections less than 1200 syd (1000 m^2) 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 1200 syd (1000 m^2) shall have a minimum of four cores drilled. Partial subsections shall not be cored unless otherwise directed. Widening of 3 ft (1.0 m) 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 (3 m) across the width of the drive. Any location deficient in thickness by 1/4 in. (6 mm) or more shall be corrected prior to placing PCCP.

(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 0.5 in. (13 mm) will be recorded as the specified PCCP thickness plus 0.5 in. (13 mm). Calculations shall be to the nearest 0.1 in. (2.5 mm).

(c) PCCP Adjusted Payment

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 0.5 in. (13 mm), 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 = The placed quantity of the PCCP section
M = The average PCCP thickness of the section
S = The specified PCCP thickness of the section
U = Unit bid price

(d) PCCP Non-Payment

Where two adjacent cores indicate a thickness deficiency of more than 1/2 in. (13 mm), 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. (13 mm) 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. (13 mm).

(e) PCCP Removal

Where two adjacent cores indicate a thickness deficiency of more than 1.0 in. (25 mm) the PCCP shall be removed and replaced. Non-adjacent cores indicating a thickness deficiency of more than 1.0 in. (25 mm) 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. (13 mm).

502.22 Method of Measurement

PCCP will be measured by the square yard (square meter) 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 shoulder corrugations will be measured in accordance with 606.02.

502.23 Basis of Payment

The accepted quantities of PCCP will be paid for at the contract unit price per square yard (square meter) for the thickness specified, complete in place.

Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment will be made for portland cement content of more than 564 lbs/yd^3 (335 kg/m^3) when ordered in writing. Additional payment for the quantity used will be at the net unit price of portland cement as shown by certified vouchers for the quantity used in accordance with 109.05.

The quality assurance adjustment quantity for thickness will be determined in accordance with 502.21(c).

An adjustment to the contract payment with respect to thickness will be made utilizing the quality assurance adjustment pay item. The unit price for this pay item will be one dollar ($1.00). The quantity is the total calculated in accordance with 502.21(c). A change order developed in accordance with 109.05 will be prepared to reflect contract adjustments.

Payment for pavement thickness determinations will be made at the contract lump sum price for coring, PCCP in accordance with 501.31. A change order in accordance with 109.05 will be developed to adjust the cost of PCCP when the final PCCP quantity differs from the bid quantity by more than 2400 syd (2000 m^2). This adjustment covers the cost of cores for the adjusted quantity of PCCP. The adjustment, plus or minus, will be based on the difference in the number of subsections, rounded to the nearest full subsection, times $100.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
PCCP, _____, in. (mm)	SYS (m2)
thickness	
Quality Assurance Adjustment	DOL

No additional payment will be made for PCCP which has an average thickness above that shown on the plans.

The cost of trial batch demonstrations shall be included in the cost of PCCP.

The cost of corrections for pavement smoothness and re-texturing shall be included in the cost of PCCP.

Removal and replacement of PCCP found to be deficient or damaged by freezing shall be completed with no additional payment.

The cost of coring and refilling of the pavement holes for appeals shall be included in the cost of PCCP.

SECTION 503 – PCCP JOINTS

503.01 Description

The construction of PCCP joints, dowel bar assemblies, and joint sealing operations shall be in accordance with the following.

MATERIALS

503.02 Materials

Materials shall be in accordance with the following:

Chemical Anchor	901.05
Dowel Bars	910.01(b)10
Epoxy Coated Reinforcing Bars	910.01(b)9
Joint Filler	906.01
Joint Materials	906
PCC Sealer/Healer	901.06
Reinforcing Bars	910.01

Tie bars shall be epoxy coated reinforcing bars.

Bent tie bars shall be deformed billet steel in accordance with 910.01 and ASTM A 615 (A 615M), grade 40 (300).

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.

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. (6 mm). 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

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 (5.5 m).

Sawed contraction joints shall be cut in two operations. The initial saw cut shall commence as soon as the concrete has hardened sufficiently to permit 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 used where conditions make sawing impractical.

The second saw cut shall be made after the concrete has sufficiently cured, but before opening the pavement to non-construction traffic. Slurry or saw residue remaining in the slot shall be immediately flushed. Construction traffic shall not be allowed on the PCCP after the second 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.

(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 16 ft (5.0 m). Tie bars shall be placed by mechanical equipment in accordance with 508.04(a), or rigidly secured in place by chairs, or other approved methods.

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 initial D-1 contraction joint slots. If random cracking occurs ahead of sawing, the sawing operations shall be discontinued in that area. A second saw cut shall be made when construction traffic uses the PCCP prior to sealing. 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

Transverse construction joints shall be constructed when there is an interruption of more than 30 min 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 (2 m) 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 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 (10 m) during straightening.

The longitudinal construction joint for shoulder widths less than 6 ft (1.8 m) may be replaced by a longitudinal joint or be eliminated by extending the type D-1 contraction joint through the shoulder. If either option is used, the mainline and shoulder shall be constructed at the same time.

(e) Terminal Joints

Terminal joints shall consist of a sleeper slab, polyethylene bond breaker, and HMA mixtures. The polyethylene bond breaker shall be an approved polyethylene sheeting having a thickness of 6 mils (150 µm) or greater. HMA mixtures shall consist of type B surface and intermediate mixtures in accordance with 402.04. A MAF in accordance with 402.05 will not apply. Aggregate requirements of 904.03(d) do not apply. The portion of the sleeper slab on which the polyethylene bond breaker is to be placed shall be finished to a smooth trowel finish.

(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.

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. (6 mm) 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 will be permitted within the expansion joint.

(g) Retrofitted Tie Bars

Retrofitted tie bars shall be secured at right angles to the pavement with a chemical anchoring system.

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 A 82. 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 (7 mm) 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 permit 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 ties shall be provided to hold the assembly in correct position during installation.

(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 (7 mm) or greater wire. Otherwise, the support shall be 1/4 in. (6 mm) or greater in diameter.

(f) 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. (300 mm) below the dowel bar assembly. Pins shall be size W 7.5 (7 mm) 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 8 pins shall be used for each 10, 11, or 12 ft (3.0, 3.4, or 3.7 m) section of assembly. A minimum of 10 pins shall be used for assembly sections greater than 12 ft (3.6 m) and less than or equal to 16 ft (5.0 m).

(g) After the dowel bar assembly is securely in place, all tie wires which parallel the dowel bars, and are welded to the two continuous parallel spacer bars, shall be cut near the center of the tie.

(h) Dowel bars shall be placed 6 in. (150 mm) from the edges of the pavement and spaced at 1 ft (0.3 m) on center across the joint.

503.05 Sealing Cracks and Joints

Cracks and joints in the PCCP shall be cleaned and sealed 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.

When preformed elastomeric joint seals are used, the material shall be installed in one continuous piece by means of an approved machine. The seal shall not be stretched more than 5% while being placed and show no twisting, rollover, folding, cutting, or excess lubricant-adhesive on the top of the seal. Elastomeric joint seal may be installed in two separate pieces for phased construction with the splice point occurring at the highest point of the joint. The splicing method used shall be in accordance with the seal manufacturer's recommendations.

503.06 Random Crack Remediation

Random cracks shall be satisfactorily corrected.

(a) Transverse

Random cracks shall be corrected by PCCP replacement. The replacement shall be full lane width and a minimum of 6 ft (1.8 m) 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 or epoxy coated tie bars. PCCP replacement areas shall have dowel bars which match contraction joints in any adjacent panels.

(b) Longitudinal

Random cracks within 18 in. (450 mm) 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 C 881, grade 1.

Random cracks outside 18 in. (450 mm) of a longitudinal joint shall be satisfactorily corrected by routing and sealing or by PCCP replacement. PCCP with random cracks where differential movement has occurred shall be replaced in accordance with 503.06(a).

503.07 Method of Measurement

D-1 contraction joints and terminal joints will be measured by the linear foot (meter). The pay length for terminal joints will equal the width of the PCCP.

Retrofitted tie bars will be measured by the number of units installed.

503.08 Basis of Payment

D-1 contraction joints and terminal joints will be paid for at the contract unit price per linear foot (meter), complete in place.

Retrofitted tie bars will be paid for at the contract unit price per each, complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
D-1 Contraction Joint	LFT (m)
Retrofitted Tie Bars	EACH
Terminal Joint	LFT (m)

The cost of furnishing and placing all materials, not specified as a pay item, shall be included in the cost of PCCP.

The cost of dowels, dowel bar assemblies, backer rod, joint sealants and all necessary incidentals shall be included in the cost of D-1 contraction joints.

The cost of the sleeper slab, reinforcing steel, bond breaker, and HMA mixtures 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:

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.

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.

The PCCP surface shall be textured with a double thickness burlap drag or a minimum 4 ft (1.2 m) wide turf drag.

The textured surface of PCCP shall be tined, unless otherwise specified. Tining shall consist of transverse grooves that are between 3/16 and 1/8 in. (2.3 and 3.3 mm) in width, between 1/8 and 3/16 in. (3 and 4.8 mm) 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. (16 mm, 25 mm, 22 mm, 16 mm, 31 mm, 19 mm, 25 mm, 25 mm,25 mm, 25 mm, 19 mm, 22 mm, 44 mm, 22 mm, 9 mm, 25 mm, 25 mm, 31 mm, 38 mm, 22 mm, 19 mm, 22 mm, 25 mm, 22 mm, 25 mm). 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.

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. (19 mm) center to center and be 1.8 in. (3.0 mm) in width and depth. Alternative patterns may be used, subject to approval. The PCCP surface, after cutting, shall not be polished.

504.04 Curing

Curing materials shall be applied to exposed surfaces and sides of newly placed PCCP within 30 min 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. (300 mm) wide or greater.

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.

Curing shall be continuous for 96 h unless a longer period is ordered and shall be in accordance with the following.

(a) Liquid Membrane Forming Compounds

Immediately after surface water has disappeared, a uniform coating of the liquid membrane forming curing compound shall be applied.

The compound shall be applied in a continuous uniform film at a rate not less than 1 gal./150 ft^2 (1 L/3.7 m^2). It shall be applied in two applications. The curing compound may be warmed in a water bath during cold weather at a temperature not exceeding 100°F (38°C). Thinning with solvents will not be permitted. Non-uniform film rates will result in the discontinuance of that application method.

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

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. (300 mm) or more and the laps held securely in place.

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.

(d) Straw

The PCCP shall be covered with wet burlap, laid directly on the surface, that is kept wet with a fine spray of water. The burlap shall be removed by 9:00 A.M. the day following its placement and the surface immediately covered with straw no less than 3 in. (75 mm) deep. The straw shall be thoroughly saturated immediately after being placed, and kept wet for the required curing period. After the cure period, the straw shall be removed from the pavement and disposed of properly.

Straw curing shall not be used in cities or towns unless written permission is obtained.

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.

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 C 173**
Flexural Strength	AASHTO T 97*
Making and Curing Specimens	AASHTO T 23*
Sampling Fresh Concrete	AASHTO T 141
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

* 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 C 173.

The chosen method of concrete consolidation shall be the same for all concrete test specimens.

(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 permitted.

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.

(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. (1.0 mm).

2. The test result shall be discarded when the break occurs outside the middle third of the beam.

(c) Exceptions to AASHTO T 121

The exceptions to AASHTO T 121 for determining the unit weight of concrete shall be as follows.

1. A strike-off bar in accordance with AASHTO T 152 may be used in lieu of a strike-off plate.

2. Weight (mass) shall be determined to the nearest 0.01 lb (0.005 kg).

(d) Exceptions to AASHTO T 141

The exceptions to AASHTO T 141 for sampling fresh concrete shall be as follows.

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.

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.

SECTION 506 – PCCP PATCHING

506.01 Description

This work shall consist of the removal and replacement of PCCP in accordance with 105.03.

MATERIALS

506.02 Materials

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
Coarse Aggregate, Class AP, Size No. 8	904
Dowel Bars	910.01(b)10
Fine Aggregate, Size No. 23	904
Portland Cement	901.01(b)
Water	913.01

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 patching shall be stone or gravel.

A bonding agent shall be selected from the Department's list of approved 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 and approved by the DMTE. 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.

(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 batch weights (mass)
(g) the names of all admixtures
(h) the admixture dosage rates and the manufacturer's recommended range

The CMDS is used to conduct a trial batch in accordance with 506.05. Upon completion of the trial batch, the Contractor shall submit results of the concrete mix design trial to the DMTE for approval a minimum of three work days prior to production utilizing the Department provided spreadsheet. The DMTE will approve the submission as a CMDP, and production may commence. Both the Contractor's and the Engineer's tests will be included in the CMDS submittal.

(a) Change in Material

A change in a CMDP to any of the following requires a new CMDS.

1. cement type
2. admixture type
3. aggregate material

(b) Change in Source

A change in a CMDP to any of the following requires a new CMDS.

1. cement source
2. admixture source
3. aggregate source

Verification of the new CMDS will be conducted during production including sampling and testing within the first 10 cyd (8 m^3), for the following.

1. cement source, type I only
2. admixture source, air entraining admixtures only

A new CMDP will be issued upon approval of test verification by the DMTE.

(c) Change in Mixture

A change in a CMDP to any of the following requires a new CMDS.

1. proportions of aggregates by weight (mass) exceeding ± 2%
2. addition or deletion of an admixture

A CMDP in accordance with 506.04 in the current or previous calendar year may be substituted for use upon the approval of the DMTE.

506.04 Concrete Mix Criteria

The fine aggregate shall be at least 35% but not more than 45% of the total weight (mass) of the aggregate in each cubic yard (cubic meter). Proportions will be based upon SSD aggregates.

The CMD shall produce workable concrete mixtures, with the minimum amount of water, having the following properties:

Minimum portland cement content ..... 658 lbs/cy^3 (390 kg/m^3)
Maximum water/cement ratio 0.45
Minimum slump .....2 in. (50 mm)
Air Content.....6.5% ± 1.5%
Minimum Flexural strength, third point
loading..... 300 psi (2100 kPa) at 24 h
Minimum flexural strength, third point
loading.....500 psi (3500 kPa) at 3 days

When calcium chloride solution is added, a maximum of 2%, by weight (mass) of cement, shall be used. The percentage shall be reduced to one if the ambient temperature is above 80°F (27°C). If the mixture is used in a 805 application, calcium chloride shall not be used.

506.05 Trial Batch

A trial batch shall be produced and tested to verify that the CMD is in accordance with the concrete mix criteria. 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. The Engineer will test the concrete's air content and determine the water/cement ratio, and prepare and test flexural beams. The flexural strength will be determined by averaging a minimum of two beam breaks. The Engineer will provide the Contractor the results of the tests.

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.

506.06 Job Control

Control of PCCP for air content 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 will be on the first load of the day and once per every 50 cyd (40 m^3). Beams will be made once per every 150 cyd (120 m^3) and tested for compliance with three day flexural strength requirements.

The Engineer will notify the Contractor when test results for air content or flexural strength are outside the requirements of 506.04. Rounding will be in accordance with 109.01(a).

CONSTRUCTION REQUIREMENTS

506.07 PCCP Removal

PCCP removal areas will be marked. Vertical saw cuts around the perimeter of the removal areas shall be made in the PCCP. Transverse cuts shall be perpendicular to the centerline of the PCCP.

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

The saw cut shall be a minimum of 1 in. (25 mm), to a maximum of 3 in. (75 mm). Removal of all unsound concrete to a minimum depth of 1 in. (25 mm) shall be by hand chipping tools or hand held mechanically driven equipment. Mechanical hammers shall not be heavier than a nominal 45 lb (21 kg) class. Mechanically driven tools shall be operated at a maximum angle of 45 degrees from the PCCP surface. If the saw cut face is damaged, a parallel saw cut 1 in. (25 mm) outside the initial saw cut shall be made and the concrete in this area shall be removed by hand chipping.

Reinforcing steel encountered during the removal operation shall be cause for a full depth patch in accordance with 506.07(b). Wire mesh reinforcement exposed during the removal operations shall be removed.

Exposure of unsound concrete below 3 in. (75 mm) shall be cause for a full depth patch in accordance with 506.07(b).

The 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

The saw cut shall be full lane width and thickness of the PCCP. 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 (3.0 m) 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 increased to a minimum of 1 ft (0.3 m) beyond the joint.

Full depth removal shall be extended until sound PCCP is encountered to allow dowel bars to be firmly anchored.

All subbase material disturbed during the removal operation shall be recompacted as directed.

506.08 Concrete Mixing and Transportation

Concrete mixing and transportation shall be completed by central mixed, shrink mixed, or transit mixed methods. Discharge from non-agitating equipment shall be completed within 30 min of mixing the water, cement, aggregates, and calcium chloride solution. Discharge from a truck agitator or a truck mixer shall be completed within 90 min of mixing the water, cement, and aggregates or within 30 min 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.

Concrete shall be uniformly mixed when delivered to the job site. Tickets for each load of PCC shall indicate the weight (mass) of cement, and aggregates, volume of water, and the type and volume of admixtures. The weight (mass) of the cement shall be within 1% of the CMDP and the saturated surface dry weight (mass) of the aggregates shall be within 2% of the CMDP.

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 min of initial mixing. Any addition of water shall be noted on the ticket and shall not occur as a continuing operation.

(a) Central Mixed Concrete

Central mixed concrete shall be in accordance with 502.10(a).

(b) Shrink Mixed Concrete

Shrink mixed concrete shall be in accordance with 502.10(b).

(c) Transit Mixed Concrete

Transit mixed concrete shall be in accordance with 502.10(c).

506.09 Weather Limitations

Placement of PCCP patches in continuous reinforced concrete pavement shall be after 1:00 P.M. when the next day's forcasted ambient temperature is 70°F (21°C) or greater, unless otherwise directed.

PCCP patches shall not be placed on frozen subgrade, subbase, or PCCP.

506.10 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.

The PCCP patch shall be cured in accordance with 504.04(a). In addition, polyethylene film shall be placed over the patch and covered with a 4 in. (100 mm) layer of rigid or flexible insulation and firmly anchored. Small dimension lumber weighted

with sandbags may be used, but large objects such as rocks or concrete blocks will not be permitted.

The PCCP patch shall be inspected in accordance with 502.17.

(a) Partial Depth

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

Patches shall be anchored with dowel bars to the adjacent PCCP as shown on the plans. Dowel bars shall be installed using a chemical anchoring system.

Patches constructed adjacent to transverse contraction joints or random cracks that are to remain in place shall be constructed with type D-1 contraction joints. The joint shall be made continuous across the width of the PCCP to match the existing joint or random crack. Patches greater than 18 ft (5.5 m) shall have type D-1 contraction joints in accordance with 503.03(a).

Concrete shall be placed around manholes or similar structures in accordance with 720.

Sawing and sealing of transverse joints may be omitted when the existing PCCP is to be overlaid as part of the contract.

506.11 Opening to Traffic

A patch may be opened to traffic in accordance with the following when calcium chloride is used.

T	H	HT	T	H	HT
40-42°F (4-5°C)	30	26	61-63°F (16-17°C)	14	9
43-45°F (6-7°C)	27	23	64-66°F (18-19°C)	14	9
46-48°F (8-9°C)	24	21	67-69°F (20-21°C)	14	8
49-51°F (10-11°C)	21	19	70-72°F (22°C)	14	7
52-54°F (12°C)	19	16	73-75°F (23-24°C)	14	6
55-57°F (13-14°C)	16	14	Above 75°F (Above 24°C)	14	5
58-60°F (15°C)	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 permitted by the above table if test beams indicate a modulus of rupture of 300 psi (2100 kPa) or greater ITM 402 may be used as an alternative method to determine the flexural strength.

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 (2100 kPa) or greater. ITM 402 may be used as an alternate method to determine the flexural strength.

506.12 Method of Measurement

Partial depth patching and full depth patching will be measured by the square yard (square meter).

PCCP removal, subbase and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, dowel bars, reinforcing bars, chemical anchor system, concrete, finishing, and curing, and sawing and sealing of joints will not be measured for payment.

506.13 Basis of Payment

PCCP patching will be paid for at the contract unit price per square yard (square meter) for the type of patching required.

Partial depth patches which have been directed to be full depth will be paid for at the contract unit price per square yard (square meter) for PCCP patching, partial depth, plus 80% of the contract unit price per square yard (square meter) for PCCP patching, full depth.

Payment will be made under:

Pay Item	Pay Unit Symbol
PCCP Patching, Full Depth	SYS (m2)
PCCP Patching, Partial Depth	SYS (m2)

The cost of PCCP removal, subbase, and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, dowel bars, reinforcing bars, chemical anchoring system, concrete, finishing and curing, and sawing and sealing of joints shall be included in the cost of PCCP patching.

The cost to repair or replace adjacent PCCP or shoulder damaged by the Contractor shall be included in the cost of PCCP patching.

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

Materials shall be in accordance with the following:

Asphalt Emulsion AE-90, AE-90S, AE-150	902.01(b)
Dowel Bars	910.01(b)10
Fine Aggregates, Size No. 23 or 24	904
Joint Sealing Materials	906.02
Rapid Set Patching Materials	901.07

CONSTRUCTION

507.03 Cracks

Sealing and filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F (4°C), or when other unsuitable conditions exist, unless approved by the Engineer.

(a) Routing, Cleaning and Sealing

Cracks in PCCP shall be routed and cleaned when specified. Cracks shall be routed with a vertical-spindle router with carbide-tipped or diamond router bits to form a reservoir not exceeding 0.5 in. (13 mm) wide with a minimum depth of 0.75 in. (19 mm). 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 (690 kPa). Water blasting shall not be utilized.

Cracks shall be sealed with asphalt rubber in accordance with the manufacturer recommendations within 0.25 in. (7 mm) of the surface. A distributor in accordance with 409.03 shall be used with an indirect-heat double boiler kettle and mechanical agitator. The asphalt rubber shall be placed utilizing a "V" shaped wand tip, to allow the penetration of the materials into the cracks.

Application of asphalt rubber 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 rubber has set.

(b) Cleaning and Filling

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 (690 kPa). Water blasting shall not be utilized.

Cracks shall be filled with asphalt emulsion. The cracks shall be completely filled or overbanded not to exceed 5 in. (125 mm), or as required. Asphalt emulsion 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 to prevent tracking of the asphalt emulsion. All excess cover material shall be removed from the pavement.

Application of asphalt emulsion 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 emulsion 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 (4°C), or when other unsuitable conditions exist, unless approved by the Engineer.

(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 (690 kPa). Water blasting shall not be utilized. 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. Traffic may be allowed on the PCCP for up to 7 calendar days after the saw cutting prior to sealing.

Joints shall be sealed with joint sealing materials in accordance with the sealant manufacturer's recommendations. Transverse joints shall be sealed with silicone sealant or preformed electrometric joint sealant. Longitudinal joints shall be sealed with an asphalt rubber 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

Joints in PCCP 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 (690 kPa). Water blasting shall not be utilized.

Joints shall be filled with asphalt rubber in accordance with the manufacturer's recommendations within 0.25 in. (7 mm) of the surface. A distributor in accordance with 409.03 shall be used with an indirect-heat double boiler kettle and mechanical agitator. The asphalt rubber shall be placed utilizing a "V" shaped wand tip, to allow the penetration of the materials into the joints.

507.05 PCCP Patching

(a) Full Depth Patching

PCCP patching shall be in accordance with 506.

(b) Partial Depth Patching

Partial depth patching shall be constructed at locations shown on the plans. Existing joints directed to be patched partial depth, shall be milled to a depth of 3 in. (75 mm) the full width of the lane. The minimum length of milling is 6 in. (150 mm) beyond the map-cracked area. The milled area shall be cleaned of all loose material prior to patching. Cleaning shall be by blowing the milled areas with compressed air at a minimum pressure of 100 psi (690 kPa). When the milled areas are satisfactorily cleaned, the milled areas shall be tacked with AE-T in accordance with 406 and patched with HMA.

The milled areas shall be filled with HMA partial depth patching. Partial depth patches shall consist of HMA Surface, type A in accordance with 402.04. MAF in accordance with 402.05 will not apply. The mixture shall be compacted by a vibratory roller in accordance with 409.03(d). A minimum of four passes of the rollers shall be completed. Partial depth patches shall be completed during work hours and opened to traffic at the close of the workday. Mixtures will be accepted in accordance with 402.09.

507.06 Profiling

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 502.28(d) after the cracks are routed, cleaned, and sealed in accordance with 507.03 and joints are sawed, 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 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 (7 kg) in weight (mass) and shall be operated at a maximum angle of 45 degrees 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 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 routed and sealed for the full lane width in accordance with 503.05.

PCCP damaged outside the area of the slots due to Contractor's operations shall be repaired in an acceptable manner or replaced.

507.09 Method of Measurement

Routing and sealing of cracks, filling of cracks, sawing and sealing of joints, and filling of joints will be measured by the linear foot (meter), 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 506.12. Profiling, regardless of depth, will be measured by the square yard (square meter). Asphalt material and drilled holes for undersealing will be measured in accordance with 612.06.

HMA partial depth patching will be measured by the ton (megagram), in accordance with 109.01(b).

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.

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

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 (meter), complete in place. The accepted quantities of retrofit load transfer will be paid for at the contract unit price per each assembly installed, compete in place. PCCP patching will be paid for in accordance with 506.13. Profiling will be paid for by the square yard (square meter). Undersealing and drilled holes will be paid for in accordance with 612.07. The accepted quantities for HMA partial depth patching will be paid for at the contract unit price per ton (megagram), complete in place.

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:

Pay Item	**Pay Unit Symbol**
Cracks in PCCP, Rout and Seal	LFT (m)
Cracks in PCCP, Filled	LFT (m)
HMA Partial Depth Patch	TON (Mg)
Joints in PCCP, Saw and Seal	LFT (m)
Joints in PCCP, Filled	LFT (m)
Profiling PCCP	SYD (m2)
Retrofit Load Transfer	EACH

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 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.

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

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 (mass) by means of automatic and interlocked proportioning devices. PCCP produced in accordance with 500 shall document each ingredient in each batch.

All scales and other measuring devices shall be accurate to within ± 0.5% throughout their range unless otherwise approved. For applied loads less than 1,000 lb (450 kg) on the cement scale and 4,000 lb (1800 kg) on the aggregate scale, the scales shall be accurate to 2.0% or one gradation.

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 accuracy of the proportioning system shall be as follows.

admixtures	± 3%
aggregates	± 2%
cementitious materials	± 1%
water, volume or weight (mass)	± 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 (mass) of all materials in the mix, volume or weight (mass) 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.

(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

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

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.

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 permit the batch to be discharged until the specified mixing time has elapsed.

2. Truck Mixers

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.

(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

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 (mass) 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.

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 min. The amplitude of vibration shall be between 0.025 in. (0.6 mm) and 0.06 in. (1.5 mm). The vibrators shall be spaced and operated to achieve acceptable consolidation. The paver shall include a hand held 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.

(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 (3 m) 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. 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 (3.0 mm in 3 m) and the upstanding leg shall not vary by more than 1/4 in. (6 mm). The forms shall contain provisions for locking the ends of abutting form sections together tightly for secure setting.

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 (4.2 m). The length of the float shall be approximately 2 in. (50 mm) 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. 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 3500 impulses per min or greater. The frequency of the internal type shall have no less than 5000 impulses per min for tube vibrators and spud vibrators shall have a frequency of from 10,000 to 12,000 impulses per min in air. The paver shall include a device, such as a hand held 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 (0.6 m). 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.

(c) Hand Placement

1. Steel Forms

Steel forms shall be 10 ft (3 m) or greater in length. Forms shall be capable of being staked in three locations or more for each 10 ft (3 m) 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 (3.0 mm in 3 m).

2. Wood Forms

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.

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 (0.6 m) 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.

A vibratory screed finisher shall consist of a truss frame with a minimum base width of 1 ft (0.3 m), which extends across the transverse width of the PCCP. The frame shall extend 2 ft (0.6 m) beyond the width of the PCCP and shall hold its shape when moved forward. The screed shall move forward with either hydraulic or manual wenches, 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.

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 7000 to 10,800 impulses per min in air. The diameter of the head shall be 1 1/4 to 2 1/2 in. (32 to 64 mm).

508.05 Curing

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 (1 L/3.7 m^2) and shall be of the fully 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

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

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 (1.5 m) in length and 6 in. (150 mm) in width. Equipment made of or coated with aluminum or aluminum alloys shall not be used.

Straight edges shall be 10 ft (3 m) in length and mounted on a long handle. The handle shall be 3 ft (1 m) longer than one-half 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 (550 kPa).

Water blasting equipment shall be capable of operating at 1500 psi (10 MPa) without damaging the PCCP.

(c) Grinding

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. (900 mm) 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 permitted.

508.09 Testing Facility and Equipment

(a) Testing Facility

The test 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.

A current set of AASHTO's Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II Tests, and ASTM C 173 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.

(c) Profilograph

The profilograph shall be in accordance with ITM 912.

(d) Straightedge – 16 ft (4.9 m)

A 16 ft (4.9 m) straightedge shall be a rigid beam mounted on two solid wheels on axles 16 ft (4.875 m) 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.

(e) Straightedge – 10 ft (3 m)

A 10 ft (3 m) straightedge is the same as a 16 ft (4.9 m) straightedge except that the wheels are mounted 10 ft (3.048 m) apart. A hand held rigid beam may be substituted.

SECTION 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.

MATERIALS

601.02 Materials

Materials shall be in accordance with the following:

Rail Accessories, Fittings, and Hardware 910.11
Steel Guardrail Posts 910.10
Steel Thrie-Beam Rail.....910.09
Steel W-Beam Rail.....910.09
Timber Posts and Blocks.....911.02(f)

All guardrail, post, accessories, fittings, and hardware shall be supplied from a source listed on the Department's list of approved Certified Guardrail Suppliers in accordance with 910.12. Guardrail end treatments shall be selected from the Department's list of approved Guardrail End Treatments in accordance with 601.07 and impact attenuators shall be selected from the Department's list of Approved Impact Attenuators in accordance with 601.08.

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 aggregate used in the barrels shall be uncrushed gravel, class F or higher, in accordance with 904 and the following gradation requirements.

Sieve Size	% Passing
1/2 in. (12.5 mm)	100
No. 50 (300 µm)	0-5
No. 100 (150 µm)	0-2

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.

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, 910.11, and 910.12.

The 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. In locations where conditions will not allow the use of 7 ft (2130 mm) posts, 6 ft (1830 mm) posts may be substituted when approved.

The base metal thickness of the steel W-beam rail element for a curved guardrail system shall be 0.105 in. (3 mm). The base metal thickness of the steel W-beam terminal connector shall be 0.138 in. (3.5 mm). The wood 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 A 500. The remaining steel components shall be in accordance with 910.

CONSTRUCTION REQUIREMENTS

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 permit the use of normal driving equipment. Where subsurface conditions prohibit driving the posts, a 12 in. (300 mm) diameter hole shall be bored to the required embedment depth. The hole shall be backfilled with suitable material in 6 in. (150 mm) 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.

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.

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 blocks 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 blocks 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 (6 m).

All damaged galvanized surfaces shall be coated in accordance with 910.11(a)4.

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

Blocks 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 (46 m) 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.

Where the W-beam terminal connector is lapped on the outside of the guardrail, a galvanized 1 in. (25 mm) inside diameter, 2 in. (50 mm) outside diameter, 0.134 in. (3.4 mm) 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 (67.8 Nm).

The installation of the type 5 anchor shall include tightening the cable with the swaged end to eliminate all slack.

The W-beam rail in the type 5 anchor shall be attached to the steel pipe with 5/8 in. (M16) diameter x 1 1/4 in. (32 mm) 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. The fabrication, assembly, and installation of thrie-beam components and timber posts and blocks for guardrail transitions will be required for the locations shown on the plans.

601.07 Guardrail End Treatments

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 Department's list of approved 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 Department's list of approved Guardrail End Treatments. The reflectorization of guardrail end treatments, and the grading requirements shall be as shown on the plans.

Double facing of guardrail end treatment type I will be required when it is used in conjunction with double faced guardrail.

Each unit shall be installed in accordance with the manufacturer's recommendations.

Assembly and installation 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. A copy of the installer's certificate shall be provided to the Engineer prior to the start of the work.

The Contractor shall provide the Department with original copies of all necessary current manufacturer's installation manuals and shop drawings prior to beginning installation work. Shop drawings shall be a minimum of 22 by 34 in. (550 by 850 mm) in size. No installation work shall begin prior to the Department's receipt of such manuals and drawings. Such manuals and drawings will remain the property of the Department. If there is a discrepancy between the shop drawings and the plans, the shop drawings shall govern.

When installing end treatments to existing rub rail type guardrail, the rub rail, if not 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.

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 Department's list of approved Impact Attenuators. Each unit shall be placed in accordance with the manufacturer's recommendations, on a PCC pad.

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. 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 original copies of all necessary current manufacturer's installation manuals and shop drawings prior to beginning installation work. Shop drawings shall be a minimum of 22 by 34 in. (55 by 850 mm) in size. No installation work shall begin prior to the Department's receipt of such manuals and drawings. Such manuals and drawings will remain the property of the Department. If there is a discrepancy between the shop drawings and the plans, the shop drawings shall govern.

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.

If a spare parts package is required for the unit being installed, such package shall consist of those parts which are shown on the list provided by the manufacturer. The spare parts shall correspond to those shown on the list for the unit to be placed. The package shall be delivered to the location directed and will become the property of the Department.

Impact attenuators may be placed on the Department's approved list based on the manufacturer's documentation subject to the Department's acceptance. The manufacturer shall provide a copy of the test report stating that its product fully complies with the requirements of NCHRP 350 crash test level 3, and that its product has been approved by the FHWA. Products will be maintained on the Department's approved list by a manufacturer's certification submitted annually in October and the Department's continued acceptance. This certification shall state that the product has not been changed since the NCHRP 350 crash testing, that the NCHRP 350 test results still apply to this product, and that the FHWA approval is still applicable.

601.09 Extension of Existing Guardrail

Extension of existing rub rail type guardrail with new W-beam guardrail shall require adjusting the post heights in the last 25 ft (8 m) 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 (8 m) 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.

601.10 Removal of Existing Guardrail

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 blocks shall be removed without being damaged. The removed material shall be stored as directed.

601.11 Adjusting Existing Guardrail Height

The height of the existing guardrail shall be adjusted by the use of moveable blocks 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 blocks shall be replaced with moveable blocks installed at the proper height. Existing moveable blocks 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

(meter) along the top of the rail element, complete in place. Nested guardrail will be measured per each 100 lft (30.48 m) run placed. Modified posts for nested guardrail will be measured per each, complete in place. Guardrail transitions, 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, reset impact attenuators, and impact attenuator spare parts packages 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 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.

601.14 Basis of Payment

W-beam guardrail will be paid for at the contract unit price per linear foot (meter) 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 (meter) 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 (30.48 m) run, complete in place for guardrail, W-beam, nested. 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. W-beam guardrail with rub rail will be paid for at the contract unit price per linear foot (meter) 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 (meter). 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. Impact attenuators, reset impact attenuators, and impact attenuator spare parts packages 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 (meter). 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.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Guardrail, Adjust Height	LFT (m)
Guardrail Connector System, W-Beam, Curved, _____ (type)	EACH
Guardrail End Treatment, _____ (type)	EACH
Guardrail, Remove	LFT (m)
Guardrail, Reset	LFT (m)

Guardrail, Terminal System, W-Beam Curved, _____ type .....EACH

Guardrail Transition, _____ type .....EACH

Guardrail Transition, VH, ____ft ____in. (m) Spacing .....EACH

Guardrail, Thrie-Beam .....LFT (m)

Guardrail, Thrie-Beam, Double Faced.....LFT (m)

Guardrail, Transition, _____ type .....EACH

Guardrail, W-Beam, ____ft ____in. (m) Spacing.....LFT (m)

Guardrail, W-Beam, Cable Terminal Anchor .....EACH

Guardrail, W-Beam, Double Faced, _____ft (m) _____in. Spacing .....LFT (m)

Guardrail, W-Beam, Nested.....EACH

Guardrail, W- Beam, Shop Curved, _____ft _____in. (m) Spacing.....LFT (m)

Guardrail, WR-Beam .....LFT (m)

Impact Attenuator, _____, _____ type-width test level .....EACH

Impact Attenuator, Reset, _____, _____ type-width test level .....EACH

Impact Attenuator Spare Parts Package, _____ type-width _____ test level .....EACH

Modified Posts, Nested Guardrail .....EACH

The substitution of 6 ft (1830 mm) posts for 7 ft (2130 mm) posts where conditions will not allow the use of the longer post will be at the same contract unit price of the longer post.

The cost of resetting guardrail shall include the removal, necessary storage, resetting and replacement of damaged or missing parts and new posts as required.

The cost of reflectorization of impact attenuators and guardrail end treatments shall be included in the respective pay items.

The cost of all grading required for the guardrail buried end treatment shall be included in the cost of guardrail end treatment, type II.

The cost of earthwork, grading, and transition panel if required, and PCC pad shall be included in the cost of impact attenuator.

The cost of excavation, concrete footings, reinforcement, and structural steel tubing required for modified posts, nested guardrail, shall be included in the cost of the pay item.

The cost of all materials, including replacing damaged or missing parts, labor, and necessary incidentals required to reset impact attenuators, will be included in the cost of impact attenuator, reset.

Where guardrail transition type TGB is used with bridge railing type TR, the cost of eliminating the thrie-beam terminal connector and driving the posts to the height above ground shown on the plans shall be included in the cost of the guardrail transition.

SECTION 602 – CONCRETE BARRIER

602.01 Description

This work shall consist of the construction of concrete barriers and concrete glare screens in accordance with these specifications, and as shown on the plans.

MATERIALS

602.02 Materials

Materials shall be in accordance with the following:

Barrier Delineators	926.02(c)
Bridge Deck Overlay Materials	722.04
Cast-in-Place Barriers	702
Cast-in-Place Concrete Glare Screens	702
Construction Warning Lights	923.03
Penetrating Sealer	709, 909.09
Precast Barriers	707
Precast Concrete Glare Screen	707
Reinforcing Steel	910.01

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.

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

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 3000 psi (20.7 MPa). 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 0.25 in. (6 mm) in 10 ft (3 m) 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 0.25 in. (6 mm) across the joint, as measured from a

10 ft (3 m) 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

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 0.25 in. (6 mm) in 10 ft (3 m) from the specified cross section, as measured from a longitudinal straightedge. Where concrete pavement or concrete shoulder abuts the concrete barrier, 0.5 in. (12 mm) preformed joint filler shall be placed as shown on the plans.

Where the concrete barrier is to be placed on PCCP, epoxy coated reinforcing steel shall be placed as shown on the plans. The epoxy coated reinforcing steel shall be installed in the PCCP by drilling and grouting.

The barrier wall shall be constructed in single pours without subsequent vertical extensions.

(c) Finishing

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 permitted. 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 (1 L/1.8m^2). 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

The type, size and location of joints and preformed joint filler shall be as shown on the plans.

(f) Reflectorization

All concrete barrier shall be reflectorized with barrier delineators spaced a minimum of 40 ft (12 m) apart and centered 2 ft (600 mm) 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 (meter) 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 (meter) along the centerline of the glare screen.

602.06 Basis of Payment

Concrete barrier will be paid for at the contract unit price per linear foot (meter), complete in place. Barrier delineators used on concrete barrier will be paid for at the contract unit price per each, complete in place.

Concrete glare screen will be paid for at the contract unit price per linear foot (meter), complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Barrier Delineator	EACH
Concrete Barrier	LFT (m)
Concrete Barrier Glare Screen	LFT (m)

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:

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

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.

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 permitted, no materials shall be installed on posts or strain placed on guys and bracing set in concrete until 96 hours 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.

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

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 (5 m) centers, and for chain link fence on 10 ft (3 m) centers. In either case, a tolerance of ± 2 ft (0.6 m) 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.

Pull posts shall be set at 500 ft (150 m) maximum intervals in straight runs and at each vertical angle point of 10 degrees or more.

Corner posts shall be set at each horizontal angle point of 10 degrees 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.

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.

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

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. (25 mm) and a maximum of 4 in. (100 mm) clearance will be permitted. 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.

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 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

Fence and resetting fence will be measured by the linear foot (meter) 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 (meter) 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.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Fence, _____, _____ in. (mm) (type, height)	LFT (m)
Fence, _____, Reset (type)	LFT (m)
Fence, Farm Field, Barbed Wire, _____ in. (mm)	LFT (m)
Fence, Farm Field, Tension Wire, _____ in. (mm)	LFT (m)
Fence Gate, _____, _____ in. (mm) x _____ft (m) (type, height, length)	EACH

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.

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.

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

Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher, Size No. 53	904
Concrete, Class A	702
Detectable Warning Elements	905.05
Fine Aggregate, Size No. 23, No. 24, or No. 15	904
Joint Filler	906.01
Paint	909.05
Reinforcing Bars	910.01
Silica Sand	ASTM C 778

Hand railing shall be aluminum pipe in accordance with ASTM 221, alloy 6063, temper T52 or galvanized steel pipe in accordance with ASTM A 53, grade B, all as specified.

The detectable warning elements shall be set in thin set latex modified mortar in accordance with ANSI A108.1 or as recommended by the element manufacturer for outdoor use for adhering brick to concrete.

A type A certification in accordance with 916 for detectable warning elements and thin set latex modified mortar shall be furnished prior to use of the materials.

A type C certification in accordance with 916 for the silica sand shall be furnished prior to use of the material.

CONSTRUCTION REQUIREMENTS

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 shall not be located within the limits of the curb ramp, exclusive of flared sides. Poles shall be located so as not to impede the usage or safety of the curb ramps. Crosswalk markings shall be located such that the curb ramps shall be 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.

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.

The curb ramp running slope shall not exceed 12:1, except where conditions necessitate, a 10:1 slope may be utilized for a maximum rise of 6 in. (150 mm). Curb ramp cross slope shall not exceed 50:1 except where infeasible.

(b) Excavation

Excavation shall be made to the required depth and to a width that will permit 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.

(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.

(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 for the type specified.

(e) Finishing

The surface shall be finished with a wooden float. No plastering of the surface will be permitted. Ramp surfaces shall be coarse broomed and corrugated transverse to the slope as shown on the plans. The surface texture of the flared sides shall be coarse broomed with the striations transverse to the slope.

All exposed edges shall be finished with a 1/4 in. (6 mm) 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. (6 mm) radius.

Preformed 1/2 in. (13 mm) 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 Elements

Detectable warning elements shall be as shown on the plans. They shall be set in a thin set mortar on top of the concrete base. The concrete base shall be cleaned of all materials which might prevent the mortar from adhering to the base. The mortar shall be applied to the concrete in accordance with the manufacturer's recommendations. Where elements smaller than full sized are needed, whole elements shall be cut full depth with an appropriate power saw.

Brick joints shall be hand tight with a maximum of 1/16 in. (1.5 mm) width.

The joints between bricks shall be filled with a fine aggregate No. 15 or an equivalent sand. This filling shall be accomplished by repeated brooming of the aggregate across the face of the bricks. Excess aggregate shall then be removed from the surface.

(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 elements are to be installed. During the curing period all pedestrian traffic shall be excluded.

(i) Painting

The exposed surfaces of the curb throughout the width of curb ramps shall be painted yellow in accordance with 808.06. Silica sand shall be applied to the wet paint along the top of the curb at the rate of 6.0 lb/gal. (0.7 kg/L).

604.04 PCC Steps

PCC steps shall be in accordance with the applicable provisions of 604.03. In addition, all exposed edges shall be rounded to a 1/4 in. (6 mm) radius.

604.05 Reconstructed PCC Sidewalk

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. (100 mm) unless another depth is designated and to the width of the adjoining walk, or to a width of no less than 48 in. (1200 mm) from the 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 back of the established line shall be replaced.

Unless otherwise directed, sidewalk which must 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. (150 mm) thick, or the same depth of the existing drive, whichever is greater.

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. (50 mm). Cracked or damaged sections shall not be re-laid but shall be disposed of as directed.

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. (100 mm) in depth. Each lift shall be thoroughly compacted.

(c) Placing HMA Sidewalk

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 A in accordance with 402. A 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 and weight (mass) in accordance with 402.15. In areas inaccessible to the roller, hand tamping will be permitted. In any case, the HMA sidewalk material shall be uniformly compacted.

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.

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.

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.

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

Concrete sidewalk, reconstructed concrete sidewalk, and re-laid concrete sidewalk will be measured by the square yard (square meter) of finished surface. HMA for sidewalk will be measured by the ton (megagram) of mixture placed. Bed course material will be measured by the ton (megagram).

Concrete curb ramps will be measured by the square yard (square meter) in accordance with the pay limits shown on the plans.

Concrete steps will be measured by the cubic yard (cubic meter) based on the neat lines shown on the plans.

Hand rails will be measured by the linear foot (meter) 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.

604.11 Basis of Payment

The accepted quantities of concrete sidewalk will be paid for at the contract unit price per square yard (square meter) for sidewalk, concrete. HMA for sidewalk will be paid for at the contract unit price per ton (megagram), complete in place. Bed course material will be paid for at the contract unit price per ton (megagram). Concrete steps will be paid for at the contract unit price per cubic yard (cubic meter) for steps, concrete. Reconstructed sidewalk and re-laid sidewalk will be paid for at the contract unit price per square yard (square meter) for sidewalk, reconstruct, or sidewalk, re-lay. Joint material will be paid for at the contract unit price per linear foot (meter), complete in place.

The accepted quantities of curb ramps will be paid for at the contract unit price per square yard (square meter) for curb ramp, concrete, per the type, complete in place.

Hand rails will be paid for at the contract unit price per linear foot (meter).

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.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Bed Course Material	TON (Mg)
Curb Ramp, Concrete, _____ type	SYS (m2)
Hand Rail, _____ type	LFT (m)
HMA for Sidewalk	TON (Mg)
Joint Material	LFT (m)
Sidewalk, Concrete	SYS (m2)
Sidewalk, Concrete, Reconstruct	SYS (m2)
Sidewalk, Concrete, Re-Lay	SYS (m2)
Steps, Concrete	CYS (m3)

The cost of excavation, backfill, 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 202.13. 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.

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 (square meters) 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 concrete base, detectable warning element, thin set mortar, fine aggregate for filling joints, and the painting of curb through the width of the curb ramp including the silica sand shall be included in the cost of the curb ramp.

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

605.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher, Size No. 53 904
Concrete 502
Joint Materials.....906
Joint Mortar.....906.03
Precast Concrete Curbing.....904.04(e)
Reinforcing Steel.....910.01

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

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 (3 m) straightedge. Portions showing irregularities of 0.25 in. (6 mm) 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

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. (150 mm) in depth.

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.

(c) Proportioning and Placing

Concrete shall be proportioned, mixed, and placed in accordance with 502. 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.

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 must have an attachment to place, consolidate and shape the concrete to the required shape and dimensions. The reinforcement 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 0.25 in. (6 mm) radius.

The face and top of the curb, integral curb, and gutter shall be checked with a 10 ft (3 m) straightedge. Portions showing irregularities of 0.25 in. (6 mm) or more shall be removed and replaced.

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 permitted. No plastering will be permitted.

(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 shall be saw cut or formed with 0.25 in. (6 mm) 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 (3 m) 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, 0.25 in. (6 mm) thick, shall be placed at the beginning and end of all curb returns and also at castings.

(f) Curing

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. (150 mm) and be tamped thoroughly.

(h) Curb Machine

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.

The reflecting surface of the curbing shall be a mortar mix consisting of one 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. (25 mm). 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 min 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.

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.

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 (3 m) straightedge. Portions showing irregularities of 0.25 in. (6 mm) 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 (15.5 m) maximum. The joints shall be saw cut or formed with 0.25 in. (6 mm) thick preformed joint material. Joint sealant is not required for joints in center curbs.

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

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

The mixture shall be in accordance with 402.07(d).

Acceptance of HMA curbing mixtures will be a type D Certification in accordance with 916. 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 ± 2.5% on the No. 200 (75 µm) sieve, ± 4.0% on the No. 4 (4.75 mm) sieve, and binder content tolerance shall be ± 0.5% from DMF.

(d) Placing

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.

The construction of curbing by means other than the automatic curber or machine may be permitted 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 (3 m) straightedge. Portions showing irregularities of 0.25 in. (6 mm) or more shall be removed and replaced.

Weather limitations shall be in accordance with 402.12.

(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.

(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 0.75 in. (20 mm) 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.

After the curb has been set, the joints shall be completely filled with mortar as specified.

(e) Backfilling

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. (150 mm) in depth.

605.09 Method of Measurement

Curbing, both new and reset, and curb removal will be measured by the linear foot (meter) 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 (meter) 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 (meter) 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 (meter), unless it is of variable width, in which case measurement will be by the square yard (square meter).

Bed course material will be measured by the ton (megagram).

605.10 Basis of Payment

The accepted quantities of curb work will be paid for at the contract unit price per linear foot (meter) 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 (square meter) for center curb, of the width specified. Bed course material will be paid for at the contract unit price per ton (megagram), complete in place.

Curb turnout will be paid for at the contract unit price per linear foot (meter) of the type of curb specified. Combined curb and gutter will be paid for at the contract unit price per linear foot (meter) for curb and gutter of the type specified.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Bed Course Material	TON (Mg)
Center Curb, _____ type	LFT (m)
Center Curb, _____ ft (m) type	SYS (m2)
Curb, _____ type	LFT (m)
Curb and Gutter, _____ type	LFT (m)
Curb, Remove	LFT (m)
Curb, Reset, _____ type	LFT (m)

The cost of tack coat, reinforcing steel or mesh 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 0.25 in. (6 mm) or more shall be included in the cost of curb.

SECTION 606 – SHOULDER CORRUGATIONS

606.01 Description

This work shall consist of placing corrugations in paved shoulders in accordance with 105.03. Corrugations shall not be constructed within the limits of reinforced concrete bridge approaches or on bridge decks.

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.

The corrugations shall be constructed by cutting smooth strips in existing or newly constructed shoulders. 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.

606.02 Method of Measurement

HMA and PCCP shoulder corrugations will be measured by the linear foot (meter), measured parallel to the center line of the roadway. Gaps in PCCP shoulder corrugations at the D-1 joints will be included as milled PCCP corrugations.

606.03 Basis of Payment

HMA and PCCP shoulder corrugations will be paid for at the contact unit price per linear foot (meter), when specified.

Payment will be made under:

Pay Item	Pay Unit Symbol
Milled HMA Shoulder Corrugations	LFT (m)
Miller PCCP Shoulder Corrugations	LFT (m)

SECTION 607 – PAVED SIDE DITCH OR CONCRETE GUTTER

607.01 Description

This work shall consist of placing a portland cement concrete lining, gutter, or reinforced concrete gutter turnout for side ditches in accordance with 105.03.

MATERIALS

607.02 Materials

Materials shall be in accordance with the following:

Concrete, Class A	702
Reinforcing Steel	910.01

CONSTRUCTION REQUIREMENTS

607.03 General Requirements

The excavation shall be to the required depth and shape of the bottom of the type and size of the side ditch being constructed, the details of which are shown on the plans. All soft, yielding, or unsuitable materials encountered at the required excavation elevation shall be removed and replaced with approved materials which shall be compacted and finished to a firm, smooth surface.

The applicable requirements of 605.04(b) shall apply to forms.

Placing, finishing, and curing shall be in accordance with 605.04 except the curing period shall be no less than 72 h. The finished surface need not be brushed.

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 (3 m) or less will be required between two different types of paved side ditches.

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

Paved side ditch or cement concrete gutter will be measured by the linear foot (meter) along the centerline of the ditch per each type specified. Each cutoff wall or lug will be measured as 8 linear feet (2.5 m) 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 (meters) 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 (meters) of the larger type of paved side ditch specified at each site.

Reinforced concrete gutter turnout will be measured as 50 lft (15 m) of concrete gutter. Additional length, if required, will be measured by the linear foot (meter) of concrete gutter.

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 (meter) complete in place. Concrete gutter turnout will be paid for at the contract unit price per linear foot (meter) for gutter, concrete, of the type specified.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Gutter, Concrete, _____ type	LFT (m)
Paved Side Ditch, _____ type	LFT (m)

The cost of reinforcing steel or mesh, 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

Materials shall be in accordance with the following:

Coarse Aggregates, Class D or Higher, Size No. 8.....904

CONSTRUCTION REQUIREMENTS

608.03 General Requirements

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. (300 mm) 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.

608.04 Method of Measurement

Shoulder drains will be measured by the ton (megagram) 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 (megagram) for aggregate for shoulder drains complete in place.

Payment will be made under:

Pay Item	Pay Unit Symbol
Aggregate for Shoulder Drains	TON (Mg)

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, on a prepared subgrade and subbase in accordance with 105.03.

MATERIALS

609.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher, Size No. 53	904
Concrete, Class C*	702
Curing Materials	912.01
Joint Materials	906.02(a)1
Reinforcing Bars, Epoxy Coated	910.01
Support Devices	910.01(b)9

*Coarse Aggregate shall be Class AP, Size No. 8

CONSTRUCTION REQUIREMENTS

609.03 General Requirements

Subgrade shall be prepared in accordance with 207. Subbase shall be prepared in accordance with 302.

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

Longitudinal construction joints will only be permitted 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 permit 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 allowed on the RCBA after the second 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.

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 (1 m) across the width of the approach. Any location deficient in depth by 1/2 in. (13 mm) or more shall be corrected prior to placing the concrete.

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.

The finished RCBA surface shall be textured with a double thickness burlap drag or a minimum 4 ft (1.2 m) 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.

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

RCBA shall be wet cured in accordance with 702 or shall have liquid membrane forming curing compound applied to exposed surfaces within 30 min 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. (300 mm) 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.

Liquid membrane forming curing compound shall be applied in a continuous uniform film at a rate not less than 1 gal./150 ft^2 (1 L/3.7 m^2). Additional applications, if needed, shall follow the previous application within 30 min. The curing compound may be warmed in a water bath during cold weather at a temperature not exceeding 100°F (38°C). Thinning with solvents will not be permitted. Non-uniform film rates will result in the discontinuance of that application method.

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 (3 m) 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. (3 mm) or less.

Smoothness variations outside specified tolerances shall be corrected in accordance with 502.20.

609.12 Opening to Traffic

RCBA may be opened to traffic after 14 days. The RCBA may be opened earlier if test beams indicate a modulus of rupture of 550 psi (3800 kPa) 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.

609.13 Method of Measurement

Reinforced concrete bridge approaches will be measured by the square yard (square meter). Dense graded subbase will be measured in accordance with 302.08. Reinforcing bars will be measured in accordance with 703.07.

Subgrade preparation will not be measured for payment. Finishing and curing of the RCBA will not be measured for payment. Construction joints or type I-A joints will not be measured.

609.14 Basis of Payment

Reinforced concrete bridge approaches will be paid for at the contract unit price per square yard (square meter). Dense graded subbase will be paid for in accordance with 302.09. Reinforcing bars will be paid for in accordance with 703.08.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Reinforced Concrete Bridge Approach, _____ in. (mm) thickness	SYS (m2)

The cost of all materials, water, equipment, and all labor for the compaction of the subgrade, shall be included in the cost of the RCBA.

The cost of finishing, furnishing and placing curing materials shall be included in the cost of the RCBA.

The cost of corrections for smoothness or re-texturing shall be included in the cost of the RCBA.

The cost of all labor and materials for the placement of construction joints and type I-A joints shall be included in the cost of the RCBA.

SECTION 610 – APPROACHES AND CROSSOVERS

610.01 Description

This work shall consist of constructing or resurfacing from the edge of the mainline pavement to the right-of-way line at public road intersections; turn lanes, passing lanes, acceleration lanes, deceleration lanes, or recovery lanes where the total longitudinal dimension is less than 100 lft (30 m), excluding tapers; mail box approaches; from the edge of the mainline surface to a width of 3 ft (1 m) on private and commercial driveways; and crossovers; all in accordance with 105.03.

MATERIALS

610.02 Materials

Materials shall be in accordance with the following:

Aggregate Base 301.02
Subbase 302.02
HMA 402.02
PCCP 502.02

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 A, B, C, or D in accordance with 402.04. A MAF in accordance with 402.04 will not apply.

Dense graded subbase shall be constructed in accordance with 302. PCCP for approaches shall be constructed in accordance with 502.

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.

610.05 Method of Measurement

Compacted aggregate base will be measured by the ton (megagram) in accordance with 109.01(b). HMA mixture for approaches will be measured by the ton (megagram) 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 in accordance with 502.22.

HMA patching in accordance with 610.04, will be measured by the ton (megagram) in accordance with 304.06. PCCP patching in accordance with 610.04, will be measured by the square yard (square meter) 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 404.09.

610.06 Basis of Payment

The accepted quantities of HMA mixture for approaches will be paid for at the contract unit price per ton (megagram) 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 (square meter), complete in place.

HMA patching will be paid for in accordance with 304.07. PCCP patching will be paid for in accordance with 305.07.

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 404.10.

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.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
HMA for Approaches Type __*__	TON (Mg)

PCCP for Approaches ..... SYS (m2)
* 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.

The cost of the 3 ft (1 m) wedge placed on approaches at the same time and in conjunction with the mainline HMA intermediate or surface, or if turn lanes, passing lanes, acceleration lanes, deceleration lanes, or recovery lanes are greater than 100 ft (30 m) longitudinally, payment will be made at the same unit price as for the material placed on the mainline.

The cost for curbing placed monolithically with the PCCP for 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 in accordance with 105.03.

MATERIALS

611.02 Materials

Materials shall be in accordance with the following:

Mailbox Support Galvanized Hardware.....ASTM A 153
Nominal Standard Galvanized Pipe .....ASTM A 53
Treated Wood Posts .....911.02(e)

CONSTRUCTION REQUIREMENTS

611.03 Mailbox Assembly

Existing mailboxes and assemblies shall be removed without damage from the highway right-of-way. Mailboxes, which must remain in service between removal and erection of the new assembly, shall be securely mounted to an empty 55 gal. (220 L) 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.

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.

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. (50 mm) or larger reflective material placed on the side of the mailbox in view of motorists in the nearest travel lane.

611.04 Method of Measurement

Mailbox assemblies will be measured by the number of units installed.

611.05 Basis of Payment

Mailbox assemblies will be paid for at the contract unit price for each, complete in place.

Payment will be made under:

Pay Item	Pay Unit Symbol
Mailbox Assembly, Double	EACH
Mailbox Assembly, 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.

SECTION 612 – UNDERSEALING

612.01 Description

This work shall consist of furnishing and pumping an asphalt material under cement concrete pavement in accordance with 105.03.

MATERIALS

612.02 Materials

Utility asphalt, UA-II or UA-III shall be in accordance with 902.01(d).

CONSTRUCTION REQUIREMENTS

612.03 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.

612.04 Drilled Holes

Where the existing pavement has transverse joints, holes not to exceed 1.5 in. (38 mm) 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. (750 to 900 mm) 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 1.5 in. (38 mm) in diameter shall, unless otherwise permitted or directed, be located on the centerline of the pavement lane to be treated and be spaced as directed.

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.

612.05 Pumping Asphalt

After the above procedure is complete, the asphalt shall then be pumped through the 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. (25 mm) nozzle and a return metallic hose shall connect the nozzle to the asphalt distributor tank.

The nozzle shall be equipped with a three way valve so designed that the asphalt may 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. Upon completion of the pumping operation, the nozzle shall be removed and a wood plug driven into the hole without an excessive back flow of asphalt material. After the material has hardened, the plug shall be removed and a hardwood plug at least 3 in. (75 mm) long and a minimum of 1/16 in. (2 mm) larger than the diameter of the drilled hole shall be driven flush with the surface of the concrete 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.

Where undersealing operations are being performed under traffic, necessary signs, barricades, watchers, and flaggers shall be used to maintain one lane traffic in the immediate vicinity of pumping operations. Traffic may be permitted to use the pumped areas upon removal of the original plugs and after the hardwood plugs are driven.

All storage tanks, pipes, retorts, booster tanks, and distributors used for storing or handling the asphalt materials shall be kept clean and in good operating condition at all times so there is no contamination of the materials.

The asphalt shall not be heated above 500°F (260°C) at any time and, when pumped under the pavement, the temperature shall be no less than 350°F (177°C). All material heated beyond 500°F (260°C) shall be rejected.

No material shall be applied on a frozen subgrade nor when the atmospheric temperature is 40°F (4°C) or lower and falling. The asphalt shall be placed only when general weather conditions are suitable.

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.

612.06 Method of Measurement

Asphalt material will be measured by the ton (megagram). Drilled holes for underseal will be measured per each hole drilled.

612.07 Basis of Payment

This work will be paid for at the contract unit price per ton (megagram) for asphalt 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:

Pay Item	**Pay Unit Symbol**
Asphalt Material for Underseal	TON (Mg)
Drilled Hole for Underseal	EACH

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

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 permit.

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

Salvaged road material will be measured by the cubic yard (cubic meter) in stockpiles after removal from its original position or, if the Contractor prefers, it will be measured by the cubic yard (cubic meter) 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.

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 (cubic meterage) of salvaged material will be deducted from the excavation quantities to be measured for payment.

613.05 Basis of Payment

The accepted quantities of salvaged road material for the use shown on the Schedule of Pay Items will be paid for at the contract unit price per cubic yard (cubic meter), complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Salvaged Road Material for _____	CYS (m3)

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

Materials shall be in accordance with the following:

Concrete 702
Reinforcing Steel.....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.

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.

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. (25 mm) diameter.

Welding shall be in accordance with 711.32.

614.05 Method of Measurement

Cement concrete header and reconstructed cement concrete header will be measured by the linear foot (meter).

614.06 Basis of Payment

The accepted quantities of this work will be paid for at the contract unit price per linear foot (meter) for header, cement concrete, of the type specified, or header, cement concrete, reconstruct, complete in place.

Payment will be made under:

Pay Item	Pay Unit Symbol
Header, Cement Concrete, _____ type	LFT (m)
Header, Cement Concrete, Reconstruct	LFT (m)

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, bench mark posts and tablets, and parking barriers in accordance with 105.03.

MATERIALS

615.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate, Class A or Higher, Size No. 8 or 91	904
Fine Aggregate, Size No. 23	904
Portland Cement	901.01(b)
Reinforcing Steel	910.01

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 (10 700 N) before the first crack appears. The specimen will be tested as a simple beam. The distance between supports shall be exactly 24 in. (600 mm) with the load applied at the rate of approximately 1200 lb (5400 N) per min 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. (25 mm) in height and shall be indented 1/8 in. (3 m).

Right-of-way markers furnished under this specification shall be covered by a type C certification in accordance with 916.

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. The tops of the monument shall be floated smooth. Monuments may be cast in place or cast outside and then set.

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 copper and shall be 1 in. (25 mm) in diameter and 5 in. (125 mm) long. If for type D monuments, the hole shall be drilled in the center with a 1/8 in. (3 mm) drill for a depth of 1.5 in. (38 mm). The hole shall be filled with lead flush with the end of the pin. Castings for protected monuments shall be in accordance with 910.05(a).

615.05 Bench Mark Posts

Bench mark 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 4000 psi (28 MPa) with no individual core strength less than 3600 psi (25 MPa). Tablets will be furnished by the Department and shall be set in the posts as indicated on the plans.

615.06 Parking Barriers

Parking barriers shall be of the dimensions shown on the plans. The 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 4000 psi (28 MPa) with no individual core strength less than 3600 psi (25 MPa).

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 (300 m) 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 (150 m) 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.

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.

615.09 Setting Monuments

If the location of a monument falls within the limits of a cement concrete pavement, a copper 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.

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.

If the existing monument is, or contains a brass or copper pin, the pin shall be extended to the surface of the new pavement by attaching a brass or copper pin with at least a 1 in. (25 mm) 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 0.25 in. (6 mm) in diameter and no less than 1 in. (25 mm) 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. (25 mm) in length.

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 Bench Mark Posts and Tablets

Bench mark posts shall be set at locations marked on the plans or as directed. 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. (150 mm) 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, bench mark 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 Bench Mark Posts

When the Proposal book provides that existing bench mark posts be reset, the existing bench mark 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, bench mark posts, and reset bench mark posts will be measured by the number of units installed. Parking barriers will be measured by the number of units installed.

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, bench mark posts, and reset bench mark posts, and 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**
Bench Mark Post	EACH
Bench Mark Post, Reset	EACH
Casting Adjusted to Grade, Monument	EACH
Monument, _____ type	EACH
Monument, Re-Establish	EACH
Parking Barrier	EACH
Right-of-Way Marker	EACH
Right-of-Way Marker, Reset	EACH

The cost of setting tablets in structures or bench mark posts, extensions for monuments, adjustment castings, re-establishing disturbed existing monuments, and other necessary incidentals shall be included in the cost of the pay items.

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 slopewall in accordance with these specifications and in accordance with 105.03.

MATERIALS

616.02 Materials

Materials shall be in accordance with the following:

Asphalt Joint Filler	906.01
Clay	903.01
Concrete, Class A	702
Fine Aggregate, Size No. 23	904
Geotextile	918.02
Portland Cement	901.01(b)
Precast Concrete Riprap	904.04(e)
Riprap	904.04
Water	913.01
Welded Steel Wire Fabric	910.01(b)5

Welded wire fabric shall be 6 in. by 6 in. (150 mm by 150 mm) mesh, W-3 x W-3 wires, with a weight (mass) per square area of 42 lb/100 ft^2 (205 kg/100 m^2).

CONSTRUCTION REQUIREMENTS

616.03 Placing Dumped Riprap

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. (225 mm) from a true plane. The thickness perpendicular to its surface shall be no more than 2 ft (0.6 m) nor less than 1 ft (0.3 m) 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.

Grout shall be composed of one part portland cement and four 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 allow 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. (225 mm) for revetment riprap or 18 in. (450 mm) for class 1 or class 2 riprap but shall not be less than the minimum depth specified.

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. (75 mm) 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

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. (10 mm), unless otherwise permitted. 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 permit class A concrete, it shall be constructed of a 1:2 mortar proportioned 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. (15 mm) of asphalt joint filler shall be used between the slopewall and such structure. Welded steel wire fabric shall be placed within the middle third 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 (1 m by 1 m) in size.

Precast concrete riprap, type B, as shown on the plans, may be used in lieu of slopewall of 4 in. (100 m) thickness.

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

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 (60°C), 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.

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 down stream sheet and the upslope sheet over the downslope sheet.

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. (460 mm) except when placed under water. When placed under water, the overlap shall be a minimum of 3 ft (1 m). Securing pins shall be steel, 3/16 in. (5 mm) in diameter, 18 in. (460 mm) long, pointed at one end and fabricated with a head to retain a steel washer having an outside diameter of no less than 1.5 in. (38 mm). 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.

TABLE 1

Slope	Pin Spacing
steeper than 3:1	2 ft (0.5 m)
3:1 to 4:1	3 ft (1.0 m)
4:1 or flatter	5 ft (1.5 m)

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 will not be allowed 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 be allowed to roll downslope and the height of drop for riprap shall be kept to less than 2 ft (0.6 m).

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 (megagram). 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 (square meter).

Grouted riprap and precast concrete riprap, including the area occupied by the wedge course, will be measured by the square yard (square meter), parallel to the slope. Slopewall will be measured by the square yard (square meter). Holes for inspecting slopewalls will be measured per each. Geotextiles used under riprap will be measured by the square yard (square meter), complete in place. Uniform riprap will be measured by the ton (megagram).

Treatment of undermined paved side ditch will be measured by the linear foot (meter) 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 (megagram). 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 (square meter). Uniform riprap will be paid for at the contract unit price per ton (megagram). Grouted riprap will be paid for at the contact unit price per square yard (square meter) of the specified depth. Precast concrete riprap, and concrete slopewall will be paid for at the contract unit price per square yard (square meter), all complete in place. If slag is used as dumped riprap and payment will be made per ton (megagram), 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 (square meter), 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 contact unit price per linear foot (meter) 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 (cubic meter) for borrow, cohesive.

Payment will be made under:

Pay Item	Pay Unit Symbol
Borrow, Cohesive	CYS (m3)
Geotextiles	SYS (m2)
Inspection Hole	EACH
Paved Side Ditch, Break	LFT (m)
Riprap, Class _____	TON (Mg) SYS (m2)
Riprap, Dumped	TON (Mg) SYS (m2)
Riprap, Grouted, _____in. (mm) depth	SYS (m2)
Riprap, Precast Concrete	SYS (m2)
Riprap, Revetment	TON (Mg) SYS (m2)
Riprap, Uniform	TON (Mg)
Slopewall	SYS (m2)
Slopewall, Concrete, _____ in. (mm) depth	SYS (m2)

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.

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 fabric 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. The cost of excavation, grading, sewing, pinning, and necessary incidentals shall be included in the cost of geotextiles.

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SECTION 618 – BLANK

SECTION 619 – PAINTING BRIDGE STEEL

619.01 Description

This work shall consist of preparing surfaces and applying paint to steel bridges in accordance with these specifications or as directed.

MATERIALS

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)
Inorganic Zinc Primer.....909.02(a)1
Organic Zinc Primer.....909.02(a)2
Polyurethane Finish Coat.....909.02(c)
Single Component Inorganic Zinc Primer.....909.02(a)2
Structural Steel Coating Systems.....909.03
Waterborne Finish Paint.....909.02(d)

Material safety data sheets shall be provided in the QCP for all materials to be delivered to the project site.

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. The QCP shall contain information specific to each bridge in the contract and shall be well organized in content. The QCP shall be submitted at least 15 work days prior to commencing this work. No work may begin until written notice has been received that the QCP was accepted by the Engineer. The QCP manager shall furnish the current SSPC Structural Steel Painting Manual, Volumes 1 and 2, at the project site.

The painting Contractor shall be certified SSPC-QP 1 for cleaning and painting bridge steel which does not have lead coatings and certified SSPC-QP 2 for cleaning and painting bridge steel which does have lead based coatings. Evidence of the certifications shall be provided in the QCP. A QCP manager and QC technicians shall also be identified in the QCP.

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.

(a) Acceptance Testing Definitions

The following definitions of terms shall apply to acceptance testing of painting steel bridge work.

1. Lot

A lot shall be a series of tests performed on each phase for each 1076 sq ft (100 m^2) or portions thereof.

2. Series

A series shall be 10 random tests performed by the Engineer on a lot.

3. Phase

A phase shall be painting operations consisting of either the cleaning of steel or the application of each coat of paint.

(b) Testing Procedure

During acceptance testing, the results of the random testing within a series will be compared to the specified requirements for that phase of work. A series of spot measurements spaced evenly over each lot will be made. The average of 10 spot measurements for each lot shall not be less than the specified thickness. A single spot measurement in any lot shall not be less than 80% of the specified thickness. A reading below the minimum of the average of 10 spot measurements less than the specified thickness shall be considered a defect. If there is only one defect for the series of tests, the lot will be accepted provided there are no visual defects. If two defects are found in the first series of tests, then a second series of tests for each lot shall be measured. If three defects are found in the first series of tests, then the lot fails. If the first and second series of tests have four or less defects, both series pass. If there are more than four defects, then the lot fails.

If a lot fails, corrective action shall be taken to make the lot acceptable. Corrective action shall be submitted in writing and performed as approved. A failed lot shall not be covered until the whole lot has been accepted.

(c) 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.

TEST/PROCEDURE	METHOD AND PROCEDURE
Surface Profile	ASTM D 4417
Clean Compressed Air	ASTM D 4285
Cleaning of Steel	SSPC Vis 1, Vis 3, and ISO 8501-1
Dry Film Thickness	SSPC PA 2
State of Cure of Inorganic Zinc Primers	ASTM D 4752
Relative Humidity	ASTM E 337

619.04 Prosecution of Work

Prosecution of work shall be in accordance with the applicable requirements of 108.03. Once the operations of cleaning and painting 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. When 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 a surface preparation phase;
(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.

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. The inspection access equipment shall be obtained, maintained, and kept in safe working order.

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. A traffic maintenance plan shall be provided in the QCP and shall be in accordance with the plans.

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.

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 Environmental and Safety Requirements

Pollution control and waste disposal of existing paint and debris shall be in accordance with the following requirements.

The QCP shall contain a written description of the Contractor's hazardous waste training program in accordance with 40 CFR 265.16 and ITM 803. Likewise, the waste contingency plan shall be contained in the QCP and in accordance with ITM 803.

A health and safety plan shall be provided in the QCP and in accordance with ITM 803. Workers shall be protected in accordance with IOSHA requirements. All personnel on the project site shall wear personal protective equipment. The protective equipment shall be furnished by the Contractor, including to Department personnel. Training shall be given to all personnel provided with the protective equipment. 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. Two rooms for changing and washing shall be provided on lead primed bridges.

(a) Pollution Control

The containment procedure plan shall be provided in the QCP. The telephone numbers for the IDEM Emergency Response Branch, local health department, and all water intake users within 500 ft (150 m) shall be provided in the QCP.

Blasting materials, scrapings, wire brushings, and paint particles shall be contained in accordance with SSPC-Guide 6 (CON), Class 3, specifically for zinc primed bridges, and SSPC-Guide 6 (CON), Class 2, for lead primed bridges.

If a spill, as defined in IDEM Regulation 327 IAC 2-6 does occur, all work shall stop and immediate action shall be taken to clean up the site. Spills of material, which enter or threaten to enter the water, shall be handled in accordance with IDEM Regulation 327 IAC 2-6. The IDEM Emergency Response Branch, the local health department, and all water intake users within 500 ft (150 m) 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)1 shall be observed.

On bridges with lead paint, steel grit blasting abrasives shall be used and recycled. The recycling equipment shall be capable of separating the blasting abrasive from the paint debris. The residue from the bridge shall be sampled within the first five days of removal and shipped to be tested. Residue shall be placed in an approved container. Such containers shall be properly labeled and maintained to comply with 40 CFR 264.

No waste shall remain on the booms or on the 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.

(b) Waste Disposal

Disposal of existing paint and debris shall be in accordance with SSPC-Guide 7 (DIS) 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.

The Contractor shall have direct knowledge regarding compliance with laws pertaining to pollution control and waste management such as follows.

a. subtitle C of the Resource Conservation and Recovery Act, 40 CFR 261, 262, 263, 265, and 268;

b. the Solid Waste Rule, 329 IAC 2;

c. the Hazardous Waste Rule, 329 IAC 3;

d. the Air Pollution Rule 326 IAC 4;

e. the Water Pollution Rule, 327 IAC 2-6;

f. the United States Department of Transportation regulations 49 CFR 172.300; and

g. OSHA worker safety regulations 29 CFR 1926.

2. Time Limitations

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 are received concerning the category of the waste, the containers shall be labeled "LEAD PAINT WASTE DEBRIS" or "ZINC PAINT WASTE DEBRIS", as appropriate. Labeling of containers as hazardous waste will not be required until the appropriate laboratory analysis determines the waste 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.

4. Instruction for Disposal of Paint Waste

Sampling and analysis of the paint waste debris shall be performed to determine if the wastes are hazardous. If the waste is not found to be hazardous in accordance with current RCRA hazardous waste definitions, the waste material shall be disposed of at an appropriate disposal facility. If the waste is found to be hazardous, IDEM shall be notified and an EPA identification number will be obtained by the Department. This 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 mixed. The Contractor shall have the responsibilities as follows:

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;

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;

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, all

deposit receipts, manifests, and required paperwork for disposal shall be given to the Engineer and all waste disposed of before the contract will be accepted.

The waste disposal site shall be identified in the QCP.

5. Instructions for Disposal of Other Project Generated Waste

The 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.

If the waste 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)4. All project generated waste and the method of recycling or disposal shall be identified in the QCP.

619.08 Surface Preparation

Cleaning of steel surfaces shall be performed by a SSPC certified contractor. This requirement will not apply to the following:

(a) shop cleaning,

(b) bearings at end bents,

(c) small sections of beams at end bents or at piers with open joints, or

(d) small sections of beams or other structural members where heat-straightening or similar repairs have taken place.

Surfaces to be painted shall be cleaned in accordance with SSPC classification, unless otherwise specified. The latest cleaning comparison chart available shall be provided in the QCP. Compressed air shall pass through an oil and water extractor before entering another apparatus.

Field cleaned steel surfaces shall be primed the same day as cleaned. 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 contaminates do not fall on wet, newly painted surfaces.

The surface profile of cleaned new steel surfaces shall not be less than 1 mil (25 µm) and not greater than 2 mil (50 µm). The surface profile of cleaned existing steel shall not be less than 1 mil (25 µm) and not greater than 3 mil (75 µm).

Pressure washing in accordance with 619.08(a) and solvent cleaning in accordance with 619.08(b) shall be performed before all other cleaning methods.

(a) Pressure Washing

All surfaces to be painted and the tops of pier and abutment caps shall be washed. The washing shall be accomplished by means of a low pressure power water washer with potable water. The pressure shall be between 800 and 1500 psi (5 and 10 MPa). If detergents or other additives are added to the water, the surface shall be rinsed with potable water before the detergents dries. All washed surfaces shall be completely free of all foreign matter and shall be approved prior to other surface preparation activities.

(b) Solvent Cleaning

After pressure washing has been approved, solvent cleaning shall be in accordance with SSPC-SP1.

(c) Near-White Blast Cleaning

Near-white blast cleaning shall be in accordance with SSPC-SP10/NACE No. 2.

(d) Commercial Blast Cleaning

Commercial blast cleaning shall be in accordance with SSPC-SP6/NACE No. 3.

(e) Hand Tool Cleaning

Hand tool cleaning shall be in accordance with SSPC-SP2.

(f) Brush-Off Blast Cleaning

Brush-off blast cleaning shall be in accordance with SSPC-SP7/NACE No. 4.

(g) Power Tool Cleaning

Power tool cleaning shall be in accordance with SSPC-SP3.

(h) Power Tool Cleaning to Bare Metal

Power tool cleaning to bare metal shall be in accordance with SSPC-SP11.

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.

(a) Structural Steel Paint System

The coating system shall consist of an inorganic zinc primer with a dry film thickness of 3 mil (75µm), an epoxy intermediate coat with a dry film thickness of 4 mil (100 µm), and a polyurethane finish coat with a dry film thickness of 3 mil (75 µm) 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 (75 µm) and a waterborne finish coat with a dry film thickness of 3 mil (75 µm) for partial painting of steel bridges and other structural steel.

619.10 Painting

Painting shall be performed by a SSPC certified contractor, except as noted in 619.08. All technical data sheets containing the manufacturer's recommendations and instructions shall be provided in the QCP and in accordance with ITM 803.

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.

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).

(a) Weather Limitations

Field painting will not be permitted between November 15 and the following April 1. Painting shall begin only when the 24 h ambient temperature is to remain above 50°F (10°C) after paint application, and the steel surface temperature is between 50 and 100°F (10 and 40°C). Coating and curing shall be done only when the relative humidity is to remain between 30 and 80%. All variations of these weather limitations to allow the use of any coating below the minimum or above the maximum temperature or humidity as may be recommended by the manufacturer shall be provided in the QCP. The pot life and induction time shall be in accordance with the manufacturer's recommendations for the existing temperature and humidity.

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 (3°C) 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 permitted 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

Paint shall be stored in accordance with the manufacturer's recommendations. If paint is permitted 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.

Partially empty containers of paint shall not be used. Partial mixing of containers will not be permitted. All paint containers shall remain closed until needed for mixing.

(d) Thinning

When required for proper application, the thinning of field paint will be permitted. 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.

The Contractor shall contact IDEM and the local air pollution control board for information about any volatile organic compound regulations or restrictions. Proof of contact to these agencies shall be provided in the QCP.

(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.

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 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. All 90 degree edges shall be striped, and then repainted with 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.

All paint coatings shall have a dry film thickness not less than 80% of the required dry film thickness.

(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 D 4752 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.

The curing time of all other paint systems or coatings shall be in accordance with the manufacturer's recommendations.

(g) Stencil Identification

After the finish coat has been approved, project identification information shall be painted with a stencil in 2 in. (50 mm) black capital letters onto the outside of both facia beams, at the right end of the beam and near the end bent, which reads as follows:

_____
bridge number

_____
contract number

PAINTED _____
date

619.11 Shop Painting

All structural steel shall be cleaned in accordance with 619.08(c). All technical data sheets containing manufacturer's recommendations and instructions shall be provided in the QCP and in accordance with ITM 803.

All structural steel, except for ASTM A 709, grade 50W (ASTM A 709M, grade 345W) steel, shall receive an inorganic zinc primer, including faying surfaces of high strength bolted connections and areas in contact with concrete. When shear connectors have been specified, the top of the flange shall not be painted.

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.

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.

Erection marks may be painted on zinc painted surfaces. Shop painted beams shall not be loaded for shipment until the paint is dry.

ASTM A 709, grade 50W (ASTM A 709, grade 345W) steel shall be left unpainted, except as shown on the plans. Surfaces, when specified, 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

All structural steel which has been painted with inorganic zinc primer in the shop, except for steel contact surfaces and surfaces to be in contact with concrete, shall be painted with the other coatings specified for structural steel paint system in accordance with 619.09(a). All steel surfaces which become inaccessible to field painting after final erection shall be painted with all coats of structural steel paint system before structural steel in erected.

If application of the inorganic zinc primer on a steel surface is not permitted in the shop before erection of the bridge, the surfaces which are exposed shall be cleaned in

accordance with 619.08(a), 619.08(b), and 619.08(c). These surfaces shall then be painted with the structural steel paint system after erection.

Surface areas where the inorganic zinc primer was damaged during shipping, handling, and erection shall be cleaned in accordance with 619.08(a), 619.08(b), and either 619.08(d) or 619.08(h). 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(h). Structural steel paint system shall then be re-applied.

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.

If the contract specifies clean steel bridge, the bridge steel shall be cleaned in accordance with 619.08(a), 619.08(b), and either 619.08(d) or 619.08(h). 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), 619.08(b), and either 619.08(d), or 619.08(g), or 619.08(h). The partial paint system in accordance with 619.09(b) shall be then be used for painting.

619.14 Drain Castings Treatment

Drain castings shall be satisfactorily cleaned. The castings shall not be shot-blasted. If castings are sandblasted, a brush blast technique shall be used in accordance with 619.08(f).

The drain castings shall be painted with a black finish coat in accordance with 909.02(c).

619.15 Claims

No claim shall be made for damage, including but not limited to, damage for delay, increased expense, maintenance, start up costs, additional costs due to passage of time arising out of a dispute, or work stoppage relating to whether a surface was adequately cleaned or painted.

No claim shall be made due to a greater amount of paint used in excess of the minimums required by the contract or for the stoppage of work. Each bridge shall be inspected before bidding for the exact type of primer that exists on each bridge.

619.16 Responsibility for Damage

All persons and property shall be protected from damage or injury from the surface preparation operations, paint, and painting operations. 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.

619.17 Method of Measurement

Cleaning and painting will not be measured.

Floor drain extensions will be measured per each drain extended.

The estimated weight (mass), length, and number of steel spans 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.

619.18 Basis of Payment

Removal of paint of an existing bridge will be paid for at the contract lump sum price for clean steel bridge or clean steel bridge, partial, at the bridge number specified. The accepted quantities of existing steel bridges to be painted, or partial 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.

Drain extensions will be paid for at the contract unit price per each.

If the contract includes a pay item for maintaining traffic, such work will be paid for at the contract lump sum price for maintaining traffic, at the bridge number specified.

Environmental control devices required when cleaning and painting existing steel bridges will be paid for at the contract lump sum price for environmental control at the bridge number specified.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Clean Steel Bridge, Br. No. _____	LS
Clean Steel Bridge, Partial, Br. No. _____	LS
Drain Extension	EACH
Environmental Control, Br. No. _____	LS
Maintaining Traffic, Br. No. _____	LS
Paint Steel Bridge, Br. No. _____	LS
Paint Steel Bridge, Partial, Br. No. _____	LS

The cost to prepare a QCP shall be included in the cost of other pay items. The cost of providing the Department with access to the bridge, the use of special cleaning methods, handling debris containers, seasonal or weather limitations, and labor, materials, and equipment required for maintaining traffic shall be included in the cost of other pay items.

The cost of furnishing all materials, equipment, and labor required for washing, 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 or clean steel bridge, partial.

The cost of furnishing all materials, equipment, and labor to perform painting with structural steel paint system shall be included in the cost of paint steel bridge and to perform painting with partial paint system shall be included in the cost of paint steel bridge, partial. Painting will not be paid for separately, unless so specified. The cost thereof shall be included in the cost of other pay items.

The cost of all equipment, material, labor, testing, and disposal of spent materials and debris shall be included in the cost of environmental control. No additional payment will be made for delays from all operations undertaken for this work. The absence of an environmental control pay item shall not negate the Contractor's responsibility for complying with the environmental control requirements in all phases of this work.

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

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)
Sod, including Nursery Sod	914.07
Top Soil	914.01
Water	914.09(a)
Wire Staples	914.09(f)

CONSTRUCTION REQUIREMENTS

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.

The seed bed, if not loose, shall be loosened to a minimum depth of 3 in. (75 mm) 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. (150 mm). 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.

For temporary seeding, the seed bed, if not loose, shall be scarified. The area to be temporary seeded need not be made smooth and uniform.

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 1.5 in. (38 mm) in diameter, and all sticks or other foreign material, which prevent the close contact of the blanket with the seed bed. 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/acre (900 kg/ha) unless otherwise specified.

(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 0.125 in. (3 mm). All other seed shall not be covered more than 0.5 in. (13 mm).

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

Mulching material, when specified, shall be applied uniformly in a continuous blanket at the rate of 2 tons/acre (4.5 Mg/ha). 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. (400 mm). 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. (200 mm) apart along the axle or shaft. Shaft or axle sections of disks shall not exceed 8 ft (2.5 m) in length.

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.

On slopes steeper than 3:1, or when specified, the following methods will be permitted.

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.

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 (0.25 L/m^2). If applied as the mulch comes from the spreader, the amount shall be approximately 60 gal./ton (0.25 L/kg) of mulch material. The exact amount shall be as directed.

3. Method C

The mulch may be held in place with binder twine fastened down with wooden pegs not less than 6 in.(150 mm) long spaced 4 ft (1.2 m) 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 (3.7 m). The strand parallel to the pavement shall cross the diagonal strands at their intersections to form equilateral triangles 12 ft (3.7 m) 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 wire 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. (1.2 m) 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 (0.3 m) on center. The ends and edges of the plastic net shall be overlapped approximately 4 in. (100 mm) and stapled. Overlaps running parallel to the slope shall be stapled 1 ft (0.3 m) on center and overlaps running perpendicular to the slope shall be stapled at least 3 ft (0.9 m) 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.

5. Method E

The area may be covered with erosion control blankets. The Contractor will be permitted 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 wire 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 (1.5 m) 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. (300 mm) 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 (0.3 m) back from the crown of the slope. These anchor trenches shall be 4 in. (100 mm) deep and at least 6 in. (150 mm) wide. One edge of the paper mat shall be placed into the top trench and stapled 9 in. (230 mm) 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 wire 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 (1.0 m) 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. (100 mm) and stapled.

Overlaps running parallel to the slope shall be stapled 18 in. (460 mm) on center and overlaps running perpendicular to the slope shall be stapled at least 9 in. (230 mm) 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 (1.0 m) increments, both longitudinally and transversely.

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 (0.9 m) 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. (600 mm) 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.

(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/acre (2200 kg/ha) 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).

621.06 Seed Mixtures

Seed mixtures shall be classified as follows. Mixes including warm season grasses, forbs, or aquatic species will be specified in the plans.

(a) Seed Mixture R

This seed mixture shall be applied at the rate of 170 lb/acre (190 kg/ha). The mixture shall consist of 95 lb (43 kg) of low endophyte Kentucky 31 Fescue or approved equal, 65 lb (30 kg) perennial ryegrass, and 10 lb (4.5 kg) Jasper Red Fescue or approved equal. 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 150 lb/acre (165 kg/ha). The mixture shall consist of 95 lb (43 kg) of a 4-way blend of turf type tall fescues such as Tribute, Rebel II, Trailblazer, or approve equal; 20 lb (9 kg) Jasper Red Fescue or approved equal; and 35 lb (16 kg) certified fine bladed perennial ryegrass such as Regal, Blazer, or approved equal. Fertilizer and mulching material, where specified or directed, shall be applied in accordance with 621.05.

(c) Seed Mixture P

This seed mixture shall be applied at the rate of 80 lb/acre (90 kg/ha). The mixture shall consist of 30 lb (14 kg) of "Fults" Puccinella Distans, 30 lb (14 kg) of Jasper Red Fescue, or approved equal, and 20 lb (9 kg) of perennial ryegrass. Fertilizer shall be applied at the rate of 400 lb/acre (450 kg/ha). Fertilizer and mulching material, where specified or directed, shall be applied in accordance with 621.05.

(d) Blank

(e) Seed Mixture D

This seed mixture is intended for ditch situations which experience seasonal to chronic saturated soils. This seed mixture shall be used on maintenance contracts or where otherwise specified. This mixture shall be applied at the rate of 14 lb 12 oz per acre (16.5 kg/ha). The mix shall be composed of 1 oz (28 g) Fowl Mana Grass, 3 oz (85 g) wetland Carex species, 2 oz (56 g) Rice Cut Grass, 2 oz (56 g) Bullrush, 2 oz (56 g) Leptochloa fasicularis, 2 oz (56 g) Barnyard Grass, 2 oz (56 g) Prairie Wild Rye, 10 lb (4.5 kg) perennial ryegrass, 2 lb (1 kg) Jasper Red Fescue, 2 oz (56 g) "Fults" Puccinella Distans, and 1 lb (0.5 kg) Redtop. If certain species in this mix are unavailable, substitutions may be submitted for approval. The mix shall be applied as specified per acre (hectare). The method of planting shall be by means of hydroseeding or by means of a hand method with a minimal amount of mulch applied in a separate operation. Fertilizer shall not be added to this seed mixture.

(f) Seed Mixture T

This seed mixture shall be used to establish a temporary cover for disturbed soil during the construction operations. Seed mixture T shall be used for soil stabilization and temporary ground cover. Temporary cover mixtures shall be placed as directed and be subject to seasonal limitations as defined herein. This mixture is not intended to be used as a permanent seed mixture. The mix shall be mulched in accordance with 621.05(c) when slopes exceed 3:1. From December 1 to March 14 and from June 16 to August 31, mulching alone shall be used to stabilize the soil. This mixture shall not be used to satisfy the requirements of the warranty bond.

1. Spring Mix

Spring mix shall be used from March 15 through June 15. This mixture shall be applied at the rate of 150 lb/acre (165 kg/ha). The mix shall consist of oats.

2. Fall Mix

Fall mix shall be used from September 1 through November 30. This mixture shall be applied at the rate of 150 lb/acre (165 kg/ha). This mix shall consist of winter wheat.

(g) Seed Mixture Grass

This seed mixture shall be placed when specified as shown below.

1. Type 1

This seed mixture shall be placed at the rate of 195 lb/acre (220 kg/ha). The mixture shall consist of 15 lb (7 kg) of Smooth Bromegrass, 10 lb (4.5 kg) of Orchardgrass, and the mixture specified in 621.06(a).

2. Type 2

This seed mixture shall be placed at the rate of 110 lb/acre (124 kg/ha). The mixture shall consist of 15 lb (7 kg) of Smooth Bromegrass, 10 lb (4.5 kg) of Orchardgrass, 40 lb (18 kg) of Certified Common Kentucky Bluegrass, 30 lb (14 kg) of Creeping Red Fescue, and 15 lb (7 kg) of Perennial Rye Grass.

(h) Seed Mixture Legume

This seed mixture shall be placed when specified as shown below. Mulched seeding, when specified, shall be in accordance with 621.07.

1. Type 1

This seed mixture shall be placed at the rate of 190 lb/acre (214 kg/ha). The mixture shall consist of 10 lb (4.5 kg) of Sericea Lespedeza or Korean Lespedeza, 10 lb (4.5 kg) of medium Red Clover or Alsike Clover, and the mixture specified in 621.06(a).

2. Type 2

This seed mixture shall be placed at the rate of 100 lb/acre (112 kg/ha). The mixture shall consist of 10 lb (4.5 kg) of Sericea Lespedeza or Korean Lespedeza, 10 lb (4.5 kg) of medium Red Clover or Alsike Clover, 10 lb (4.5 kg) of Birdsfoot Trefoil, 40 lb (18 kg) of Certified Kentucky Bluegrass, 30 lb (14 kg) of Creeping Red Fescue, and 10 lb (4.5 kg) of Annual Rye Grass.

"Do Not Spray" signs shall be placed near the beginning and end of this work, at 200 ft (60 m) intervals, or as otherwise directed. The sign shall be 16 gage (1.6 mm) 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.

621.07 Mulched Seeding

Mulched seeding, when specified, shall consist of applying the seed mixtures in accordance with 621.06(a), 621.06(b), and 621.06(c) 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 permitted to use excelsior blanket, paper mat, or straw mat in accordance with 621.05(d), 621.05(e), or 621.05(f), respectively.

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/acre (450 kg/ha). The surface shall be loosened to a depth of 1 to 2 in. (25 to 50 mm) and then raked before the sod is placed. All clods, lumps, boulders, or waste material shall be removed satisfactorily.

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 carefully by hand 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 permitted. 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 permitted. 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 (610 mm) apart in each strip measured lengthwise of the strip. Pegs shall be driven down until no more than 1 in. (25 mm) 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 0.5 in. by 0.75 in. by 12 in. (13 mm by 19 mm by 300 mm). In lieu of pegs, T-shaped wire pins may be used. The pins shall be machine bent from 8 gage (4 mm) low carbon steel with a minimum of a 8 in. (200 mm) leg, a 4 in. (100 mm) head, and a 1 in (25 mm) 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 (millimeters) 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 107.18 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 a seed mixture grass type 2 in accordance with 621.06(g)2 or seed mixture legume type 2 in accordance with 621.06(h)2 as directed. If the contract contains seed mixtures other than the two listed here, the Contractor may seed the disturbed area with the mixture contained in the contract provided the area is less than 1 acre (0.5 ha) 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, or P shall 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.

Winter sodding will be permitted when the temperature is above 35°F (2°C). 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

Fertilizer and mulching material will be measured by the ton (megagram). Seed mixtures will be measured by the pound (kilogram). Topsoil will be measured by the cubic yard (cubic meter) in accordance with 211.09. Mulched seeding and sodding will be measured by the square yard (square meter). Water will be measured by the 1,000 gal. (kiloliter). 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

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 (megagram), except as set out below for sodding. Seed mixtures will be paid for at the contract unit price per pound (kilogram) for the class and type specified. Mulched seeding will be paid for at the contract unit price per square yard (square meter) for the class and type specified, complete in place. Topsoil will be paid for at the contract unit price per cubic yard (cubic meter). Sodding and nursery sodding will be paid for at the

contract unit price per square yard (square meter), 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 temporary seeding 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.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Erosion Control Blanket	SYS (m2)
Fertilizer	TON (Mg)
Mobilization and Demobilization for Seeding	EACH
Mulched Seeding _____, _____ (class type)	SYS (m2)
Mulching Material	TON (Mg)
Seed Mixture _____, _____ (class type)	LBS (kg)
Sign, "Do Not Spray"	EACH
Sodding	SYS (m2)
Sodding, Nursery	SYS (m2)
Topsoil	CYS (m3)
Water	kGAL. (kL)

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 furnishing and placing fertilizer, 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.

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.

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

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 permit the final acceptance of the contract and payment of the retainage. All seeding which has significantly failed to attain approximately 60% 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.

For the terms of the warranty, a reseeding unit shall be defined as an area equal to or larger than 2,000 sq ft (185 m^2) 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.

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.

(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 (mass) of the material will be checked. Moisture content of the mulch will be determined on the basis of air dry weight as follows:

$$\text{Moisture Content \%} = \frac{\text{Wet Weight (Mass) of sample} - \text{Air Dry Weight (Mass) of sample}}{\text{Air Dry Weight (Mass) of Sample}} \times 100$$

The gross, or wet, weight (mass) 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 (mass) to be paid for will be the gross, or wet, weight (mass) minus the weight (mass) of excess moisture computed as follows:

$$\text{Weight (Mass) to be paid for} = G \times \frac{110}{(100 + M)}$$

G = Gross, or wet, weight (mass) of mulching material
M = Moisture content, percent, 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, and vines, and also 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.

MATERIALS

622.02 Materials

Materials shall be in accordance with the following:

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 gage (2.0 mm) galvanized wire.

CONSTRUCTION REQUIREMENTS

622.03 Care and Handling of Plants

(a) Bare Rooted Plants

If the outside air temperature exceeds 35°F (2°C) 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. 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 (2°C) 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 (2°C) provided they are puddled again and then heeled-in.

Temperature inside the storage building shall be maintained between 35°F (2°C) and 55°F (13°C). Plants shall not remain in storage, either inside or outside, for more than seven days, unless otherwise permitted 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 (2°C). 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 permitted because of unfavorable planting conditions.

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.

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

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-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 ground water, 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

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 (2°C). 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 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. These plants shall have an establishment period which 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 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. (10 mm) in diameter at the point of cut will not be permitted. 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. (10 mm) 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. (150 mm) 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. (25 mm) deep, it shall be backfilled with topsoil to 1 in. (25 mm) above the original ground. After sod and vegetation removal and backfilling, the bed area shall be cultivated to a depth of 6 in. (150 mm). 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 (1.0 m) 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, the minimum supplemental waterings required shall be two 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. 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 permitted.

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.

(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. (150 mm) 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. (100 mm) 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.

(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.

(c) Seedlings for Wildlife Habitat

Seedlings shall be from 6 to 18 in. (150 to 450 mm) 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.

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. (0.36 kg/400 L) 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

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

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 (1.2 to 1.8 m) 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

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. (1 L to 100 L) of water or thiodan 50 at the rate of 1 lb to 50 gal. (1 kg to 420 L) of water.

(b) Wrapping for Rodent Protection

Within seven days after planting, all crabapple and shade trees with a 0.5 in. (13 mm) diameter or larger, except for multi-stem forms, shall be wrapped with a double layer of 18 by 14 wires per in.^{2} (71 by 55 wires per 10,000 mm^2) 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. (50 mm) 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 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. (50 mm) greater than the tree's calipered size at installation. The protection shall permit 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.

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 0.5 in. (13 mm) 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

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 (0.6 m) 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

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. (75 mm) for fills of 1 ft (300 mm) or less to 12 in. (300 mm) for fills of 4 ft (1.2 m) 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.

Where the earth fill is less than 12 in. (300 mm) 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 truck in collar form for a distance of 12 in. (300 mm), 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.

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 permitted. 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. (10 mm) or more in diameter shall be covered completely with a tree wound dressing.

622.17 Grass and Weed Control

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 (0.6 m) of the outer limits of all group plantings and shrub beds and within 2 ft (0.6 m) 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 (0.6 m) beyond the stub stakes of the guy wires or 2 ft (0.6 m) beyond the mulched area. In general, theses areas shall be in accordance with the plans.

622.18 Care, Inspection, and Replacement

(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.

(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.

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.

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.

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.

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.

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

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 (cubic meter). Porous material for root protection will be measured by the ton (megagram). Drain tile will be measured by the linear foot (meter).

622.22 Basis of Payment

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 (cubic meter). Porous material for root protection will be paid for at the contract unit price per ton (megagram). Drain tile will be paid for at the contract unit price per linear foot (meter) of the diameter specified.

Payment will be made under:

Pay Item	Pay Unit Symbol
Draintile, _____in. (mm) diameter	LFT (m)
Masonry Wall	CYS (m3)
Masonry Tree Well	CYS (m3)
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
Plant, Coniferous Evergreen, Cone, Broad Upright, _____ size	EACH
Plant, Coniferous Evergreen, Globe, Dwarf, _____ size	EACH
Plant, Coniferous Evergreen, Prostate Broad Spreading, Semispreading, _____ size	EACH
Plant, Deciduous Shrub, _____ size	EACH
Plant, Deciduous Tree, Multi-Stem, _____ size	EACH
Plant, Deciduous Tree, Single Stem, _____ size	EACH
Plant, Ground Cover	EACH
Plant, Perennial	EACH
Plant, Root Tuber, Corm, Bulb	EACH
Plant, Rose Grade	EACH
Porous Material for Root Protection	TON (Mg)
Seedling	EACH
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.

SECTION 700 – STRUCTURES

SECTION 701 – DRIVEN PILING

701.01 Description

This work shall consist of furnishing and driving foundation piles of the type and dimensions designated including cutting off or building up foundation piles when required. Piling shall conform to and be installed at the location, tip elevation, penetration, or bearing in accordance with 105.03.

MATERIALS

701.02 Materials

Materials shall be in accordance with the following:

Epoxy Coating for Piles	915.01(d)
Reinforcing Steel	910.01
Steel Encased Concrete Piles	915.01
Steel H Piles	915.02
Structural Concrete	702
Timber Piling, Treated	911.02(c)
Timber Piling, Untreated	911.01(e)

Reinforcing steel within steel shell piles and in the reinforced concrete pile encasement shall not be epoxy coated.

Powdered epoxy resin shall be used to coat the epoxy coated portion of the steel shell encased concrete piles.

The Contractor may furnish and drive thicker walled steel shells than specified.

701.03 Handling of Epoxy Coated Piles

Piles shall be shipped using dunnage and padding shall be used with chains or steel bands.

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

All pile driving equipment furnished by the Contractor shall be in working condition and subject to approval. All pile driving equipment shall be sized such that the piles can be driven with reasonable effort to the ordered lengths without damage. The pile driving equipment shall not be used until approval is received in writing. The Contractor shall submit to the Geotechnical Engineer, Materials and Tests Division, with a copy to

the Engineer, a completed Pile and Driving Equipment Data Form at least 15 calendar days prior to driving piles. The form will be included in the Proposal book. Pile driving equipment will be subject to satisfactory performance during production.

The Engineer will use the information provided by the Contractor to run the wave equation analysis or the alternate method, from which the acceptance of the pile driving equipment will be founded. Approval criteria of pile driving systems will consist of both the required number of hammer blows per foot (meter) and the pile stresses at the required pile capacity. The required number of hammer blows indicated by the wave equation at the ultimate pile load shall be less than 180 blows per foot (600 blows per meter) for the pile driving equipment to be acceptable.

1. 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 may be calculated as follows:

a. The maximum allowable compressive and tensile stress for steel piles = 0.9Fy.

b. The maximum allowable compressive stress for prestressed concrete piles = 0.85fc′ - effective prestress.

c. The maximum allowable tensile stress, psi (MPa), for prestressed concrete piles = $3\sqrt{fc'}$ + effective prestress, where fc′ is expressed in psi ($0.25\sqrt{fc'}$ + effective prestress, where fc′ is expressed in MPa).

d. The effective prestress may be obtained from the approved shop drawings.

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. If the wave equation analysis shows that either pile damage or inability to reasonably drive a pile with respect to allowable blows counts will result from the proposed equipment, the Contractor shall modify or replace the proposed equipment until subsequent wave equation analyses indicate the piles can be reasonably driven to the desired ultimate capacity, without damage. The Engineer will notify the Contractor of the acceptance of the revised driving system within seven calendar days of receipt of a revised data form.

No variation in the pile driving system will be permitted without written approval, with the exception of increasing concrete pile cushion thickness to control driving stresses. Changes in the driving system will only be considered after the Contractor has submitted the necessary information for a revised wave equation analysis. The Contractor will be notified of the acceptance of the pile driving system changes within three business days of the receipt of the requested change.

2. Alternate Method

If the alternate 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 ultimate pile capacity as shown in the table below. The ultimate pile capacity as shown on the plans is equal to the design load times the factor of safety.

ALTERNATE METHOD
MINIMUM PILE HAMMER REQUIREMENTS

Ultimate Pile Capacity, Kips	(Kilonewtons)	Minimum Manufacturer's Rated Hammer Energy Foot-pounds	(Joules)
100 and under	(450 and under)	7,250	(9 830)
101 to 180	(451 to 800)	9,000	(12 200)
181 to 300	(801 to 1330)	15,000	(20 340)
301 and over	(1331 and over)	wave equation required	

The Contractor shall use the approved system and no variations in the driving system will be permitted without the Engineer's approval. All changes 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 the proposed change in driving equipment within three business days of receipt of the data form. If the Engineer determines the Contractor's hammer is not functioning properly and is unable to drive the pile to the required depth, the hammer shall be removed from service.

(b) Pile Hammers

Concrete piles of 20 in. (500 mm) diameter or width and larger shall be driven by means of air, steam, diesel, or hydraulic hammers, unless otherwise approved. Steel piles shall be driven with air, steam, diesel, or hydraulic hammers. Gravity hammers shall only be used if specifically permitted in the contract or approved in writing.

1. Gravity Hammers

When gravity hammers are permitted, the ram shall have a weight (mass) of between 3,000 and 3,500 lbs (1360 and 1590 kg). The height of drop shall not exceed 15 ft (4.5 m). The weight (mass) of gravity hammers shall not be less than the combined weight (mass) of the drive head and pile. All gravity hammers shall be equipped with hammer guides to ensure concentric impact on the drive head.

2. Steam and Air Hammers

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 plant and equipment shall be equipped with accurate chamber pressure gauges which are accessible to the Engineer. When wave equation analysis is not used for pre-approval, the weight of the striking parts of air and steam hammers shall not be less than one third the weight of the drive head and pile being driven. The striking parts shall not weigh less than 2,750 lbs (1250 kg).

3. Diesel Hammers

Open-end or single acting diesel hammers shall be equipped with a device such as rings on the ram, a scale, or a jump stick, extending above the ram cylinder, to permit 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 open-end diesel hammer. Closed-end double acting diesel hammers shall be equipped with a bounce chamber pressure gauge, in working order, mounted near ground level so as to be read by the Engineer.

The Contractor shall provide the Engineer a chart equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used. This calibration to actual hammer performance shall be performed within 90 days before the beginning of the work.

4. Pile Driving Aids

Pile driving aids such as jets, followers, and prebored holes shall not be used unless specified. If specified, pile driving aids shall be used for installing production piles only after the pile tip elevation for safe support of the pile load is established by means of load testing or test piles conventionally driven. The Contractor shall perform all extra load tests or extra work required to drive test piles as determined by the Engineer.

(c) Pile Driving Appurtenance

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. Hammer cushions shall be made of durable, manufactured materials, provided in accordance with the hammer manufacturer's guidelines. All wood, wire rope, and asbestos hammer cushions will not be permitted. 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 at the beginning of pile driving and after each 100 h of pile driving. A hammer cushion whose thickness has been reduced to less than 75% of the original thickness shall be replaced.

2. Pile Drive Head

Piles driven with impact hammer shall have an adequate drive head to distribute the hammer blow to the pile head, be axially aligned with the hammer and the pile, be guided by the leads, and not be free-swinging. The drive head 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.

A drive head 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 be protected with a pile cushion made of plywood. The minimum plywood thickness placed on the pile head prior to driving shall not be less than 4 in. (100 mm). 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 burn. 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.

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 be adequately embedded in the ground, or the pile shall be constrained in a structural frame such as a template to maintain alignment.

5. Followers

Followers shall only be used when approved in writing by the Engineer. If a follower is permitted, 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 desired pile capacity. The follower and pile shall be held and maintained in equal and proper alignment during driving. The follower shall be of such material and dimensions to permit the piles to be driven to the length 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. (75 mm) from the locations shown on the plans before additional piles are installed.

6. Jets

Jetting will not be permitted for concrete piles unless otherwise specified. 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 improper jetting operations. If jetting is specified, the jetting plant shall have sufficient capacity to permit installation to the required elevation, location, and alignment in accordance with 701.09(b). Unless otherwise directed, external jet pipes shall be removed when the pile tip is 10 ft (3.0 m) above the prescribed tip elevation, depending on soil conditions. The pile shall then be driven to the required bearing capacity with an impact hammer. The Contractor shall control, treat if necessary, and dispose of all jet water in accordance with 108.03.

Upon completion of driving a jetted pile, all voids around the pile shall be filled with B borrow and saturated with water.

701.05 Test Piles

Test piles shall be driven when shown on the plans at the locations and to the lengths specified or as directed by the Engineer. Unless otherwise directed, test piles shall be driven at such locations to permit their use in the finished structure. Test piles shall not be driven outside of permanent pile locations and be pulled and redriven as production piles. Test piles specified to be used as permanent piles in a structure shall have sufficient length to be cut off at the plan grade for top of pile. The length of 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 (3.0 m) longer than the estimated length of piling shown on the plans. Steel piles shall be provided such that additional 10 ft (3.0 m) of driving will not require an additional splice.

The driving equipment used for driving 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 test pile to the elevation of the bottom of the footing before the pile is driven, unless shown on the plans or otherwise directed.

Test piles shall be driven to the required pile capacity or as directed. Each test pile shall be restruck after a 24 to 72 h waiting period to assess the effects of setup and relaxation unless otherwise approved. The hammer shall be warmed up before driving begins by applying at least 20 blows to another fixed object. If the test pile does attain the specified capacity upon restriking, the blow count attained during initial driving shall be used to establish the adequacy of production piles. If the specified capacity is not attained on restriking, the Contractor shall redrive the test pile till it achieves the required capacity and repeat the restrike procedure. Test piles driven full length without attaining the required capacity shall be spliced and driven until the required bearing is obtained. Splices for test piles shall be in accordance with 701.11.

A record of driving of test piles which includes the number of hammer blows per 1 ft (0.3 m) for the entire driven length, the as-driven length, cutoff elevation, penetration, and all other pertinent information will be kept by the Engineer. The test pile shall be redriven when it has been determined from a load test that the test pile does not have adequate capacity. If a redrive is necessary, the Engineer will record the number of hammer blows per 1 in. (25 mm) of pile movement for the first 1 ft (0.3 m) of redrive.

701.06 Driven Pile Capacity

The Engineer will use the following methods in determining driven pile capacity as shown in the Contract Information book.

(a) Wave Equation Analysis Program, or WEAP

The pile capacity will be determined based on the pile capacity versus blow count relationship obtained from the wave equation analysis. Piles shall be driven with the approved driving equipment to the length necessary to obtain the required blow count. Jetting or other methods to facilitate pile penetration shall not be used unless specified or approved in writing after a revised driving resistance is established from the wave equation analysis. Adequate pile penetration shall be considered to be obtained when the specified wave equation resistance criteria is achieved within 5 ft (1.5 m) of the estimated tip elevation, when provided, based on ordered length. Piles not achieving the specified

resistance within these limits, or those requiring a minimum tip elevation, shall be driven to capacities determined by the Engineer.

(b) Dynamic Formula

The ultimate pile capacity will be determined by means of dynamic formula. Piles shall be driven to the length necessary to obtain the ultimate pile capacity which is equal to the factor of safety times the design load. The ultimate pile capacity, as shown on the plans, can be calculated from the formula as follows:

English: $Ru = 0.5[1.75 \sqrt{E} (\log 10N) - 100]$

Metric: $Ru = 7 \sqrt{E} (\log 10N) - 550$

where Ru = The ultimate pile capacity in tons (kilonewtons)

E = The manufacturer's rated energy in foot pounds (joules) at the ram stroke observed in the field 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. (25 mm) at final penetration.

(c) Dynamic Pile Load Test

Dynamic measurements will be used to evaluate hammer and driving system performance, pile driving stresses, pile structural integrity, and pile bearing capacity. Dynamic monitoring will be conducted by the pile driving analysis, or PDA, consultant in accordance with ASTM D 4945. The PDA consultant will be acquired by the Department. The Contractor may require approximately 1 h per pile to install the dynamic monitoring equipment. The number of piles to be monitored may be increased if so directed.

For piles to be dynamically monitored, the Contractor shall predrill the required instrument attachment holes prior to placing the pile in the leads. The Contractor shall furnish the equipment, materials, and labor necessary for drilling holes in each pile and mounting the instruments near the head of the pile with bolts through the drilled holes. Each pile to be tested shall be instrumented with force and acceleration transducers provided by the PDA consultant, installed by the Contractor, before striking.

The Contractor shall provide access to the pile for attaching instruments after the pile is placed in the leads.

Upon determination by the Engineer that valid data have been secured, the PDA consultant, with the assistance of the Contractor, shall remove the instrumentation from the piles.

The Contractor shall furnish electric power for the dynamic test equipment. The power supply at the outlet shall be 10 A, 115 V, 55-60 cycles, AC only. If a field generator is used as the power source, it shall be equipped with functioning meters for monitoring voltage and frequency levels.

The Contractor shall drive the test pile to the depth at which the dynamic test equipment indicates that the ultimate pile capacity shown on the plans has been achieved, unless otherwise directed. The Contractor shall drive test piles to the minimum tip elevation and a depth that satisfies the required bearing. The stress in the piles will be monitored during driving with the dynamic testing equipment to ensure that the values developed do not exceed the values shown in 701.04(a). 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). If non-axial driving is indicated by the dynamic test equipment measurements, the Contractor shall immediately realign the hammer system.

The Contractor shall wait a minimum of 24 h, or up to 72 h, depending on the soil conditions, and after the instruments are reattached, restrike the test pile. It is estimated that the Contractor will require approximately 1 h to reattach the 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 redrive shall be 6 in. (150 mm) or the total number of hammer blows shall be 50, whichever occurs first. After restriking, the Engineer will either accept the tip elevation or specify additional pile penetration and testing.

(d) Static Load Test

The test pile capacity shall be verified by performing actual loading tests of designated piles in the structure in accordance with ASTM D 1143, Quick Load Test Method, with loads applied by hydraulic jack. Such tests shall consist of the incremental application and removal of static pressure exerted on the pile through approved rigging, together with suitable apparatus for accurately determining the superimposed weight of pressure and pile settlement under each increment of load. The safe allowable load will be determined from the settlement versus load curve generated by the incremental loading in accordance with 701.06(d)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. (6 mm) shall be redriven, or jacked, to the original elevation prior to testing. A minimum 36 h waiting period shall be observed between the driving of a load test pile and the commencement of the load testing unless otherwise specified or authorized.

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 (10°C) 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.

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 1000 t (8900 kN) or 300% of the design load, whichever is less. A minimum of five calendar days prior to construction

of the reaction frame or load platform, the Contractor shall submit, for review and approval, plans for the reaction frame or load platform. The reaction frame shall be designed by a professional engineer. The primary method of determining the applied load shall be from a calibrated load cell. Incremental loads of 10% of the design load shall be placed on the pile at 2 1/2 min intervals until continuous jacking is required to maintain the incremental load or the capacity of the load frame is reached.

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 (6 m), and a weight (mass) of 5 to 20 lb/ft (7.5 to 30 kg/m) 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 assist in performing the static load test by operating the pump, reading the gauges, etc. 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 ultimate capacity of a pile from the load settlement curve does not equal or exceed the ultimate pile capacity shown on the plans, the Contractor shall redrive the pile to an adequate bearing capacity. The increase in bearing capacity shall be determined by the 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.

2. Hydraulic Jacks and Load Gages

Hydraulic jacks and gages shall be used for the superimposed load. The jacks, gages, and hydraulic pumps shall be calibrated with each other within the last six months by an independent laboratory. All calibration checks shall be within 5% of the applied load. When a jack, gage, and hydraulic pump are calibrated, they shall be used as a unit. Changing one of the three components shall require a recalibration. Gages shall be of the size that provides ease of reading: approximately 4 1/2 in. (110 mm) diameter with gradations for 2 t (8.9 kN) or less for loads under 100 t (890 kN), and gradations of 5 t (44.5 kN) or less for loads over 100 t (890 kN).

3. General Requirements

On completion of the load testing, 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 (0.3 m) below either the bottom of footing or the finished ground elevation if not located within the footing area.

701.07 Piling Length

The estimated length of piles shown on the plans and in the Schedule of Pay Items are for bidding purposes only. The Contractor shall provide the lengths of such piles necessary to obtain the bearing and penetration required as determined from results obtained in driving representative test piles or other pertinent data. There will be expected variations in final tip elevations due to differences in driving resistance. The final tip elevation of each pile will be determined during the driving operation. When minimum tip elevations are specified, the Contractor shall drive piles to a depth that satisfies this requirement in addition to required bearing. The Contractor shall furnish the proposed pile length for use in each bent of a structure before driving the piles. There shall not be more than two splices exposed to view in each length of piling after driving is completed.

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.

The limits of the epoxy coated steel shell portion of the pile, and the limits of the reinforced concrete shall be as shown on the plans.

701.08 Required Bearing Capacity

Piles shall be driven to the penetration necessary to obtain the required ultimate pile capacity, which shall be the factor of safety times design load, as shown on the plans. A blow count/ultimate pile capacity relationship will be determined based on the driving of representative, test piles.

Jetting or other methods shall not be used to facilitate pile penetration unless shown on the plans. The ultimate pile capacity of jetted piles shall be based on impact driving blow count after the jet pipes have been removed. Jetted piles not attaining the required ultimate pile capacity at the ordered length shall be spliced and driven with an impact hammer until the required ultimate pile capacity is achieved in accordance with the driving criteria in 701.06.

The required ultimate capacity of piles driven with followers will only be considered acceptable when 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.

701.09 Preparation and Driving

The heads of all piles shall be plane and perpendicular to the longitudinal axis of the pile before the drive head is attached. The heads of all concrete piles shall be protected with a pile cushion as described in 701.04(c)3.

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, improper construction methods, etc. 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

Augering, wet-rotary drilling, or other methods of boring pilot holes shall be used only when specified or approved. The procedures shall be carried out so as not to impair the carrying capacity of the piles already in place or the safety of existing adjacent structures. Prebored holes shall not be of a size smaller than the diameter or diagonal of the pile cross section. 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. The use of spuds or a short strong driven member which is removed to make a hole for inserting a pile, will not be permitted in lieu of preboring.

If new embankment through which H-piles are to be driven is 20 ft (6.0 m) or more in height, holes to receive the piles shall be prebored.

Before driving piles for the end bents, holes to receive the piling shall be prebored through the embankment elevation to the original ground. After the piles have been driven, the space between the pile and the prebored hole shall be backfilled with B borrow as directed. If the embankment in the area of the end bents is to be constructed of sand, gravel, or other permeable material in which a prebored hole would not remain open, the piling shall be driven before the embankment is constructed.

After a pile is driven, the 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.

Except for end bearing piles, preboring shall be stopped at least 5 ft (1.5 m) above the pile tip elevation determined from the ordered length. The pile shall be driven with an impact hammer to the specified blow count. 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.

If the Engineer determines that pre-excavation has disturbed the load bearing capacities of previously installed piles, those piles that have been disturbed shall be restored by means of redriving or other approved remedial measures. Redriving or other remedial measures shall be instituted after the preboring operations in the area have been completed.

Holes may be required to 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 cored through the embankment into solid rock to the elevations shown on the plans or as otherwise directed. The piles shall be driven to approximate refusal at the bottoms of the cored holes. Approximate refusal will be considered as 180 blows per foot (600 blows per meter). The holes in cored rock shall then be filled with concrete. Holes through embankment shall be filled with B borrow as described above.

(b) Location and Alignment Tolerance

Piles shall not be spaced closer than 30 in. (760 mm) center to center. A maximum deviation of 1 1/2 in. (38 mm) in any direction from exact position will be permissible in pile trestle bents and pile bents. A maximum deviation of 6 in. (150 mm) in any direction will be permitted 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. After all piles in a bent are aligned, the bent cap shall be placed on the piles.

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. Proposed corrective measures shall be subject to approval.

(c) Heaved Piles

Level readings for checking on pile heave after driving shall be made at the start of pile driving operations and shall continue until the Engineer determines that such checking is no longer required. Level readings shall be taken immediately after the pile

has been driven and again after piles within a radius of 15 ft (4.5 m) have been driven. If pile heave of 1/4 in. (6 mm) is observed, accurate level readings referenced to a fixed datum shall be taken on all piles immediately after installation and periodically thereafter as adjacent piles are driven to determine the pile heave range. All piles which have been heaved more than 1/4 in. (6 mm) shall be redriven to the required resistance or penetration. Concrete shall not be placed in pile casings until pile driving has progressed beyond a radius of 15 ft (4.5 m) from the pile to be concreted. If pile heave is detected for pipe or shell piles which have been filled with concrete, the piles shall be redriven to original position. The previously approved hammer-pile cushion system shall be used.

(d) Installation Sequence

The order of placing individual piles in pile groups shall be starting from the center of the group and proceeding outward in both directions, unless an alternate installation sequence is approved.

(e) Inspection

The Engineer shall be given 24 h notice before the driving of each pile, test or production. No pile shall be driven except in the presence of the Engineer.

Prior to placing concrete in cast-in-place pipe or shell concrete piles in driven shells, the Contractor shall supply a suitable light for the inspection of each shell throughout its entire length.

(f) Pouring Concrete

After all water and other foreign substances have been removed from the shells and the final approval given, the reinforcing steel, if specified, shall be placed, and the shells shall be filled with class A concrete in the presence of the Engineer. Concrete shall be deposited into pile shells in a stream with a cross-sectional area that is no more than approximately 50% of the area of the pile shell to prevent air pockets from forming. Concrete shall be vibrated in the upper 25 to 30 ft (7.5 to 9.0 m) of the piles. Epoxy coated piles shall be protected during riprap placement. All damaged epoxy coating shall be repaired in accordance with 915.01(d).

701.10 Unsatisfactory Piles

The method used in driving piles shall not subject the piles to excessive or undue abuse which produces crushing and spalling of concrete, injurious splitting, splintering, brooming of the wood, or deformation of the steel. Misaligned piles shall not be forced into proper position. All piles damaged during driving by reason of internal defects, or by improper driving, or driven out of its proper location, or driven below the designated cutoff elevation shall be corrected as directed.

Piles which have been bent, or otherwise damaged, during installation shall be considered unsatisfactory unless the bearing capacity is proven by load tests performed by the Contractor. If such tests indicate inadequate capacity, corrective measures as determined by the Engineer shall be taken such as use of bent piles at reduced capacity, installation of additional piles, strengthening of bent piles, or replacement of bent piles.

A concrete pile will be considered defective if a visible crack, or cracks, appears around the entire periphery of the pile, or if a defect is observed, as determined by the Engineer.

701.11 Splicing Piles

Full length piles should be placed in leads when practical, however, when splicing is necessary, the following methods shall be used.

Splicing of steel piles and steel shells for cast-in-place concrete piles shall be made as shown on the plans. Welded connections for splices shall be used. All work shall be done with approved methods, and materials, and by welders qualified in accordance with 711.32.

701.12 Steel H Pile Tips

Steel H pile tips shall be cast-in-one-piece steel in accordance with ASTM A 27 Grade 65-35 (ASTM A 27M Grade 450-240). The tips shall have sufficient flange and continuous web vertical back-ups to ensure proper alignment and fitting to the pile. They shall provide full bearing for the piles. The soil or rock bearing surfaces of the tips shall be sloped downward toward the web with a minimum of 15 degrees, but not to exceed 30 degrees to the horizontal under the flanges. The sloped surfaces of the points shall terminate so as to form a flat surface which does not exceed one fourth of the flange width. The surfaces may have individual or continuous cutting teeth. The minimum weight of the pile tips shall be in accordance with the schedule as follows:

PILE TIP SIZE	MIN. WEIGHT OF TIP, lb (kg)
HP 10 (HP 254)	22 (10)
HP 12 (HP 305)	28 (13)
HP 14 (HP 356)	46 (21)

The welds for the attachment of a pile tip shall be partial penetration single bevel groove welds placed full flange width along the outside of each pile flange.

Either the pile tip or the outside of each flange of the pile shall be beveled 45 degrees. The depth of the bevel shall be a minimum of 3/8 in. (10 mm) for HP 10 x 42 and HP 12 x 53 (HP 250 x 62 and HP 310 x 79) piles; and a minimum of 7/16 in. (11 mm) for HP 13 x 73, HP 14 x 73, and HP 14 x 89 (HP 330 x 109, HP 360 x 108, and HP 360 x 132) piles. The width of weld at the outside face of the pile flange shall be the same as the beveled depth. E60XX welding rods shall be used. All welds shall be made in the flat position.

The ends of the piles shall be prepared and welded to the pile tips in accordance with the manufacturer's recommendations.

Steel H pile tips furnished shall be covered by a type C certification in accordance with 916. The Engineer will randomly select one pile tip of each size to verify the minimum weight requirement, prior to use.

701.13 Cut-Off Lengths

The tops of all permanent piles and pile casings shall be cut off at the elevation shown on the plans. All cut-off lengths shall become the property of the Contractor and shall be removed from the project site.

701.14 Method of Measurement

Piles, epoxy coated piles, and cored holes in rock will be measured by the linear foot (meter) complete in place. Timber piles will be measured by the linear foot (meter) furnished and by the linear foot (meter) driven. Test pile, dynamic pile load test, static pile load test, test pile restriking, and pile tip will be measured per each. Encasement, class A concrete filling, reinforcing steel, and epoxy coating will not be measured for payment.

701.15 Basis of Payment

The accepted quantities of steel shell encased concrete piles, epoxy coated steel shell encased reinforced concrete piles, steel H piles, epoxy coated steel H piles, reinforced concrete encased steel H piles and cored holes in rock will be paid for at the contract unit price per linear foot (meter) for the thickness and diameter, or size specified, complete in place. The accepted quantities of furnished timber piles will be paid for at the contract unit price per linear foot (meter). The accepted quantities of driven timber piles will be paid for at the contract unit price per linear foot (meter). Test piles, dynamic pile load test; static pile load test; test pile, restrike; and pile tip will be paid for at the contract unit price per each for the pile size or designation specified.

(a) Timber Pile Furnished

Timber foundation piles including piles used as test piles, but not including test piles driven outside the limits of the structure, will be paid for at the contract unit price per linear foot (meter) for pile, timber, furnished, for the length of accepted piles actually placed in the leads, except as follows.

For all timber piles delivered to the site of the work on written orders and accepted but not used because of unforeseen foundation conditions or a change in plans, payment will be made at 50% of the contract unit price for timber piles furnished. Such piling shall remain the property of the Contractor, and shall be removed from the project site before the completion of the work.

(b) Timber Piles Driven

Timber piles driven, complete in place and accepted, including test piles, will be paid for at the contract unit price per linear foot (meter) for pile, timber, driven. Payment will be made only for actual number of linear feet (meters) of piling left in place.

(c) Epoxy Coated Piles

Epoxy coated piles may be furnished and driven at lengths greater than those shown on the plans. Additional lengths of such epoxy coated piles left in place and accepted will be paid for as steel shell encased piles or steel H piles.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Cored Hole in Rock, _____ in. (mm) (diameter)	LFT (m)
Dynamic Pile Load Test	EACH
Pile, Concrete, Steel Shell Encased, _____ (shell thickness), _____ (diameter)	LFT (m)
Pile, Reinforced Concrete, Steel Shell Encased, Epoxy Coated, _____ (shell thickness), _____ (diameter)	LFT (m)
Pile, Steel H, Epoxy Coated, HP _____ x _____ (size)	LFT (m)
Pile, Steel H, HP _____ x _____ (size)	LFT (m)
Pile, Steel H, Reinforced Concrete Encased, HP _____ x _____ (size)	LFT (m)
Pile, Timber, Driven	LFT (m)
Pile, Timber, Furnished	LFT (m)
Pile, Timber, Treated, Driven	LFT (m)
Pile, Timber, Treated, Furnished	LFT (m)
Pile Tip, _____ (pile size), _____ (type)	EACH
Static Pile Load Test, _____ (pile size)	EACH
Test Pile, _____ (pile size)	EACH
Test Pile, Restrike, _____ (pile size)	EACH

The cost of furnishing, driving, placing piles, concrete or B borrow necessary to fill cored holes, and all necessary incidentals shall be included in the cost of this work.

The cost of cut off piling; piling which is not driven in accordance with these specifications; piling which was not ordered or is not acceptable; broken, split, or misplaced piles; piles driven with tops lower than the cutoff elevation; and all labor, equipment, and necessary incidentals shall be included in the cost of the pile, timber, driven. Such cost shall not include the cost of furnishing the piles.

The cost of the following items shall be included in the cost of steel shell encased piles or steel H piles.

(a) amounts cut off;
(b) broken, bent, damaged, or misplaced shells or piles;
(c) concrete filling;
(d) corrective location or alignment measures;
(e) epoxy coating;
(f) furnishing or splicing steel encased piles;

(g) modifying or replacing pile driving equipment;
(h) redriving piles which have heaved more than 1/4 in. (6 mm);
(i) reinforcing steel;
(j) repairing epoxy coating;
(k) replacing epoxy coated piling;
(l) shells of piles which are not acceptable or damaged during driving;
(m) shells of piles which were not driven in accordance with these specifications;
(n) splicing of jetted sites; and
(o) steel H piles.

No payment will be made for shells or piles delivered to the project site but not used due to unforeseen foundation conditions or a revision in the plans. Such shells or piles shall remain the property of the Contractor and shall be removed from the project site before completion of the work. No additional payment will be made if the Contractor elects to furnish and drive thicker walled pile shells than specified.

The cost of spudding or jetting of concrete piles to obtain the desired penetration shall be included in the cost of concrete piling.

The cost of reaction piles used in the static load test shall be included in the cost of the static load test. The reaction piles will not be paid for as production piles, even when used as a production pile.

The cost of reinforcing steel which extends beyond the limits of the epoxy coating as shown on the plans and of repair to damaged epoxy coating shall be included in the cost of the epoxy coated steel shell encased reinforced concrete pile.

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 these specifications and in reasonably close conformance with the lines, grades, and dimensions as shown on the plans or as directed.

702.02 Classes of Concrete

The following classes of concrete shall be used where specified.

Class of Concrete	**A**	**B**	**C**
Cement content in pounds per cubic yard (kilograms per cubic meter) of concrete	564 (335)	470 (279)	658 (391)
Maximum water/cement ratio in pounds (kilogram) of water per pound (kilogram) of cement	0.490	0.620	0.443

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.

702.03 Materials

Materials shall be in accordance with the following:

Admixture for Concrete 912.03
Castings 910.05
Cast Iron Soil Pipe 908.10
Coarse Aggregate
For exposed concrete, Class A or Higher,
Size No. 8 904
For non-exposed concrete, Class B or Higher,
Size No. 8 904
Curing Materials.....912.01
Curing-Sealing Materials 912.02
Fabric for Waterproofing 918.01
Fine Aggregate Size No. 23 904
Fly Ash 901.02
Geotextile for Use With Underdrain 918.03
Ground Granulated Blast Furnace Slag.....901.03
Permanent Metal Forms 910.03
Portland Cement.....901.01(b)
Steel Drain Pipe.....910.07
Utility Asphalt, UA-1 .....902.01(d)
Water 913.01

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 an approved 100% solids chemical anchor system.

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

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/cy yd (36 kg/m^3). 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 (i.e. 1.06 x 564 = 598 lb/cu yd (1.06 x 335 = 355 kilograms per cubic meter) for class A concrete).

Fly ash from an approved source may be used as a partial replacement for portland cement. The substitution of fly ash for portland cement will not be permitted in conjunction with the use of blended portland cement nor ground granulated blast furnace slag. Mix designs will be based on using a maximum 20% cement reduction with a minimum 1.25 to 1 ash-to-cement replacement ratio by weight.

Ground granulated blast furnace slag from an approved 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 permitted in conjunction with the use of blended portland cement nor fly ash. Mix designs will be based on using a maximum 30% cement substitution with a 1:1 slag-to-cement ratio, by weight.

Blended portland pozzolan cements, fly ash, and ground granulated blast furnace slag used as a pozzolan may only be used in concrete bridge decks between April 1 and October 15 of the same calendar year.

Fine aggregate shall be no less than 35% nor more than 45% of the total weight of aggregates used, except the limit may be increased to 50% when slag coarse aggregate is used. The aggregates shall be proportioned to use the maximum amount of coarse aggregate which produces a workable mix.

When fly ash or ground granulated blast furnace slag is used, an acceptable concrete mix design shall be submitted. Fly ash or ground granulated blast furnace slag and all other material sources proposed for portland cement concrete mix designs shall be furnished at least 15 days prior to the initiation of work. Prior to use, it shall be demonstrated by trial batch that the concrete mix design will produce concrete complying with all requirements. A concrete mix design will not be considered approved until this trial batch demonstration is successfully completed, including flexural strength data. The required 550 psi (3,800 kPa) flexural strength shall be obtained at an age consistent with the contract work schedule, but not to exceed 28 days.

Once a mix design has demonstrated for the contract that the concrete mix design with a specific fly ash source or a specific ground granulated blast furnace slag source produces a concrete which is in accordance with the mix design requirements, further trial batch demonstration will be at the Engineer's discretion for this contract and subsequent contracts.

All concrete shall have an air content of 6.5% ± 1.5% by volume. Air content shall be determined in accordance with 505. When fly ash is used, the first concrete truck on the contract will be tested by the Department for complete compliance with plastic concrete requirements for air content, slump, and yield. If not in complete compliance, the concrete will be rejected and no further concrete with fly ash in it will be considered

on the contract until it is demonstrated by an additional trial batch that the concrete mix design, or modification thereof, complies. All demonstration testing shall be conducted by the Contractor. During the placement of concrete containing fly ash, the air content of the concrete shall be determined to be at least equal to the testing requirements set out in the Department's Manual for Frequency of Sampling and Testing and Basis for Use of Materials. Additional testing may be required, as conditions warrant. All such air content testing of the concrete shall be performed by a certified technician. A certified technician must have successfully completed a concrete course offered by the Department's Human Resources Division, the National Ready Mix Concrete Association, the American Concrete Institute, or approved equal.

Portland cement concrete with fly ash or ground granulated blast furnace slag which does not consistently comply with Department concrete requirements due to the presence of the fly ash or ground granulated blast furnace slag will be grounds for rejection of its further use. In the event of such a rejection of further use, all unsatisfactory work shall be corrected with no additional payment and the contract shall be completed using portland cement without fly ash.

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 C concrete shall contain either a water-reducing admixture or a water-reducing retarding admixture. The type used shall not be changed during any individual contiguous pour. The type admixture to be used will be selected based on the expected concrete or air temperature. When either temperature is expected to be 65°F (18°C) or above, a water-reducing retarding admixture shall be used. A water-reducing admixture shall be used when both temperatures are expected to be below 65°F (18°C) 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. Air-entraining cements will not be permitted 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 approved 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 will be 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.

702.06 Batching

Unless otherwise permitted, the minimum batch shall be 2 cu yd (1.5 m^3). 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 one unit of the structure except in an emergency and then only by written permission.

(a) Portland Cement

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 nor leak from it. Accuracy of batching shall be ± 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.

(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

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 (1.8 m) 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.

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 ± 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 (4450 N) and greater on the cement scale and applied loads of 4,000 lb (17 800 N) and greater on the aggregate scale, the scales shall be accurate to 0.5%. For applied loads of less than 1,000 lb (4450 N) and 4,000 lb (17 800 N) 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 (23 kg) 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 permitted after initial set. When concrete is delivered in transit mixers, additional water may be added occasionally to increase the slump, if permitted, 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 accurately and noted on the batch ticket. Such addition of water will not be permitted 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 not within the specified slump limits at time of placement shall not be used. Except as required in 702.05 for class C concrete, a water reducing admixture, type A, or a water reducing and retarding admixture, type D, may be used in the concrete. Chemical admixtures type B, type C, and type E will be permitted only with prior written permission.

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 (85 kg) except for pours of 20 cu yd (15.3 m^3) or less, or where otherwise specifically permitted, a 94 lb (42.5 kg) 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.

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 nor 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.

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.

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 permitted 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 0.5 cu yd (0.4 m^3) in volume.

702.09 Ready-Mixed Concrete

(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.

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.

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 to which the concrete is to be put. 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.

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. Equipment once assigned to a pour shall not be diverted for another purpose without approval.

(b) Mixers and Agitators

Mixers and agitators shall be in accordance with the following:

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 permit 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.

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).

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).

4. Slump tests may be made of individual samples taken when discharged at approximately the 1/4 and 3/4 points of each load. If the

slumps differ by more than 1 in. (25 mm) when the average slump is 3 in. (75 mm) or less, or by more than 2 in. (50 mm) when the average slump is greater than 3 in. (75 mm), 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 permitted when operations with a longer mixing time or with a smaller load will permit the requirements in requirement 4 of 702.09(b) to be met.

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.

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.

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 nor 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.

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 nor more than 100, but not less than that recommended by the mixer manufacturer.

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.

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 min 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 min 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.

7. For truck-mixers, wash water shall not be used as a portion of the mixing water for succeeding batches.

(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 permit control of the discharge of the concrete. Covers shall be provided for protection of the concrete when required.

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 min after the introduction of the mixing water to the cement and aggregates.

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).

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 permits the requirements in requirement 3 of 702.09(d) to be met.

702.10 Pumping Concrete

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 steel. 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 (3 m) 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 (0.6 m) 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 35°F (2°C), or whenever it is determined that the temperature may fall below 35°F (2°C) 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 must be heated, the concrete shall have a temperature of at least 50°F (10°C) and not more than 80°F (27°C) 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 (66°C). The maximum temperature of concrete produced with heated aggregates shall be 90°F (32°C). Materials containing frost or lumps of frozen material shall not be used. When either aggregates or water are heated to 100°F (38°C), they shall be combined first in the mixer before cement is added.

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 in accordance with 409.02(a) may be used if approved.

When aggregates are heated in bins, steam-coil or 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 permitted unless approved in writing.

Immediately after a pour is completed, the freshly poured concrete and forms shall be covered so as to form a protective enclosure and the air in the enclosure kept at a temperature above 50°F (10°C) for at least 144 h for bridge decks, the top surface of reinforced concrete slab bridges, and for at least 72 h for all other concrete. If for any

reason this 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 the concrete. Adequate fire protection shall be provided where heating is in progress and such protection shall be accessible at all times.

Where practicable, forms insulated with at least 2 in. (50 mm) 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 (10°C) 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

Slump will be measured in accordance with 505 and shall be no less than 1 in. (25 mm) nor more than 4 in. (100 mm) 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.

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.

In designing forms, fresh concrete shall be considered as a liquid weighing 150 lb/cu ft (2430 kg/m^3) for vertical loads and 100 lb/cu ft (1600 kg/m^3) for horizontal pressure. A live load allowance of 50 lb/sq ft (2.4 kPa) 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 (2.4 m) from the centerline of track and a clearance height of not less than 22 ft (6.7 m) 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.

Forms shall be filleted and chamfered as shown on the plans and shall be given a bevel or draft for 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 permit their removal to a depth of at least 1 in. (25 mm) 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 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 permitted in copings, railings, and walls less than 2 ft (0.6 m) thick. Devices which, when removed, leave an opening entirely through the concrete will not be permitted 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.

(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

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

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 702.13(e).

The metal forms shall be designed on the basis of dead load of form, reinforcing steel, and plastic concrete plus 50 lb/sq ft (2.4 kPa) 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 (250 MPa).

Deflection under the weight of the forms, the plastic concrete and reinforcing steel shall not exceed 1/180 of the form span or 0.5 in. (13 mm) whichever is less. However, the deflection loading shall not be less than 120 lb/sq ft (5.8 kPa) total. The permissible 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. (50 mm) measured parallel to the form flutes. If the design span of the form sheets exceeds 9.5 ft (2.9 m), concrete will not be permitted 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.

All reinforcing steel shall have a minimum clearance of 1 in. (25 mm) from the forms. The plan dimensions from the top surface for all primary deck reinforcing steel shall be maintained. The deck reinforcing steel shall be tied down at a maximum of 6 ft (1.8 m) centers. Permanent metal forms shall not remain in place closer than one foot from any joint exposed to the underside of the slab, except when an overlay is used on the deck.

Fabricator's shop and erection drawings shall be submitted for approval. These plans 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 plans 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 be permitted to rest directly on the top of the beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1 in. (25 mm) 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 (3 mm) fillet welds will be permitted.

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 gage (4.2 mm) thick, fit tight, and shall not be galvanized. Welding of form supports to flanges of non-weldable grades of steel and to steel flanges subject to tensile stresses shall not be permitted.

Form supports at prestressed concrete I-beam and box beam bridges shall be placed in direct contact with the sides of the box or edge of the I-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 or I-beam, straps extending across the top of the flange, hangers mechanically attached to reinforcing steel extending from the top flange, or by other approved methods. If straps are used across the top flange, they shall be No. 8 gage (4.2 mm) thick, fit tight, and shall not be galvanized. Welding of attachments directly to beam reinforcing steel shall not be permitted. In addition, the use of recesses cast into the beam to serve as a form support shall not be permitted.

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 TT-P-641(d), 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 should 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 approved.

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.

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 class 1 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.

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 facilities shall be provided as are required for the safe and convenient conduct of inspection procedures.

(f) Precast Concrete Deck Panels

The construction and furnishing of precast prestressed concrete deck panels in accordance with 707.10 will be permitted as an alternate method of forming a bridge deck slab for a prestressed concrete I-beam bridge. Precast concrete deck panels will not be permitted on a prestressed concrete I-beam bridge which is built on a sag vertical curve or on a superelevation transition unless otherwise shown on the plans. Precast

concrete deck panels will not be permitted for use on a steel beam, steel girder, prestressed concrete bulb-T beam, or prestressed concrete spread box beam bridge.

The deck panel system shall replace the bottom mat of slab reinforcing and, depending on panel depth, the bottom 2 1/2 or 3 in. (65 or 75mm) of the class C concrete slab. Formwork is eliminated in the areas between the beams, but forms shall be used for the copings and diaphragms.

Mating surfaces of the deck panels shall have a maximum deviation of 1/8 in. in 6 ft (3 mm in 1.8 m). All other dimensions as shown on the plans shall be fabricated to ± 1/4 in. (± 6 mm), except the vertical location of prestressing strands shall be ± 1/16 in. (± 2 mm). All panel joints shall be mortar tight immediately prior to placing the cast-in-place portion of the deck slab. Immediately prior to placement of concrete, the precast deck panels shall be wetted until free moisture appears and remains without ponding.

(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 (5°C), for removal of forms and supports may be used as a guide.

Centering under beams..... 15 days
Roadway Slabs..... 7 days
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).

In order to obtain a satisfactory surface finish, forms for railings, parapets, and exposed vertical surfaces shall be removed no less than 12 h nor 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.

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 it is to the advantage of the Department or Contractor, 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, supports, and housings, and the discontinuance of heating and curing may be permitted when the modulus of rupture reaches or exceeds the following values:

Concrete Used in	Required Flexural Strength, psi (kPa), Dead Load Only
Girders, Arches, and similar units	390 (2690)
Interior Bent or Pier Caps	480 (3310)

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 plans for falsework and arch centering signed by and bearing the seal of a registered professional engineer shall be submitted. These plans shall be in such form that they may be readily reproduced by white printing or some similar process. They shall be approved before falsework and centering is started. Responsibility will not be relieved by the use of these plans. Since the quality of the lumber is not known and because of the uncertainty of computing nailed joints, no responsibility will be assumed for the strength of falsework and centering.

The falsework drawings shall include details for support of interior bent caps, hammerhead piers, and the portion of the bridge floor and coping beyond facia girders or beams if the overhang is 18 in. (460 mm), 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 horizontal clearance of not less than 8 ft (2.4 m) from the centerline of track and a clearance height of not less than 22 ft (6.7 m) from the top of the track rail.

(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 so shown on the plans, and the falsework shall be set to provide it.

For designing falsework and centering, a weight of 150 lb/ft^3 (2400 kg/m^3) shall be assumed for plastic concrete. A live load allowance of 50 lb/ft^2 (2.4 kPa) 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 permitted.

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:

For Douglas fir, white oak, long-leaf yellow pine:
Bending ..... 1800 psi (12 410 kPa)
Columns ..... 1800 [I-L/60D] psi (12 410 kPa)
For spruce, cypress, short-leaf pine, white pine, western hemlock:
Bending ..... 1500 psi (10 342 kPa)
Columns ..... 1500 [I-L/60D] psi (10 340 kPa)

In the above:

L = Length of column in inches (millimeters)
D = Least diameter or least dimension in inches (millimeters).

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 permit 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 permitted, the nominal thickness shall be no less than 2 in. (50 mm). 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.

Unless driving of piles for falsework bents is precluded by soil or other special conditions or unless otherwise permitted, all bents for falsework shall have driven piles. These shall be so 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 provided or permitted, the following shall apply to the removal of falsework and centering:

1. Falsework under beams, slabs, girders, interior bent or pier caps, and arches shall, in warm weather, remain in place at least 15 days after the concrete is poured except, if directed, this period shall be increased.

2. 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.

3. 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.

4. 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 (10°C), the above periods shall be increased 20%. For concrete poured during December, January, and February, they shall be increased 40%.

5. If field operations are controlled by beam tests, the provisions of 702.13(h) shall apply to the time of removal of falsework unless other provisions of these specifications prohibit removal.

6. Removal of supports shall be such that permits the concrete to take the stresses, due to its own weight, uniformly and gradually.

7. 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.

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 permitted in writing, in accordance with this specification.

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.

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 can not 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.

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 permitted in footings. If there is a probability that the entire amount of concrete can not be poured monolithically, vertical or other construction joints shall be provided as directed.

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. (150 mm) or, if there is a coping, no less than the depth of the coping. Horizontal construction joints will not be permitted in the stems of concrete T-beams nor at the junction of T-beam stems and flanges.

(b) Expansion Joints

Structural 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 material 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 906.01.

(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. (3 mm) 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 otherwise treated if so designated.

702.16 Drainage Pipes Through Concrete Masonry

At all enclosures where water could not otherwise escape through the concrete, 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 permit free drainage. Drains through abutments and retaining walls shall be placed with a slight incline downward towards the exposed face.

702.17 Incased 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 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 nor on any other bents falling within the 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 steel 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.

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.

Except as otherwise provided, concrete shall be placed in horizontal layers of no more than 24 in. (600 mm) 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. (13 mm) and then struck off to the required elevation prior to the initial set of the concrete.

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. (460 mm) of the top of a face. However, if provisions have been made for a coping of less than 18 in. (460 mm) 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 reinforcing steel 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.

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

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 must 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 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 (1.5 m) 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.

(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. (32 to 64 mm). 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 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 nor 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 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. (260 mm) and constructed in sections having flanged couplings fitted with gaskets. Support of the tremie shall be such that permits free movement of the discharge end over the entire top surface of the area on which the concrete is to be deposited and also permit 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

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.

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. (300 mm) 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.

Piling, if any, shall be driven to or cut off at the proper elevation to permit 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.

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 nor 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 such dimensions as are necessary. 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. (130 to 200 mm), 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.

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).

All concrete surfaces shall be given a finish immediately following the removal of any forms.

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 (250 μm). 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.

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.

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 6 parts of pre-mix mortar mix for masonry and 1 part white portland cement in accordance with ASTM C-150, 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.

702.22 Curing Concrete

Concrete in bridge decks or the top surface of reinforced concrete slab bridges shall be cured continuously for at least 168 h commencing immediately after the surface is able to support the protective covering without deformation. Curing of patches or small full depth deck replacement areas on existing bridge decks that are to be overlayed, may be controlled by test beams in accordance with 702.24(a).

Unless otherwise specified or permitted, all other concrete shall be cured for at least 96 h commencing immediately after the surface is able to support the protective covering without deformation. If portland-pozzolan cement, type IP or IP-A, or fly ash is used, the concrete shall be cured for at least 120 h.

Membrane forming curing compound may be used in lieu of protective covering curing methods. Where it has been determined that a surface treatment or class 2 finish is to be used, the membrane forming curing compound shall not be used.

The curing of surfaces to be waterproofed may be discontinued when waterproofing is started.

If field operations are controlled by beam tests, the curing time, except for bridge decks and the top surface of reinforced concrete slab bridges, shall be in accordance with 702.13(h).

If further precautions are necessary to ensure strength, they shall be taken as directed.

(a) Protective Covering Curing Methods

Surfaces to be cured shall be protected by covering with cotton mats, burlap, or other satisfactory protective material and shall be kept continuously and thoroughly wet during the curing period. 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.

(b) 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 method of curing.

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. (3.8 L) of liquid coating for 150 sq ft (14 m^2) of concrete surface. 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.

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.

(c) Curing-Sealing Materials

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.

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 in the list of approved 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.

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) and 709, respectively.

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) may be required. The concrete shall then be surfaced 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.

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 permit 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.

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 (2°C), waterproofing shall not be done, unless otherwise permitted.

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 (150°C) and 350°F (177°C). 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:

(a) Equipment or traffic will not be permitted on structures until all concrete required to carry live loads has been poured for at least 15 days or a flexural strength of 550 psi (3800 kPa) for third point loading has been attained.

(b) Unbalanced backfill will not be permitted until the concrete required to resist it is at least 10 days old or a flexural strength of 440 psi (3030 kPa) for third point loading has been attained. The unbalanced height shall not exceed 10 ft (3 m) until the concrete is at least 15 days old or a flexural strength of 480 psi (3310 kPa) for third point loading has been attained.

(c) The dead weight of steel or precast concrete superstructure shall not be placed on concrete until the concrete is at least five days old, or longer as directed, or a flexural strength of 400 psi (2760 kPa) for third point loading has been attained. A dead load shall not be placed on hammer-head piers until the concrete is 15 days old or until test beams attain a flexural strength of at least 480 psi (3310 kPa) for third point loading. The concrete floor, if to be placed thereon, shall not be poured until the concrete supporting the superstructure is at least 10 days old or until test beams attain a flexural strength of at least 440 psi (3030 kPa) for third point loading.

(d) Concrete anchoring inserts to support falsework shall be in place 15 days or the test beams shall attain a flexural strength of at least 480 psi (3310 kPa) for third point loading, before a dead load of concrete is applied.

For concrete poured during March, April, October, November, or at any other time between April and October when the average temperature is less than 50°F (10°C), the above periods shall be increased 20%. For concrete placed during December, January, and February, the above periods shall be increased 40%. When test beams indicate the required flexural strength, the required time periods may be reduced. If at the expiration of the specified periods test beams do not indicate the required flexural strength, the periods shall be lengthened until the required strength is attained. If portland-pozzolan cement, type IP or IP-A, fly ash, or ground granulated blast furnace slag used as an additive is incorporated into the concrete, the specified periods shall not apply and the application of loads shall be controlled by beam tests. No time extension will be considered for delays due to additional time necessary to attain specified strengths.

Traffic, live loads, and backfill against wingwalls, spandrel walls, and abutments may be allowed when test beams indicate a flexural strength of 480 psi (3300 kPa) or greater for third point loading. Concrete pavement may be opened to traffic in accordance with 502.18. Beams will be prepared and tested in accordance with 702.13(g). Before traffic is permitted over a concrete structure built to be under fill, it shall be covered with 9 in. (225 mm) or more of earth or other suitable material, or otherwise protected. All other structures shall be properly protected against impact or other damage.

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 be put into service, standard specimens shall be made and cured in accordance with ASTM C 31, and shall be tested in accordance with ASTM C 39. Strength requirements shall be in accordance with ASTM C 94, 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 one 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

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. (50 mm) 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 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.

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

Concrete will be measured by the cubic yard (cubic meter) 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 (0.1 m^2).

Cast iron drain pipes, grates, basins, and fittings will be measured by the pound (kilogram) based on the theoretical weight (mass) shown on the plans. Bronze plates will be measured by the pound (kilogram) based on a theoretical weight of 536 lb/ft^3 (mass of 8 540 kg/m^3). The volume will be computed based on finished dimensions. Steel drain pipe will not be measured for payment. Field drilled holes will be measured by the number of holes drilled.

Concrete in railings will be measured in accordance with 706.05. Reinforcing steel 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 (cubic meter) of concrete, for the class and use specified. Cast iron grates, basins, and fittings will be paid for at the contract unit price per pound (kilogram). Cast iron soil pipe will be paid for at the contract unit price per pound (kilogram) for the diameter specified. Bronze plates will be paid for at the contract unit price per pound (kilogram). 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.

Concrete in railings will be paid for in accordance with 706.06. Reinforcing steel will be paid for in accordance with 703.08.

If a foundation seal is constructed as shown on the plans, it will be paid for at the contract price per cubic yard (cubic meter) for concrete, foundation seal. If ordered to be done, or permitted to be done, payment will be made at a unit price per cubic yard (cubic meter) equal to 3/4 of the contract unit price per cubic yard (cubic meter) for class B concrete in footings. The excavation for the foundation seal will be paid for at the contract unit price per cubic yard (cubic meter) 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. (460 mm) 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. (150 mm) 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.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Bronze Plates	LBS (kg)
Concrete, A, Substructure	CYS (m3)
Concrete, A , Superstructure	CYS (m3)
Concrete, B Above Footings	CYS (m3)
Concrete, B, Footings	CYS (m3)
Concrete, C, ____ (use)	CYS (m3)
Concrete, Foundation Seal	CYS (m3)
Drain Pipe, Steel	LS
Field Drilled Hole in Concrete	EACH
Grates, Basins, and Fittings, Cast Iron	LBS (kg)
Soil Pipe, Cast Iron, _____ in. (mm) (diameter)	LBS (kg)

The cost of forms, falsework, falsework piling, centering, expansion joints, waterproofing, curing, finishing, and necessary incidentals shall be included in the cost of the pay items. The 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 (cubic meters) 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 for its advantage, no additional compensation will be made.

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.

The cost of precast prestressed concrete deck panels shall be included in the cost of concrete, C, superstructure. The pay quantity of such concrete in the slab will be computed from the dimensions for the formed and poured bridge floor slab shown on the plans. The pay quantity of reinforcing steel will be the plan quantity shown with no adjustment for eliminating the bottom reinforcing steel layer nor for additional reinforcing steel required due to use of the precast concrete deck panels.

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.

The cost of grout for grouting reinforcing steel 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 steel required shall be included in the cost of field drilled hole in concrete.

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.

703.02 Materials

Materials shall be in accordance with the following:

Reinforcing Bars, Plain or Epoxy Coated	910.01
Reinforcing Bar Splicing System	910.01(b)3
Support Devices	910.01(b)9
Threaded Tie Bar Assembly	910.01(b)2

All uncoated reinforcing bars and epoxy coated reinforcing bars shall be supplied from a source listed on the Department's list of Certified Uncoated Reinforcing Bar Manufacturers and Certified Reinforcing Bar Epoxy Coaters respectively.

703.03 Bar List

The quantity and size of the reinforcing bars shall be verified against the structure drawings. The necessary corrections, if any, shall be made before 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

Reinforcing bars shall be protected at all times from damage. When placed in the work, the reinforcing bars shall be free from dirt, harmful rust, detrimental scale, paint,

oil, or other foreign substance. The various sizes and lengths shall be marked plainly to facilitate inspection and checking.

Epoxy coated reinforcing bars shall be handled and stored so as to prevent damage to the reinforcing bars and the coating. All systems for handling coated reinforcing bars shall have padded contact areas. All bundling bands shall be padded or banding shall be used which prevents damage to the coating. All bundles of coated bars shall be lifted with a spreader bar, multiple supports, or a platform bridge to prevent bar to bar abrasion from sags in the bundles of coated reinforcing bars. The reinforcing bars shall not be dropped or dragged. The bundled bars shall be stored above the ground on wooden or padded supports.

Repairs to the epoxy coating on epoxy coated reinforcing bars shall be performed on all damaged areas larger than 1/4 in. by 1/4 in. (5 mm by 5 mm). A bar will be rejected if the total area of damage exceeds 2% of the surface area or if the total area of repair exceeds 5% of the surface area. All damage within each area shall be cleaned and the repair shall be performed before visible oxidation appears. The patching or repair material shall be in accordance with 910.01(b)9.

CONSTRUCTION REQUIREMENTS

703.05 Bending

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

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. Welding of reinforcing bars at intersections will not be permitted. 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.

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 permitted.

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. 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 permitted at points where the section does not provide a distance of at least 2 in. (50 mm) between the splice and the nearest adjacent bar or surface of the concrete.

When splicing is indicated or permitted, an appropriate splice system on the list of approved Reinforcing Steel Splicing Systems may be used in lieu of lapped bars. The splicing system shall be installed in accordance with the manufacturer's recommendations.

Welded wire fabric, 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 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 load in accordance with 910.01(b)2.

703.07 Method of Measurement

Reinforcing bars will be measured by the pound (kilogram) based on the theoretical number of pounds (kilograms) 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 (masses) of the reinforcing bars actually placed in accordance with these specifications. The weights (masses) calculated shall be based upon the following tables.

English 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

Metric Table

Bar Designation No.	Mass per meter, kilograms	Bar Designation No.	Mass per meter, kilograms
10	0.560	29	5.060
13	0.994	32	6.404
16	1.552	36	7.907
19	2.235	43	11.38
22	3.042	57	20.24
25	3.973		

Threaded tie bar assemblies will be measured by the number of assemblies placed.

Welded wire fabric will not be measured.

703.08 Basis of Payment

The accepted quantities of reinforcing bars will be paid for at the contract price per pound (kilogram), complete in place.

If the substitution of reinforcing bars larger than those specified is permitted, payment will be made for only that weight (mass) which would be required if the specified bars had been used.

If the use of reinforcing bar lengths shorter than those shown on the plans is permitted for convenience in transporting or placing the bars, payment will be based on the weight (mass) 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.

Payment will be made under:

Pay Item	Pay Unit Symbol
Reinforcing Bars	LBS (kg)
Reinforcing Bars, Epoxy Coated	LBS (kg)
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 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 welded wire fabric is required, the cost of furnishing and placing it 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 steel as a bridge floor in accordance with these specifications and in reasonably close conformance with the lines, grades, and cross sections as shown on the plans or as directed.

704.02 Materials

Materials shall be in accordance with the following:

Castings	910.05
Cast Iron Soil Pipe	908.10
Concrete, Class C	702
Joint Materials	906
Reinforcing Steel	910.01

CONSTRUCTION REQUIREMENTS

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.

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 permitted. The areas where welding will be established in writing.

704.04 Placing Reinforcement and Concrete

Applicable provisions of 703 shall apply to placing reinforcing steel. 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 permitted without prior written approval. Splices, when permitted, shall be at locations of least tension in the steel.

The concrete deck pour sequence and procedure shall be submitted for approval. The minimum pour rate is that which permits the finishing machine to progress at a rate of at least 25 ft/h (7.6 m/h). If this rate is not achieved, placement of transverse construction joints may be directed. The addition of construction joints shall be performed with no additional payment. Placement of concrete, when once started, shall be continuous between joints. Horizontal joints will not be permitted.

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. (13 mm) 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.

Transverse construction joints as shown on the plans for the floor slab of prestressed concrete beam structures may be eliminated by written approval under the condition as follows:

(a) A retarding or a water-reducing retarding admixture shall be used in the concrete to delay set as required and approved.

(b) Concrete shall be placed for the full width of the structure, unless otherwise approved.

(c) It is determined that the concrete on two adjacent spans can be placed within a period of time which is less than the time for the initial set of the concrete section over the pier common to the two spans.

704.05 Finishing Concrete

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 (18.3 m) 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 screen. 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 screen. Welding of supports to structural bridge members will not be permitted. 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 screen 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 will be permitted 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. (225 mm) 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 504 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 (3 m) straightedge of light construction laid parallel to the centerline at intervals of no more than 2 ft (0.6 m) transversely and 5 ft (1.5 m) 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 depressions filled with fresh concrete and then leveled with a float having a blade approximately 5 ft (1.5 m) long and 8 in. (200 mm) 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 the light weight 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. (6 mm) radius. Longitudinal construction joints shall not be edged unless otherwise directed.

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 one of the methods of 702.22. If membrane curing is used, no exposed reinforcing steel shall be coated with the material. 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 the floor slab or any part of the superstructure. All vertical surfaces with reinforcing steel exposed 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 (cubic meter) in accordance with 702.27. However, no allowance will be made for variations in beam fillet depths, coping depths, or diaphragm depths, which are deemed necessary due to the beam camber, as constructed, which varies from that shown on the plans. Reinforcing steel will be measured in accordance with 703.07. Castings and cast iron pipe 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 (cubic meter) for concrete, C, superstructure. Reinforcing steel will be paid for in accordance with 703.08. Castings and cast iron pipe will be paid for in accordance with 702.28.

Payment will be made under:

Pay Item	Pay Unit Symbol
Concrete, C, Superstructure	CYS (m3)
Reinforcing Steel	LBS (kg)

The cost of forms, curing, finishing, preformed expansion joints within structure limits, and necessary incidentals shall be included in the cost of the pay items.

SECTION 705 – SIDEWALKS ON STRUCTURES

705.01 Description

This work shall consist of placing cement concrete sidewalks as an integral part of structures in accordance with 105.03.

705.02 Materials

Materials shall be in accordance with the following:

Concrete, Class C	702
Joint Filler	906.01
Reinforcing Steel	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 steel shall be in accordance with 703.

After floating, the surface shall be marked into uniform rectangles by transverse markings formed with a jointer having 1/4 in. (6 mm) 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. (6 mm) radius.

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 (3 m) 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. (3 mm) from the straightedge, except at grade changes, and shall be free from blemishes.

705.04 Method of Measurement

Sidewalks on structures will be measured by the cubic yard (cubic meter) in accordance with the dimensions shown on the plans or as ordered. Reinforcing steel will be measured by the pound (kilogram) in accordance with 703.07.

705.05 Basis of Payment

The accepted quantities of sidewalks on structures will be paid for at the contract unit price per cubic yard (cubic meter) for concrete, C, superstructure. Reinforcing steel will be paid for at the contract unit price per pound (kilogram) in accordance with 703.08.

Payment will be made under:

Pay Item	Pay Unit Symbol
Concrete, C, Superstructure	CYS (m3)
Reinforcing Steel	LBS (kg)

SECTION 706 – BRIDGE RAILINGS

706.01 Description

This work shall consist of the furnishing and placing of concrete or steel railings on bridges and on top of wingwalls and retaining walls in accordance with 105.03.

706.02 Materials

Materials shall be in accordance with the following:

Barrier Delineators	926.02(c)
Concrete, Class C	702
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

Thrie-beam railing and guardrail elements for retrofit bridge railing shall be steel and shall be in accordance with the applicable requirements for steel beam guardrail shown in 910.09, 910.11, and 910.12.

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.

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. (50 mm) thick shall be used for coping forms.

The slip form method may be permitted 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 steel 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 slump shall be 1/2 in. (13 mm) ± 1/2 in. (13 mm). 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. (64 mm) ± 1/2 in. (13 mm) at the joint locations may be made as soon as the concrete has hardened sufficiently to permit 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.

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. (6 mm) in 10 ft (3 m) from the specified cross section, as measured longitudinally.

706.04 Steel Railings

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.

706.05 Method of Measurement

Concrete railing, including all concrete work above the top of curb, will be measured by the linear foot (meter) or by the cubic yard (cubic meter) 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.

Reinforcing bars 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 (meter) in accordance with the dimensions shown on the plans or as directed.

Linear measurements will be made from end to end of the railing along the centerline.

706.06 Basis of Payment

The accepted quantities of concrete railing will be paid for at the contract price per linear foot (meter) or cubic yard (cubic meter), for railing, concrete, of the class specified. Steel railing will be paid for at the contract unit price per linear foot (meter) of the type specified. Concrete bridge railing transitions will be paid for at the contract unit price per each for the type specified. 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**
Concrete Bridge Railing Transition, ____ type	EACH
Railing, ____ type	LFT (m)
Railing, Concrete ____ type	LFT (m) CYS (m3)

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.

Concrete railing which the Engineer has ordered removed and replaced in accordance with 706.03 shall be with no additional payment.

SECTION 707 – PRECAST AND PRESTRESSED CONCRETE STRUCTURAL MEMBERS

707.01 Description

This work shall consist of the construction and furnishing of reinforced or prestressed concrete structural members or, if specified, concrete deck panels cast outside the structure, transported to, and incorporated into the structure in accordance with 105.03.

707.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregates, Class A or Higher, Size No. 91.....904
Concrete Curing Materials and Admixtures 912
Concrete Sealers.....909.09, 909.10
Elastomeric Bearings 915.04
Fine Aggregates, Size No. 23.....904
Fly Ash.....901.02
Portland Cement.....901.01(b)

Prestressing Steel .....910.01(b)7
Reinforcing Steel.....910.01

707.03 General Requirements

Structural members including bridge slabs, box-beams, and I-beams, shall be manufactured in an approved plant where strict control over manufacturing and curing procedure is maintained at all times. 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.

If detailed design drawings are not included in the plans, one set of design computations and four sets of detailed shop drawings shall be submitted for approval. The submitted drawings shall be 22 in. by 34 in. (560 mm by 860 mm) in overall size. These shop drawings will be reviewed for design features only. The Contractor shall be responsible for dimensions, accuracy, and fit of work. Certified mill test reports shall be furnished for all high tensile steel. Fabrication shall not begin until the shop drawings are approved.

CONSTRUCTION REQUIREMENTS

707.04 Steel and Concrete Requirements

(a) Reinforcing Steel

A tight coat of concrete grout will be permitted on stirrups extending from precast members. All loose and flaky material shall be removed.

(b) Welding Reinforcing Steel

In lieu of tying, reinforcing steel except prestressing steel may be welded in accordance with the following:

1. Welding will be permitted only at intersections of bars. Splicing of the reinforcing steel by welding will not be permitted. Welds shall have a satisfactory appearance. There are no numerical strength requirements for the completed welds. However, they shall be of such strength as to adequately hold the crossing bars in their true position during the placement of concrete. As low a current as possible shall be used so as to preclude notching and undercutting and still provide a weld of the intended strength. Notching or undercutting of the bars will be cause for rejection of the bars so damaged and the bars shall be replaced as directed.

2. Welding shall be by the shielded metal-arc process using only electrodes with low hydrogen classifications E7015, E7016, E7018, or E7028 in accordance with AWS A5.1. No minimum preheat or interpass temperature is required, except that welding shall be done only when the base metal temperature is above 35°F (2°C). The low hydrogen electrodes shall be dried for at least 2 h at a temperature between 450°F (232°C) and 500°F (260°C) before they are used. Electrodes shall be stored immediately after drying in a storage oven

held at a temperature of at least 250°F (121°C). Electrodes that are not used within 4 h after removal from a drying or storage oven shall be re-dried before use. Electrodes which have been wet shall not be used.

3. All welding procedures and welders to be employed shall be qualified by tests as prescribed below. Evidence may be accepted of previous qualification of the welding procedures and welders to be employed. The same bar stock and type of welding equipment that is required for fabrication of the steel shall be used in qualifying welding procedures and welders. Welding procedures shall be qualified by preparing and testing two sample welds of each combination of bar size and steel type to be welded at intersections in the construction work. Each sample shall be subjected to a tensile test across the point of the weld. The specimens shall develop the minimum requirements for tensile strength and yield strength of the bar stock. However, failure to be in accordance with the percentage of elongation specified for the steel bars used will not be cause for disqualifying the welding procedure or the welder.

4. Welders shall be qualified by preparing and testing samples in the same manner as specified above for qualification of welding procedures. Preparation of welds for qualifying procedures and welders shall be done in the presence of the Engineer. Such inspection shall be requested at least five days in advance. All necessary equipment, personnel, and materials shall be assembled and any experimental work performed so that qualification of welders and welding procedures can be concentrated on a reasonably short and continuous period of time. The cost of qualifying the welders and welding procedures shall be at the expense of the Contractor and will be considered incidental to and included in the pay item for structural members, except that testing of the specimens will be performed by the Department at no expense to the Contractor.

(c) Concrete

Concrete shall be air entrained and in accordance with the applicable requirements of 702.05. Chemical admixture types A, D, F, or G shall be used in combination with an air entraining admixture. High range water reducing, HRWR, and high range water reducing retarding, HRWRR, admixture systems may be used. Chemical admixture types B, C, and E will be permitted only with written permission. Admixtures, other than air-entraining admixtures, shall not be used with air-entrained cement. 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 not exceed 800 lb/cyd (475 kg/m^3). Slump shall be no less than 2 in. (50 mm) nor more than 5 in. (125 mm) for concrete without chemical admixtures or concrete containing chemical admixture types A and D.

Concrete containing admixture type F, G, or admixture systems shall have a slump no less than 3 in. (75 mm) nor more than 7 in. (175 mm). The amount of time from

mixing to placement and consolidation shall be a maximum of 30 min. The concrete shall not be retempered with additional amounts of chemical admixture types F or G after the initial mixing has been completed.

Precast concrete members which are not prestressed shall have a minimum compressive strength of 4500 psi (31 MPa) in 28 days. Prestressed members shall be in accordance with the following unless otherwise shown on the plans:

1. Maximum water/cement ratio in pounds (kilograms) of water per pound (kilogram) of cement shall be 0.400.

2. Minimum 28 day compressive strength of concrete shall be 5000 psi (34.5 MPa).

3. Minimum compressive strength of concrete at time of prestressing shall be 4000 psi (27.6 MPa).

4. Initial tension of prestressing steel shall be as shown on the plans.

Inspection of the precast member during manufacture and checking and testing aggregates, cement, concrete, and steel specimens will be performed. All specimens shall be furnished without cost to the Department. Notification shall be made as soon as reinforcing steel is available for sampling and testing, and also at least five days in advance of the beginning of the manufacture of the precast member. This inspection, checking, and testing performed by the Department will not relieve the Contractor or his manufacturers from performing their own inspection, testing, and checking as necessary to maintain strict control over the manufacturing, handling, and curing procedure. By means of a mechanical recording device, a permanent record of the force applied to each strand of prestressing steel and the identification of the strand and unit to which the record applies shall be provided.

707.05 Forms

Structural members shall be manufactured in steel forms which are unyielding 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 filleted at all sharp corners and shall be given a bevel or draft at all projections to ensure easy removal. 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 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 reinforcing or prestressing steel.

707.06 Placing and Finishing Cement Concrete

Concrete, during and immediately after depositing, 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.

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 member shall be placed in one continuous operation. The outside vertical faces of facia girders and the exposed face and top of the curb section shall be finished in accordance with 702.21.

The tops of all beams and the outside faces of the fascia beams shall be sealed with an approved concrete sealer in accordance with 709.

707.07 Removal of Forms and Curing

Side forms may be removed when no distortion, slump, or misalignment of the concrete will result. Precast 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 (13.8 MPa) as evidenced by test cylinders made and cured in the same manner as the slab.

Curing may be done by wet curing or by accelerated curing.

When wet curing is used, the exposed surfaces of the members shall be covered by two layers of wet burlap and the burlap shall be kept wet. Additional curing of precast or prestressed units will not be required provided the minimum specified ultimate strength can be obtained.

When accelerated curing of the concrete is used, it shall be done by low pressure steam or radiant heat curing. Insulated blankets may be used to reduce heat and moisture loss subject to maintaining a 50°F (10°C) minimum temperature. The 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 curing cycle.

Curing shall be in a suitable enclosure to minimize heat and moisture loss. Except to maintain a minimum temperature of 50°F (10°C), heat shall not be applied until the concrete has attained its initial set. The time of initial set may be determined by ASTM C 403. When the initial set is not determined by ASTM C 403, the initial application of heat shall be from 2 to 4 h after final placement. If retarders are used, this time shall be increased to 4 to 6 h.

During the initial application of radiant heat or live steam, the ambient temperature within the curing enclosure shall increase at an average rate not exceeding 40°F/h (5°C/h) until the curing temperature is reached. Neither the maximum temperature within the enclosure nor the maximum temperature on the surface of the concrete shall exceed 160°F (71°C). The maximum curing temperature shall be held until the concrete has reached the minimum required strength for moving precast units. Detensioning should be accomplished immediately after accelerated curing has been discontinued.

Additional curing of precast or prestressed units will not be required provided the minimum specified ultimate strength can be obtained.

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 test cylinders. the steam shall be at 100% relative humidity to prevent loss of moisture and to provide moisture for proper hydration of the cement.

During the period of initial set of the member and during the accelerated curing by radiant heat, the concrete shall be kept wet by the method outlined above for wet curing.

A recording thermometer shall be provided and used to verify compliance with the temperature requirements.

Approval shall be obtained before curing is done by any means other than those outlined above.

707.08 Handling and Shipping

The precast members shall not be subjected to excessive abuse which produces crushing or undue marring of the concrete. All members damaged during handling, storing, transporting, or erecting shall be replaced. Unless some other method is approved, precast 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 member due to lifting and shall be equipped with leads and hooks at each end. The girders shall be lifted by the devices shown on the plans. Alternate lifting devices and procedures shall be at the owner's or supplier's option, and must be approved prior to use. If any other method of handling is used, it shall be shown on the shop drawings and approved prior to use. If the method produces horizontal forces in the precast member, sufficient steel reinforcement shall be added to compensate for them.

The 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, I-beams, box-beams, and slabs shall be fully supported across their width on battens not less than 4 in. (100 mm) wide with one being placed at each end at the centerline of the bearing. The supports of the members while in storage shall be maintained in a level position so no twisting occurs.

The precast members shall not be shipped nor used until the concrete reaches a strength of 4,500 psi (31 MPa) for members which are not prestressed and 5,000 psi (34.5 MPa) for members which are prestressed as evidenced by test cylinders made at the time of casting and cured in the same manner as the precast members which they represent. If they are shipped prior to 28 days, additional test cylinders shall be made to ensure adequate 28 day results in case of earlier failure.

During transportation, the members shall be supported with truck bolsters or battens no less than 4 in. (100 mm) wide which are padded with no less than 1/2 in. (13 mm) of rubber. The ends of I-beams shall extend no more than the depth of the beam and not more than 3.5 ft (1 m) 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 (0.9 m) 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. Trucks with double bolsters will be permitted, provided the beams are fully seated on the outer bolsters and the inner bolsters are no more than 8 ft (2.4 m) 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 the precast deck shall commence at the centerline and proceed out to the curb, one member at a time. As each member is placed, the transverse tie bars, if shown on the plans, shall be inserted and secured. Any shifting of the members shall be done while they are held free of the supports by the hoisting device. The use of a steel pinch bar will not be permitted. 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, 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 one part portland cement, two parts No. 23 fine aggregate, and an approved non-shrinking additive or a non-shrink, non-metallic cementation grout in accordance with ASTM C 1107. All bolts or drains shown on the plans as necessary or desirable 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 members together shall be furnished.

Dowel holes shall not be grouted nor concrete or the forming therefor, be placed in floor slabs, diaphragms, or shear keys prior to receipt of complete documentation of the acceptability of the members and bearing pads, including the satisfactory laboratory reports and certifications in accordance with 915.04(e). Neither the members, nor the bearings will be considered incorporated into the work, and neither will be paid for until this documentation is accomplished satisfactorily.

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 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.

Cranes or other heavy erection equipment may be operated on the precast or prestressed members only if approved in writing and if a proposed operating procedure is submitted showing loading, distribution of loads, resulting stresses, and that the design of the members is satisfactory to permit. However, such approval shall not relieve the Contractor of any damage from this operation.

707.10 Precast Prestressed Concrete Deck Panels

Precast prestressed concrete deck panels shall be designed as a non-composite section to support the dead load of the panel, reinforcement, plastic concrete, and a construction load of 50 lb/ft^2 (2.4 kPa). The panel shall be designed as a composite section with the class C concrete to support the live load. The Contractor shall revise the area of top longitudinal reinforcing steel over interior supports for negative moment to be equal to the total area of top and bottom longitudinal reinforcing steel.

Shop drawings and design computations shall be submitted in accordance with 707.03. Design computations for deck panels shall be submitted for approval for total slab thickness greater than 8 in. (200 mm) or clear spans in excess of 7.5 ft (2.3 m). Design shall be in accordance with the AASHTO Standard Specifications for Highway Bridges. Details such as type, size, and location of the reinforcing steel, the prestressing strands, welded wire fabric, and concrete shall be as shown on the plans.

The concrete for deck panels shall be placed in accordance with 702.20. The concrete shall be vibrated to prevent honeycombs and voids, especially at the corners and edges of the panels. The tops of the deck panels shall be broom or wire brush finished in the direction of the prestressing strands. The corrugations formed shall be uniform in appearance and shall not be more than 1/4 in. (6 mm) in depth. The coarse aggregate shall not be displaced when preparing the roughened surface.

707.11 Method of Measurement

Precast or prestressed concrete structural members will be measured by the linear foot (meter) along the top of each member or by the square foot (square meter) of top surface of each member. Railing will be measured in accordance with 706.05 if specified as a pay item.

707.12 Basis of Payment

The accepted quantities of precast or prestressed concrete structural members will be paid for at the contract unit price per linear foot (meter) or per square foot (square meter) for structural member, concrete, of the type and size specified. Precast or prestressed concrete structural members for which the type and size is not shown in the Schedule of Pay Items will be paid for at the contract lump sum price for structural members, concrete.

Railing will be paid for in accordance with 706.06 when specified as a pay item.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Structural Member, Concrete, ____, ____ (type, size)	LFT (m) SFT (m2)

Reinforcing steel, elastomeric bearing pads, bearing beams required for box beams, bearing assemblies required for I-beams and box beams, bearing plates, expanded polystyrene, threaded dowels, threaded inserts in facia beams, hex bolts, sealer on the

outside face of facia beams and on the tops of all beams, and necessary incidentals shall be included in the cost of this work.

No payment will be made for replacing precast members damaged during handling, storing, transporting or erecting.

The cost of railing shall be included in the cost of this work if such railing is not specified as a pay item.

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.

708.02 Materials

Materials shall be in accordance with the following:

Fine Aggregate	904.02(d)
Fly Ash	901.02
Portland Cement	901.01(b)
Water	913.01
Welded Steel Wire Fabric	910.01(b)5

Welded steel wire fabric shall consist of wire, size W 1.5 or approximately No. 10 gage (3.43 mm), spaced and welded at 3 in. (75 mm) intervals, or wire, size W 1 or approximately No. 12 gage (2.68 mm), spaced and welded at 2 in. (50 mm) intervals.

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.

708.04 Reinforcement

If wire mesh fabric 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 (0.6 m).

Insofar as feasible, the mesh shall parallel the surface of steel members 3/4 in. (19 mm) out from the face. Where sheets meet, they shall lap at least 4 in. (100 mm) and shall be fastened together securely.

Wire fabric reinforcement shall be used in all areas where the thickness of the mortar exceeds 3 in. (75 mm) and also if the present steel reinforcement is exposed after

the disintegrated concrete has been removed. The wire fabric shall be fastened to the concrete masonry with 1/4 in. (6 mm) 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. (200 mm) centers in each direction and shall be of sufficient length to space the fabric approximately 2 in. (50 mm) from the surface being repaired. Where the fabric can be fastened to the reinforcing steel, the bolts, pins, or nails may be omitted.

708.05 Proportioning and Mixing

The dry mixture shall consist of one part portland cement to three 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. (6 mm) 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.

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.

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. (50 mm) thick in one operation. Where a finished thickness of more than 2 in. (50 mm) is required, it shall be obtained in successive operations and enough time allowed to permit 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. (3 mm) 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. (3 mm) or larger shall be removed by screening. No less than one bag of the white cement to each 300 sq ft (28 m^2) of surface shall be used.

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 (10°C) nor 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 (square meter), complete in place. The area measured will be the actual finished surface. Welded steel wire fabric, where used, will be measured by the square foot (square meter), complete in place.

708.09 Basis of Payment

The accepted quantities of pneumatically placed mortar and welded steel wire fabric will be paid for at the contract unit price per square foot (square meter), complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Pneumatically Placed Mortar	SFT (m2)
Welded Steel Wire Fabric	SFT (m2)

The areas where loose or defective portions of masonry exceed an average of 4 in. (100 mm) 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. (100 mm) but less than 6 in. (150 mm).....1.25

(b) for portions thereof whose average depth is greater than or equal to 6 in. (150 mm) but less than 8 in. (200 mm).....1.50

(c) for portions thereof whose average depth is greater than or equal to 8 in. (200 mm) but less than 10 in. (250 mm).....1.75

(d) for portions thereof whose average depth is greater than or equal to 10 in. (250 mm) but less than 12 in. (300 mm).....2.00

(e) For all portions thereof whose average depth is greater than or equal to 12 in. (300 mm), 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.

709.02 Materials

Materials shall be in accordance with the following:

Epoxy Penetrating Sealers.....909.09
Other Portland Cement Concrete Sealers.....909.10

CONSTRUCTION REQUIREMENTS

709.03 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.

709.04 Environmental Requirements

(a) General Requirements

Concrete sealer shall not be applied in rainy conditions or if rain is anticipated within 2 h after application. Concrete sealer shall be applied when the temperature of the concrete surface to be sealed is 40°F (5°C) or above and when the air temperature is 50°F (10°C) or above, unless otherwise approved in writing. Concrete sealer shall not be applied when the ambient temperature is expected to fall below 35°F (2°C) within 12 h after application.

(b) Epoxy Penetrating Sealers

Cast-in-place concrete shall have a minimum of 3 days dry cure prior to the application of epoxy penetrating sealer.

(c) Other Portland Cement Concrete Sealers

The concrete to be sealed shall be cured as stated on the list of approved Other Portland Cement Concrete Sealers prior to sealer application.

(d) Low Temperature Epoxy Penetrating Sealer

A low temperature epoxy penetrating sealer shall be applied in accordance with the requirements for epoxy penetrating sealer. However, the low temperature epoxy penetrating sealer shall be applied when the temperatures of the concrete surface and the

air are 35°F (2°C) or above. Low temperature concrete sealer shall not be applied when the ambient temperature is expected to fall below 20°F (-7°C) within 12 h of application.

709.05 Sealer Application

(a) General Requirements

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.

(b) Epoxy Penetrating Sealer

The mixing of the 2-component parts of the epoxy penetrating sealer, their handling and application on the concrete surface shall be in strict accordance with the recommendations of the manufacturer except as may be otherwise specifically covered in these specifications. Under no circumstances shall any solvent be added to the compounds.

The epoxy penetrating sealer shall be applied at the rate of 90 to 110 sq ft/gal. (2.2 to 2.7 m^2/L). The sealer shall be mixed in the exact manner the manufacturer recommends. After the material has been adequately mixed, preferably by power, and the induction time completed in accordance to manufacturer's recommendations, it shall be applied to the cleaned dry surface by brush, roller, squeegee, or other approved method.

All cracks shall be filled before beginning the complete sealing of the entire required surface. This crack filling operation shall cure a minimum of 2 h or in accordance with the manufacturer's recommendations before the complete surface is sealed with the epoxy penetrating sealer. After the surface has been sealed and properly cured, all cracks that are not completely filled shall be retreated. This retreatment of cracks shall be completed within 72 h.

After sufficient amounts of the epoxy penetrating sealer have been applied and before the material has started its initial set or becomes tacky, a light coating of dry clean sand shall be broadcast at a rate of 1 to 2 lb/sq yd (0.55 to 1.10 kg/m^2) onto all treated surfaces which carry vehicular or pedestrian traffic. The sand shall contain not less than 90% silica and shall be in accordance with the following gradation:

SIEVE	PERCENT PASSING
No. 16 (1.18 mm)	100
No. 100 (150 µm)	0-5

After the sand has been applied, the sealed surface shall be allowed to cure.

(c) Other Portland Cement Concrete Sealers

The sealer chosen for use shall be applied at the application rate specified on the list of approved Other 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 (105 kPa) 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 Department's list of approved Other 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 sequence. If brooming is specified, a clean, stiff-bristled broom shall be used to spread and work the sealer into the concrete surface.

(d) Clear Sealers

Clear sealers shall be used on all vertical wall surfaces such as concrete bridge railing, barrier wall, exterior concrete bridge beams, etc., when sealing is specified for these items. The epoxy penetrating sealers are not clear sealers. Clear sealers will be those identified on the list of approved Other Portland Cement Concrete Sealers.

(e) Alternate To Concrete Sealers

In lieu of concrete surface sealing for concrete barrier wall and concrete bridge railing, an alternate concrete mix design may be used. The concrete mix design shall be as specified, except either 3% silica fume by weight (mass) of cementitious material shall be added to the mix design or 30% ground granulated blast furnace slag substitution based on the required cement content shall be incorporated into the mix. The substitution of ground granulated blast furnace slag 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

Epoxy materials are toxic and may be dermititic. Precautions shall be taken to protect workers from the hazards of these materials. Solvents in the epoxy penetrating sealers and some of the other sealers are flammable. All necessary precautions shall be taken pertaining to the handling and potential overspray of these concrete sealers.

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.

If an alternate concrete mix design in accordance with 709.05(e) 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.

If a curing-sealing material in accordance with 702.22(c) is used in lieu of sealing concrete surfaces or portions thereof, it will be paid for as surface seal.

SECTION 710 – REPOINTING MASONRY IN STRUCTURES

710.01 Description

This work shall consist of repointing concrete, rubble, dressed stone, or brick masonry structures with mortar in accordance with 105.03.

710.02 Materials

Materials shall be in accordance with the following:

Fine Aggregate	904.01
Hydrated Lime	913.04
Masonry Cement	901.01(c)
Portland Cement	901.01(b)

CONSTRUCTION REQUIREMENTS

710.03 Repointing Concrete Masonry

All honeycombed, weathered, or disintegrated areas in the concrete shall be cut out and thoroughly cleaned of all loose concrete, dirt, or other foreign material to a depth and over the area necessary to produce a firm and solid connecting surface for the adherence of the new mortar. This prepared surface shall be coated with epoxy resin adhesive in accordance with AASHTO M 235, class I, filled with mortar well driven in, and finished to meet approval. Where the surface is to be cleaned out to such depth and area that the new mortar does not stay in place without support, a form shall be placed over the area and the space so enclosed filled with well-consolidated mortar. After the forms are removed the mortar shall be protected in accordance with 708.07.

710.04 Repointing Rubble Masonry

All spaces around the rubble aggregate, after being cleaned, shall be well filled with mortar. If any of the rubble is loose, it shall be settled into place before the mortar has set.

710.05 Repointing Dressed Stone and Brick Masonry

The joints in the masonry shall be cleaned of all loose mortar and foreign material for a depth of at least twice the width of the joint. The joints shall then be filled with mortar, well driven in and neatly finished.

710.06 Method of Measurement

Repointing masonry in structures will be measured by the square foot (square meter) of actual surface area of masonry repointed. Individual patches of less than 1 sq ft (0.1 m^2) in area will be considered as 1 sq ft (0.1 m^2).

710.07 Basis of Payment

The accepted quantities of repointing masonry in structures will be paid for at the contract unit price per square foot (square meter) of repointed masonry complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Repointing Masonry in Structures	SFT (m2)

Areas where repointing masonry in structures exceeds an average of 4 in. (100 mm) in depth, the work shall be completed as extra work. Payment will be made in accordance with 104.03.

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.

711.02 Materials

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

Material specifications shall be shown on the shop 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.

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. (13 mm) 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.

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.

Structural steel, regardless of its source, shall be fabricated within the continental limits of the United States of America.

711.04 Certification of Fabricators

The fabricator of structural steel furnished under this section shall be certified in accordance with the American Institute of Steel Construction and Quality Certification Program (Category III) before the fabricator will be permitted to fabricate a welded plate girder. It shall be the fabricator's responsibility to maintain a valid certification and annual endorsements thereto.

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 must be submitted with the request.

711.05 Shop Drawings

Five sets of detailed shop drawings shall be submitted for approval. Fabrication shall not begin until the shop drawings are approved. These shop drawings will be reviewed for design features only. The Contractor shall be responsible for dimensions, accuracy, and fit of work. One set will be returned either approved or showing changes or corrections required. If required to be changed or corrected, copies shall be resubmitted until they receive approval. No deviations will be allowed from the approved working drawings without written consent.

Shop drawings shall include a detailed bill of materials showing weights of materials completed in accordance with 711.73(b) when payment is on a unit weight basis. On completion of the shop fabrication and before the contract is completed, the tracings of all approved shop drawings shall be furnished. The tracings shall be linen cloth or a suitable reproduction, subject to approval. Drawings or tracings shall be 22 in. by 34 in. (560 mm by 860 mm) in overall size.

If the contract plans include detailed structural steel drawings, they may be used. These detailed structural steel drawings in the plans shall be checked, and the Contractor shall provide notification in writing that he 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.

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

Prior to, or concurrent with, the fabrication, four copies of mill test reports shall be furnished. 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 calculated stress and not to be marked in accordance with ASTM A 6 (ASTM A 6M), Article 9, 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 shop plans. Approval of shop plans 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 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

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 permitted, shall be done by methods that do not produce fracture or other injury. 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 A 709 grade 100 (ASTM A 709M grade 690) steel members will not be permitted. The temperatures of the heated area shall not exceed 1200°F (650°C), 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 permitted. Following the straightening of a bend or buckle, the surface of the metal shall be inspected for evidence of fracture.

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.

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.

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. (10 mm) 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

Structural steel permitted by 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. (2 mm) radius by grinding after flame cutting.

Re-entrant cuts shall be filleted to a radius of not les than 3/4 in. (19 mm).

Surface roughness exceeding the above values and occasional gouges not more than 3/16 in. (5 mm) 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. (5 mm) deep but not more than 7/16 in. (11 mm) deep may be repaired by welding with low hydrogen electrodes not exceeding 5/32 in. (4 mm) in diameter and with a preheat of 250°F (121°C). The completed weld shall be ground smooth and flush with the adjacent surface.

711.14 Edge Planing

Edge planing will not be required on plates having rolled edges.

Sheared edges of plates more than 1/2 in. (13 mm) in thickness and carrying calculated stress shall be planed to a depth of 1/4 in. (6 mm). Re-entrant cuts shall be filleted before cutting.

Visually observed defects in sheared or flame cut edges of plates 4 in. (100 mm) or less in thickness, except ASTM A 709 grade 100 (ASTM A 709M grade 690) steel plates, shall be investigated or repaired in accordance with the following table. Repairs made by welding shall be in accordance with 711.32.

TABLE

Description of Discontinuity	Repair Required
All discontinuity of 1/8 in. (3mm) Maximum depth.	None-depth shall be explored as directed.
Any discontinuity over 1 in. (25 mm) in length with depth over 1/8 in. (3 mm) but not greater than 1/4 in.(6 mm)	Remove and weld.
Any discontinuity over 1 in. (25 mm) in length with depth over 1/4 in. (6 mm) but not greater than 7/16 in. (11 mm).	Remove completely and weld. Aggregate length of welding not over 20% of plate edge length being repaired.
Any discontinuity over 1 in. (25 mm) in length with depth greater than 7/16 in. (11 mm).	Plate rejected. Defective portion may be removed and remainder may be used in 7/16 in. (11 mm) 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. (6 mm).

711.16 End Connection Angles

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 a permissible tolerance of +0 to 1/16 in. (+0 to 2 mm). 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 detail drawings after facing.

711.17 Blank

711.18 Blank

711.19 Bent Plates

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 (mm)	Up to 1/2 in. (13 mm)	Over 1/2 in. (13 mm) to 1 in. (25 mm)	Over 1 in. (25 mm) to 1 1/2 in. (38 mm)	Over 1 1/2 in. (38 mm) to 2 1/2 in. (63 mm)	Over 2 1/2 in. (63 mm) to 4 in. (100 mm)
All grades of structural steel in this specification	2t 51 mm	2 1/2t 63 mm	3t 76 mm	3 1/2t 89 mm	4t 102 mm

If a shorter radius is essential, the plates shall be bent hot at a temperature no greater than 1200°F (649°C). 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. (2 mm) throughout that portion of the plate at which the bending is to occur.

711.20 Fit of Stiffeners

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.

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 nor more than six times the web thickness.

711.21 Bolt Holes

(a) High Tensile Strength Bolts, and Unfinished Bolts

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. (2 mm) larger than the nominal diameter of the bolts whenever the thickness of the metal is no greater than 3/4 in. (19 mm) for structural steel or 5/8 in. (16 mm) for high-strength steel. If there are more than five thicknesses or when the main material is thicker than 3/4 in. (19 mm) for structural steel, or 5/8 in. (16 mm) for high strength steel, or if required in accordance with 711.24, all holes shall be subpunched or subdrilled 3/16 in. (5 mm) smaller and, after assembling, reamed 1/16 in. (2 mm) larger or drilled from the solid to 1/16 in. (2 mm) larger than the nominal diameter of the bolts.

(b) Ribbed Bolts, Turned Bolts, or other Approved Bearing-Type Bolts

All holes for ribbed bolts, turned bolts, or other approved bearing type bolts shall be subpunched or subdrilled 3/16 in. (5 mm) 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

The diameter of the die shall not exceed the diameter of the punch by more than 1/16 in. (2 mm). If any holes must be enlarged to admit the bolts, such holes shall be reamed. Holes must be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection.

711.23 Reamed or Drilled Holes

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. (2 mm) 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. (3 mm) 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. (25 mm). Open holes for high strength bolts shall be 15/16 in. (24 mm) 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.

The shop drawings shall indicate whether reaming is to be done in the shop or in the field. If beams or girders are shop reamed or drilled, progressive beam or girder assembly will be permitted 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.

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. (3 mm) 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. 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.

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. (3 mm) 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. (5 mm) smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

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. (0.8 mm) 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

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

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. (3 mm), 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. (6 mm). The cuts shall be straight enough that a 1/8 in. (3 mm) plate passes between the parts on any designated straightline cut.

711.30 Blank

711.31 Blank

711.32 Welds

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 structures, when authorized, shall be performed in accordance with the following AWS Specifications.

A5.1 Mild Steel Covered Arc-Welding Electrodes.
A5.5 Low-Alloy Steel Covered Arc-Welding Electrodes.
A5.17 Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding.
A5.18 Mild Steel Electrodes for Gas Metal-Arc Welding.
A5.20 Mild Steel Electrodes for Flux-Cored Arc Welding.
D1.5 (AASHTO/AWS) Bridge Welding Code.

Welders, welder operators, and track welders shall be qualified in accordance with AWS D1.5 Chapter 5 Part B.

(b) Edge Blocks

Edge blocks shall be used when radiographing flange butt shop welds of greater than 1/2 in. (13 mm) thickness. The edge blocks shall have the dimensions shown on the plans. The edge block shall be centered on the weld with a snug fit against the plate being radiographed, with the maximum gap shown on the plans. Edge blocks shall not be tack welded. Edge blocks shall be made of radiographically clean steel. The surface shall have an ANSI finish of 0.125 mil (3 µm) or smoother.

Field welding shall be in accordance with the requirements herein, except where welded connections do not carry calculated stresses. Magnetic particle inspection will not be required, so ANSI/AASHTO/AWS D1.5-88 Table 4.4 "Minimum Preheat and Interpass Temperature" as it refers to thicknesses to 3/4 in. (19 mm) inclusive, shall read "None". Electrodes with a low hydrogen classification will not be required.

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

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 A 941. 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 (38°C) at any one time.

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

Pin holes may be flame cut at least 2 in. (50 mm) 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 (5 mm in 1 m).

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.

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.

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 B46.1:

Bridge rollers and rockers ..... ANSI 250
Heavy plates in contact with shoes to be welded ..... ANSI 1000
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

Pins and rollers shall be turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Pins and rollers more than 9 in. (230 mm) in diameter shall be forged. Pins and rollers 9 in. (230 mm) or less in diameter may be forged or cold finished, carbon steel shafting. In pins larger than 9 in. (230 mm) in diameter, a hole no less than 2 in. (50 mm) 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 compression members shall not vary from that specified more than 1/32 in. (1 mm). 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. (0.5 mm) for pins 5 in. (125 mm) or less in diameter, nor 1/32 in. (1 mm) 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 threads and Class 2B for internal threads, except that pin ends having a diameter of 1 3/8 in. (35 mm) or more shall be threaded 6 threads per 1 in. (25 mm).

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 marks. If marked "rough finish" the tool marks need not be removed. However, there shall be no irregularities greater than 1/32 in. (1 mm) 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 (1 mm in 1 m), with a maximum variation not to exceed 3/16 in. (5 mm) 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.

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 is used, the camber diagram shall show calculated camber.

(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 shop plans.

1. This method shall consist of the assembly of at least three contiguous members, and no less than 150 ft (46 m). 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.

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 shall be permitted to complete the structure. This laydown shall be the last span unless otherwise approved on shop plans. 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.

(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 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

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

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 must 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

Shop cleaning and painting shall be in accordance with applicable requirements of 619.

711.48 Shop Cleaning and Storage of ASTM A 709 Grade 50W (ASTM A 709M Grade 345W) 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. Storage shall be such to permit free drainage to avoid moisture pockets.

A sound uniform surface for the formation of a protective oxide coating on surfaces shall be prepared as follows:

(a) Hot Rolled Products

These products shall include structural shapes, plates, hot-rolled sheets, and hot-rolled strip. The outside of each facia beam or girder, including the bottom of the bottom flange, shall be cleaned in accordance with 619.08(c). Contamination from grease, oil, or shop marking shall be avoided. If such contamination is unavoidable, such surfaces shall be cleaned in accordance with 619.08(b).

(b) Welded Area

All exposed welds on facia surfaces shall be prepared by means of power grinding or blast cleaning in accordance with 619.08(d) to remove welding flux, slag, scale, or spatter.

711.49 Furnishing Bolts

Sufficient field bolts shall be furnished to complete the entire structure.

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 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.

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.

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.

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.

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

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

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 approval. Approval of these plans shall not be considered as relieving the Contractor of any responsibility.

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 expansion ends of spans shall be adjusted to permit 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

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 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 permit 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 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. The shop drawings shall indicate which splices are to be eliminated. 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 permitted. If other connections are to be used, 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 permitted 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 A 325 (ASTM A 325M) high strength carbon steel bolts, or equivalent fasteners, 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. (22 mm) in diameter unless noted.

(b) Bolts, Nuts, and Washers

Bolts, nuts, and washers shall be in accordance with 910.02(e). 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

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, lose scale, burrs, other foreign material, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or rust inhibitor.

(d) Installation

1. Bolt Tension

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 of fastener used.

TABLE A

BOLT TENSION FOR ASTM A 325 (ASTM A 325M) BOLTS

Bolt Size in. (mm)	Minimum Bolt Tension,* pounds (kilonewtons)
1/2 (13)	12,050 (54)
5/8 (16)	19,200 (86)
3/4 (19)	28,400 (126)
7/8 (22)	39,250 (175)
1 (25)	51,500 (229)
1 1/8 (29)	56,450 (251)
1 1/4 (32)	71,700 (319)
1 3/8 (35)	85,450 (380)
1 1/2 (38)	104,000 (463)

* Equal to the proof load (length measurement method) given in ASTM A 325 (ASTM A 325M)

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 Standard Specifications for Highway Bridges, Division II. The snug tight condition as defined in AASHTO Specifications for Highway Bridges, Division II, shall be obtained for all final tightening.

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

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

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

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 one 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 exceeding8 diameters or 8 in. (200 mm).	Bolt length[4] exceeding 8 diameters or 8 in. (200 mm).	For all lengths of bolts.
1/2 turn	2/3 turn	3/4 turn

(1) For coarse thread heavy hexagon structural bolts of all sizes and lengths and heavy hexagon semi-finished nuts.

(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.

(3) Slope 1:20 maximum.

(4) Bolt length is measured from underside of head to extreme, end of point.

(e) Inspection

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.

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.

   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 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 degrees, or approximately 1 in. (25 mm) at a 12 in. (300 mm) radius, in the tightening direction shall be determined. The average torque measured in the tests of 3 bolts shall be taken as the job inspecting torque to be used in the manner specified in requirement 3e of 711.65(e).

   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).

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.

711.66 Bolted Connections Using Other Than High Strength Bolts

Bolts for these connections shall be in accordance with 910.02(f).

711.67 Final Clean-Up

Final clean-up shall be conducted in accordance with 104.07.

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 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.

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 ASTM A 709 Grade 50W (ASTM A 709M Grade 345W) Steel

Cleaning of structural steel specified to be left unpainted shall be in accordance with 619.08(b) or 619.08(f) 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 permitted.

Storage shall be such to permit 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

Plain structural steel shapes, fabricated steel, steel castings, iron castings, bolts, pins, rollers, rockers, anchor bolts, and threaded rods will be measured by the pound (kilogram). 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.

Bronze plates will be measured by the pound (kilogram). Pay weight (mass) will be based on a theoretical weight of 536 lb/cu ft (mass of 8,590 kg/m^3). 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 (square millimeter) 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.

711.73 Basis of Payment

The accepted quantities of plain 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 (kilogram) for structural steel. Such pay item will include all work listed above, complete in place. Payment will be in accordance with 711.73(b).

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 (kilogram). The accepted quantities of field structural steel cutting will be paid for at the contract unit price per square inch (square millimeter) 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.

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.

Bolts, including anchor bolts and threaded rods, will be paid for as the full width (mass) computed on the basis of 490 lb/cu ft (7,850 kg/m^3), including nuts and washers, for the actual number of bolts in the structure.

If welding is shown on the plans, the weights (masses) of the structural steel parts will be computed as described above.

The weight (mass) of castings will be computed on the basis of 490 lb/cu ft (7,850 kg/m^3) for cast steel, and 450 lb/cu ft (7,210 kg/m^3) 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

An estimated weight (mass) of structural steel will be shown on the plans. Such weight (mass) will be computed by the same method as that used when computing the estimated weight (mass) when paid for on a unit price per pound (kilogram) basis from semi-detailed plans. This weight (mass) will include all structural steel and miscellaneous metals unless otherwise included in specific pay items.

The weight (mass) of structural steel shown on the plans is approximate only. For a lump sum pay unit, the Contractor shall determine the weight (mass) on which the bid is based.

If there is a discrepancy between the plan weight (mass) and the actual weight (mass), no decrease or increase in the payment for the work will be made on account of such discrepancy.

If a change in the plans is made which will affect the weight (mass) 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 (kilogram) obtained by dividing the lump sum amount for structural steel by the total estimated weight (mass) 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 (mass) of materials will be shown in the bill of materials on the plans when shop details are included in such plans, or as computed from the fabricator's approved shop details, when shop details are not included in the plans. In either case, such weight (mass) shall include all changes ordered.

For rolled sections, the gross weight (mass) of the steel will be considered. The weight (mass) will be figured on the basis of 490 lb/cu ft (7,850 kg/m^3). The weight

(mass) of each piece will be the weight (mass) 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 shop plans, the weight (mass) of groups of two or more pieces shall be the weight (mass) 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**
Bolt, Remove	EACH
Bronze Plates	LBS (kg)
Drilled Hole	EACH
Jacking and Supporting _____ structural member type	LS
Rivet, Remove	EACH
Structural Steel	LS LBS (kg)
Structural Steel, Field Cut	SIN (mm2)
Stud Shear Connectors	EACH

The cost of drilling holes for anchor bolts, bridge bearing pads, fabrication, erecting falsework, welding material, Charpy V-Notch toughness tests, and necessary incidentals shall be included in the cost of the pay items.

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 permitted if diaphragm connections other than those shown on the plans are approved and used.

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 (mass) of shims required does not exceed that planned. No shim shall be less than 1/8 in. (3 mm) in thickness.

No allowance in weight (mass) 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.

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(f)
Steel Castings	910.05(a)
Structural Steel	910.02
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 OG 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.

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. (300 mm) 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.

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.

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 permitted in making joints nor will open joints be accepted. Timbers requiring an exact fit shall be matchmarked.

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. (2 mm) 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;

(d) rods shall be 1/16 in. (2 mm) larger than the rod; and

(e) lag screws shall be the screw diameter to the base of thread, and half 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.

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. (6 mm) 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. (16 mm) in diameter. Intermediate intersections shall be bolted or spiked with wire or boat spikes as shown on the plans.

712.04 Caps

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. (19 mm) in diameter extending at least 9 in. (230 mm) 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 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.

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. (13 mm) 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.

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. (19 mm) in diameter and shall project at least 6 in. (150 mm) 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. (19 mm) in diameter and extend into the mudsills or piles at least 6 in. (150 mm). When feasible, all earth shall be removed from contact with sills to permit free circulation of air around them.

Posts shall be fastened to pedestals with dowels of no less than 3/4 in. (19 mm) in diameter extending at least 6 in. (150 mm) 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. (19 mm) in diameter driven diagonally through the base of the post, and extending at least 9 in. (230 mm) into the sill, or by means of dowels of no less than 3/4 in. (19 mm) in diameter extending at least 6 in. (150 mm) into posts and sills. Pile bents shall be driven in accordance with 701.

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 (3.7 m) 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.

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.

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

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. (6 mm) 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 (0.9 m). Ends shall be fastened securely. If required, the outer ends of the top planks shall be beveled at each end of the bridge.

712.11 Method of Measurement

Structural timber and lumber, both treated and untreated, will be measured by the 1,000 feet board measure (cubic meter). Planks for floors will be measured by the square foot (square meter). 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 (kilogram) computed in accordance with 711.73(b). Bolts, dowels, washers, nails, spikes, and lag screws will be classed as hardware.

712.12 Basis of Payment

The accepted quantities of lumber and timber will be paid for at the contract unit price per 1,000 feet board measure (cubic meter) for lumber and timber, either treated or untreated as specified. Plank floors will be paid for at the contract unit price per square foot (square meter) for plank floors of the ply specified. Metal parts will be paid for at the contract unit price per pound (kilogram).

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Metal Parts	LBS (kg)
Plank Floors, ____ Ply	SFT (m2)
Lumber and Timber, Treated	MFBM (m3)

Lumber and Timber, Untreated.....MFBM (m3)

The cost of preservative treatment, hardware, painting, and necessary incidentals shall be included in the cost of the pay items.

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.

713.02 Materials

Materials shall be in accordance with the following:

Delineators 926.02
Delineator Posts 910.15
Fence 910.18
Piling 701

CONSTRUCTION REQUIREMENTS

713.03 General Requirements

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.

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 (8.5 m) 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 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 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. 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.

713.06 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.

713.07 Removal

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 (0.6 m) 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.

713.08 Method of Measurement

Temporary bridges and approaches will not be measured for payment unless otherwise specified. HMA mixtures for temporary pavement will be measured by the ton (megagram). Guardrail of the type specified will be measured by the linear foot (meter) 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.

713.09 Basis of Payment

The accepted quantities of temporary bridge and approaches will be paid for at the contract lump sum price for the work, complete in place and later removed as specified. HMA mixtures for temporary pavement will be paid for as the type of mixture specified, in accordance with 610.06, complete in place. Guardrail installed along approaches will be paid for at the contract unit price per linear foot (meter). Guardrail end treatment will

be paid for at the contract unit price per each for the type specified. Temporary pavement markings will be paid for in accordance with 801.18.

Seeding and sodding will be paid for in accordance with 621.14.

If adjustment of approach embankments is necessary, the additional excavation and borrow will be paid for in accordance with 203.28.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Guardrail End Treatment, ____, Temporary Bridge Approaches (type)	EACH
Guardrail, W-Beam, ____ ft.-____ in. (m) Spacing, Temporary Bridge Approaches	LFT (m)
Temporary Bridge	LS
Temporary Bridge and Approaches	LS

The cost of excavation, embankment, backfill, removal and disposal of temporary HMA pavement, delineators, and temporary fence, shall be included in the cost of the pay items.

The cost of furnishing, installation, and removal of guardrail and guardrail end treatment shall be included in the cost of the pay items.

If the Contractor elects to build a longer bridge or approaches than specified, such work shall be done with no additional payment. If such work requires additional right-of-way, it shall be provided with no additional payment.

SECTION 714 – CONCRETE CULVERTS AND RETAINING WALLS

714.01 Description

This work shall consist of the construction of concrete retaining walls, concrete drainage structures with less than 20 ft (6.1 m) span, and such parts of similar structures composed of concrete in accordance with these specifications and 105.03.

714.02 Materials

Materials shall be in accordance with the following:

Bituminous Mastic Pipe Joint Sealer	906.05
Chemical Anchor System	901.05
Concrete	702
Geotextile	918.02
Joint Membrane System for Precast Reinforced Concrete Box Sections	906.06
Precast Reinforced Concrete Box Culverts	907.05
Reinforcing Steel	910.01
Structure Backfill	904

Concrete in cast-in-place splices between an existing culvert and a precast reinforced concrete box section extension or used to seal existing culverts shall be class A.

CONSTRUCTION REQUIREMENTS

714.03 General Requirements

Unless otherwise specified, applicable provisions of 702 and 703 shall apply to the construction of culverts, culvert extensions, retaining walls, and concrete parts of similar structures. 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.

Detailed plans for falsework and centering will not be required.

714.04 Extension of Existing Culverts

All pertinent requirements of this specification shall apply to extensions of existing box culverts, slab top culverts, and arch culverts. Such portions of the existing culvert 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.

All existing reinforcing steel exposed after concrete removal shall be cleaned and straightened in preparation for lapping with reinforcement from adjacent new work. Where existing reinforcing steel 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 steel. The holes shall be of the diameter and length shown on the plans or as directed and shall be cleaned prior to placement of the reinforcement and an approved chemical anchor system.

Existing culverts shall be extended by one of the following methods:

(a) Precast Concrete Box Sections Extension

A cast-in-place concrete splice shall be constructed as a transition between the existing structure and the precast extension. The splice reinforcement shall be lapped with the exposed existing structure reinforcing steel and with exposed reinforcing mesh from the extension as shown on the plans.

(b) Cast-In-Place Concrete Culvert Extension

The reinforcing steel for the extension shall be directly lapped with the exposed reinforcement of the existing structure as shown on the plans.

714.05 Precast Reinforced Concrete Box Section Joints

Precast reinforced concrete box section joints shall be sealed as shown on the plans. A bituminous mastic pipe joint sealer system or self-adhering joint membrane systems shall be applied when the concrete surface temperature is above 40°F (5°C) or sufficient to allow adherence. Prior to application of the mastic or membrane material, the concrete surfaces shall be cleaned and dry. Heat may be applied to the concrete surfaces until they are in accordance with the temperature and dryness requirements. The mastic or membrane material 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. (65 mm) shall be required to start the next roll of material. The manufacturer's application instructions shall apply in addition to the above requirements.

714.06 Sealing Existing Culverts

When existing culverts are no longer needed, but do not require removal, they shall be sealed with concrete at both ends as shown on the plans or as directed. Existing headwall removal shall be as shown on the plans or as directed.

714.07 Method of Measurement

Concrete used in retaining walls, culverts, and culvert extensions will be measured in accordance with 702.27. Reinforcing steel will be measured in accordance with 703.07. Precast reinforced concrete box sections and precast reinforced concrete box section extensions will be measured by the linear foot (meter), complete in place. Structure backfill will be measured in accordance with 211.09. Field drilled holes will be measured in accordance with 702.27.

714.08 Basis of Payment

The accepted quantities of concrete used in retaining walls, culverts, and culvert extensions will be paid for at the contract unit price per cubic yard (cubic meter) for concrete, of the class specified, structures. Reinforcing steel will be paid for in accordance with 703.08. Precast reinforced concrete box sections will be paid for at the contract unit price per linear foot (meter) for culvert, precast reinforced concrete box sections, of the size specified, complete in place. Precast reinforced concrete box section extensions will be paid for at the contract unit price per linear foot (meter) for culvert extension, precast reinforced concrete box sections, of the size specified, complete in place. Structure backfill will be paid for in accordance with 211.10. Field drilled holes will be paid for in accordance with 702.28.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Concrete, _____, Structures (class)	CYS (m3)
Concrete Culvert Extension, Precast Reinforced Concrete Box Sections, ____ ft (mm) x ____ ft (mm) (span, rise)	LFT (m)

Culvert, Precast Reinforced Concrete Box
Sections, ____ ft (mm) x ____ ft (mm) .....LFT (m)
span rise

The cost of excavation except as provided in 206.11(a), expansion joint material, perpetuation of existing drains shown on the plans, sealing of existing structures, removal of existing structures, removal of portions of existing structures, cleaning out old channels, approved chemical anchor system, precast reinforced concrete structure joints, and necessary incidentals shall be included in the cost of the pay items in this section.

No additional payment will be made for carrying an underground drain through a culvert or culvert extension. However, no deduction will be made for the volume of concrete occupied by the drain pipe in a cast-in-place culvert or culvert 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

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.

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. 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.

Materials shall be in accordance with the following:

B Borrow.....211
Bituminous Mastic Pipe Joint Sealer 906.05
Concrete 702
Flowable Backfill.....213
Reinforcing Steel.....910.01
Rubber Type Gaskets 906.04
Straps, Hook Bolts, and Nuts 908.12

Structure Backfill 904

(a) Type 1 Pipe

Type 1 pipe shall be used for culverts under mainline pavement and public road approaches.

Clay Pipe, Extra Strength.....907.08
Corrugated Aluminum Alloy Pipe and Pipe-Arches.....908.04
Corrugated Polyethylene Pipe, Type S 907.19
Corrugated Steel Pipe and Pipe-Arches 908.02
Non-Reinforced Concrete Pipe, Class 3.....907.01
Polymer Precoated Galvanized Corrugated Steel
Pipe and Pipe-Arches.....908.08
Profile Wall Polyvinyl Chloride Pipe 907.22
Reinforced Concrete Horizontal Elliptical Pipe.....907.03
Reinforced Concrete Pipe 907.02
Ribbed Polyethylene Pipe 907.20
Smooth Wall Polyethylene Pipe.....907.21
Smooth Wall Polyvinyl Chloride Pipe.....907.23
Structural Plate Pipe and Pipe-Arches 908.09

(b) Type 2 Pipe

Type 2 pipe shall be used for storm sewers.

Clay Pipe, Extra Strength.....907.08
Corrugated Polyethylene Pipe, Type S 907.19
Fully Bituminous Coated and Lined Corrugated Steel
Pipe and Pipe-Arches.....908.13
Non-Reinforced Concrete Pipe, Class 3.....907.01
Polymer Precoated Galvanized Corrugated Steel
Pipe and Pipe-Arches.....908.08
Profile Wall Polyvinyl Chloride Pipe 907.22
Reinforced Concrete Horizontal Elliptical Pipe.....907.03
Reinforced Concrete Pipe 907.02
Ribbed Polyethylene Pipe 907.20
Smooth Wall Polyethylene Pipe.....907.21
Smooth Wall Polyvinyl Chloride Pipe.....907.23

(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

Type 4 pipe shall be used for drain tile and longitudinal underdrains.

Clay Pipe* 907.08
Corrugated Polyethylene Drainage Tubing.....907.17
Corrugated Polyethylene Pipe, Type S* 907.19
Corrugated Polyethylene Pipe, Type SP 907.19

Drain Tile* 907.11
Non-Reinforced Concrete Pipe 907.01
Perforated Clay Pipe* 907.09
Perforated Polyvinyl Chloride Semicircular Pipe.....907.18
Profile Wall Polyvinyl Chloride Pipe 907.22
* 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.

Corrugated Aluminum Alloy Pipe and Pipe-Arches.....908.04
Corrugated Polyethylene Pipe, Type S 907.19
Corrugated Steel Pipe and Pipe-Arches 908.02
Fully Bituminous Coated and Lined Corrugated
Steel Pipe and Pipe-Arches.....908.13
Polymer Precoated Galvanized Corrugated Steel
Pipe and Pipe-Arches.....908.08
Profile Wall Polyvinyl Chloride Pipe 907.22
Ribbed Polyethylene Pipe 907.20
Smooth Wall Polyethylene Pipe.....907.21
Smooth Wall Polyvinyl Chloride Pipe.....907.23

(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.

(g) Slotted Vane Drain Pipe

Slotted vane drain pipe shall be used to drain driveway areas. Slotted vane drain pipe shall be smooth wall polyvinyl chloride pipe in accordance with 907.23. The slotted vane drain casting shall be in accordance with 910.05(b). The finish shall be standard black asphalt emulsion. Individual units shall have a minimum weight (mass) of 155 lbs (70 kg).

(h) End Bent Drain Pipe

End bent drain pipe shall be perforated profile wall polyvinyl chloride pipe in accordance with 907.22 or perforated smooth wall polyvinyl chloride pipe in accordance with 907.23.

(i) Underdrain Outlet Pipe

Pipe shall be in accordance with 907.22 or 907.24.

(j) Grated Box End Sections

Steel pipe and steel tubing shall be in accordance with ASTM A 53, Grade B or ASTM A 501. Such pipe and tubing shall be galvanized in accordance with ASTM A 123. All other related hardware shall be galvanized in accordance with ASTM A 153. Structural steel grates shall be ASTM A 36 (ASTM A 36M) for end sections having widths less than or equal to 3 ft (0.9 m) and shall be ASTM A 572 grade 50 (ASTM A 572M grade 345) for widths greater than 3 ft (0.9 m). Threaded inserts shall have a

minimum pull-out capacity of 6,000 lb (27 kN). The 1/2 in. (M13) 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. (6 mm) mesh or galvanized steel wire No. 4 mesh with a minimum wire diameter of 1/32 in. (0.8 mm). It shall be firmly anchored to the outside of the structure and shall be centered on the holes.

Pipe with a 4 in. (100 mm) outside diameter and in accordance with ASTM A 513, Type 5, may be used as an alternate to the 4 in. (100 mm) outside diameter pipe specified. The pipe used as an alternate shall have a minimum wall thickness of 5/16 in. (8 mm) and a minimum yield strength of 50,000 psi (345 MPa). Steel tube of 4 in. by 4 in. by 3/8 in. (100 mm by 100 mm by 9.5 mm), and in accordance with ASTM A 500, Grade B, will also be permitted as an alternate to the 4 in. (100 mm) outside diameter pipe specified.

Pipe furnished as an alternate as described herein shall be covered by a type B certification in accordance with 916.

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
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:

(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.

CONSTRUCTION REQUIREMENTS

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.

Where rock or boulder formation is encountered at or above the proposed trench bottom elevation, the trench shall be excavated at least 8 in. (200 mm) 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.

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 corrugated steel pipe and pipe-arches shall only be placed when the ambient temperature is 35°F (2°C) or above.

Concrete and clay pipe shall be laid with hub upgrade, 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 approved rubber type gaskets, caulking, bituminous mastic pipe joint sealer, elastomeric material, or sealing compound. Circular concrete pipe joints shall utilize rubber type gaskets.

If the infiltration of water is a factor, each joint, regardless of the type used, shall be sealed with an approved compression type joint sealer in accordance with ASTM C 425 or ASTM C 443, whichever is applicable.

Joints and stub-tee connections for plastic pipe shall be in accordance with the requirements of the respective material specifications for each type of pipe.

Connections of plastic pipe to manholes, catch basins, and inlets shall be in accordance with the manufacturer's recommendations.

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.

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

At the connection of a pipe extension to an existing structure where the extension is a different pipe material from that in place, or a satisfactory joint cannot be obtained, 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. (450 mm) and a thickness of at least 6 in. (150 mm) 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. (150 mm) 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 (6 m) sections 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. (150 mm) 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.

The stub-tee connection to a corrugated metal pipe or pipe-arch shall be constructed of corrugated 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 metal pipe to the corrugated metal pipe or pipe-arch 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-P641, type II or MIL-P-21035. 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. (150 mm) nor more than 12 in. (300 mm). The pipe connection to the concrete stub shall be made by means of a cement mortar bead or concrete collar or as directed.

715.08 Blank

715.09 Backfilling

All plastic pipes, except longitudinal underdrains, which are not fabricated with hydrostatic design basis rated resins and are installed within 5 ft (1.5 m) of mainline or public road approach pavement, paved shoulders, or sidewalks shall be backfilled with flowable backfill. Flowable backfill shall be placed in accordance with 213.07. All other pipe installations shall be backfilled as shown on the plans or as directed. Structure backfill shall be placed in accordance with 211.04.

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 (0.6 m) above the groundwater. The remainder of the trench shall be backfilled as shown on the plans.

Except where prohibited due to groundwater, flowable backfill may be used as a substitute for structure backfill.

After the completion of the backfill operation and prior to beginning the paving operation, all plastic pipes, except longitudinal underdrains, not fabricated with hydrostatic design basis rated resins installed within 5 ft (1.5 m) of mainline or public road approach pavement, paved shoulders, or sidewalks shall be mandrel tested. The mandrel shall be a go/no go mandrel with a minimum of nine arms or prongs and a diameter of 5% less than the pipe pay item diameter. If the mandrel does not pass through the pipe when pulled by hand or the mandrel damages the pipe, the deficient pipe shall be removed, replaced, and mandrel tested after the flowable backfill has been replaced.

Where material other than structure backfill or flowable backfill is permitted and used for backfilling, it shall be of such nature that compacts readily. That portion around and for 6 in. (150 mm) above the top of the pipe shall be free from large stones. This material shall be placed in layers not to exceed 6 in. (150 mm), loose measurement, and each layer compacted thoroughly by means of mechanical tamps.

An adequate earth cover, as shown on the plans, shall be placed over the structure before heavy equipment is driven over it.

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. Straps or hook bolts required for anchors shall be as shown on the plans. 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 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. (150 mm) 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. (150 mm) 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 reinforcing steel shall have a minimum cover of 1 1/2 in. (40 mm) and shall have a minimum lap of 21 in. (540 mm). The type A construction joint between the floor and the wall is optional for cast in place units.

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.

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. A 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.

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, and sanitary sewer pipe will be measured by the linear foot (meter), complete in place. 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 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 deformed pipe will be made along the bottom centerline of the pipe.

Reinforcing steel, 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.

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.

Tee, stub-tee, and wye branch connections will be measured along the centerline of the barrel. An additional allowance of 5 lft (1.5 m) of the smaller diameter pipe will be permitted for making such connection.

Elbow connections will be measured along the centerline of such connection. An additional 2 lft (0.6 m) of pipe of the same diameter as that of the elbow will be permitted for each such connection.

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.

For structures for which the plans permit pipes of differing sizes for either smooth or corrugated interiors, and the corrugated interior alternate is installed, measurement of

B borrow for structure backfill or flowable mortar 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.

715.14 Basis of Payment

The accepted quantities of pipe will be paid for at the contract unit price per linear foot (meter) for pipe of the type, shape, and size specified, complete in place.

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. Structure backfill will be paid for in accordance with 211.10. If utilized as a substitute for structure backfill or if used to backfill thermoplastic pipes fabricated of non-hydrostatic design basis resins, flowable backfill will be paid for as structure backfill. Otherwise, flowable backfill will be paid for in accordance with 213.09.

Pavement replacement necessary due to structure installation under an existing pavement will be paid for at the contract unit price per ton (megagram) of HMA for structure installation of the type specified and per square yard (square meter) for PCCP for structure installation. Subbase will be paid for in accordance with 302.09.

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 yd (8 m^3) or less.

Tee, stub-tee, and wye connections will be paid for by means of the allowance of 5 lft (1.5 m) of the smaller diameter pipe. Elbow connections will be paid for by means of the allowance of 2 lft (0.6 m) of pipe of the same diameter as the elbow. Increaser and reducer sections will be paid for at the contract unit price for the larger diameter pipe.

For structures for which the plans permit pipes of differing sizes for entire smooth or corrugated interiors, and 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.

Payment will be made under:

Pay Item	Pay Unit Symbol
Concrete Anchor, _____ in. (mm) (diameter)	EACH
Concrete Anchor, Min. Area ____ sq ft (sq m)	EACH
Concrete Anchor, _____ in. (mm) (diameter) or _____ in. (mm) (diameter)	EACH
Concrete Anchor, Min. Area ____ sq ft (sq m) or ____ sq ft (sq m)	EACH
Grated Box End Section, ____ (type), ____ (slope), _____ in. (mm) (diameter)	EACH
Grated Box End Section, ____ (type), ____ (slope), Min. Area ____ sq ft (sq m)	EACH
Grated Box End Section, ____ (type), ____ (slope), _____ in. (mm) (diameter) or _____ in. (mm) (diameter)	EACH
Grated Box End Section, ____ (type), ____ (slope), Min. Area ____ sq ft (sq m) or ____ sq ft (sq m)	EACH
Grated Box End Section, ____ (type), ____ (slope), _____ in. (mm) (diameter) or Concrete Anchor, _____ in. (mm)	EACH
Grated Box End Section, ____ (type), ____ (slope), Min. Area ____ sq ft (sq m) or Concrete Anchor, Min. Area ____ sq ft (sq m)	EACH
HMA for Structure Installation, Type __*__	TON (Mg)
PCCP for Structure Installation	SYS (m2)
Pipe, End Bent Drain, _____ in. (mm) (diameter)	LFT (m)
Pipe End Section, _____ in. (mm) (diameter)	EACH
Pipe End Section, Min. Area ____ sq ft (sq m)	EACH
Pipe End Section, _____ in. (mm) (diameter) or _____ in. (mm) (diameter)	EACH
Pipe End Section, Min. Area ____ sq ft (sq m) or ____ sq ft (sq m)	EACH
Pipe End Section, _____ in. (mm) (diameter) or Concrete Anchor, _____ in. (mm) (diameter)	EACH
Pipe End Section, Min. Area ____ sq ft (sq m) or Concrete Anchor, Min. Area ____ sq ft (sq m)	EACH
Pipe End Section, _____ in. (mm) (diameter) or Grated Box End Section, ____ (type), ____ (slope), _____ in. (mm) (diameter)	EACH
Pipe End Section, Min. Area ____ sq ft (sq m) or Grated Box End Section, ____ (type), ____ (slope), Min. Area ____ sq ft (sq m)	EACH

Pipe End Section, _____ in. (mm) or Safety Metal End
Section, ____, _____ in. (mm).....EACH
slope diameter

Pipe End Section, Min. Area ____ sq ft (sq m) or Safety Metal End
Section, ____, Min. Area ____ sq ft (sq m).....EACH
slope

Pipe Extension, Circular, _____ in., (mm), _____.....LFT (m)
diameter material

520 Pipe Extension, Deformed, Min. Area ____ sq ft, (sq m), _____....LFT (m)
material

Pipe, Relaid, _____ in. (mm) .....LFT (m)
diameter

Pipe, Relaid, ____ in. (mm) x ____ in. (mm) .....LFT (m)
span rise

Pipe, Sanitary Sewer, _____ in. (mm) .....LFT (m)
diameter

Pipe, Slotted Drain, _____ in., (mm) _____ in. (mm) .....LFT (m)
diameter thickness

530 Pipe, Slotted Vane Drain, _____ in. (mm).....LFT (m)
diameter

Pipe, Type ____, Circular, _____ in. (mm) .....LFT (m)
diameter

Pipe, Type ____, Deformed, Min. Area ____ sq ft (sq m) .....LFT (m)

Pipe, Underdrain Outlet, _____ in. (mm) .....LFT (m)
diameter

Safety Metal End Section, ____, _____ in. (mm).....EACH
slope diameter

Safety Metal End Section, ____, Min. Area ____ sq ft (sq m).....EACH
540 slope

Safety Metal End Section, ____, _____ in. (mm) or
slope diameter
_____ in. (mm).....EACH
diameter

Safety Metal End Section, ____, Min. Area ____ sq ft (sq m) or
slope
____ sq ft (sq m) .....EACH

Safety Metal End Section, ____, _____ in. (mm) or
slope diameter
550 Concrete Anchor, _____ in. (mm) .....EACH
diameter

Safety Metal End Section, ____, Min Area ____ sq ft (sq m) or
slope
Concrete Anchor, Min. Area ____ sq ft (sq m) .....EACH

Safety Metal End Section, ____, _____ in. (mm) or Grated Box End
slope diameter
Section, ____, ____, _____ in. (mm).....EACH
type slope diameter

Safety Metal End Section, ____, Min. Area ____ sq ft (sq m) or Grated
slope
Box End Section, ____, ____, Min. Area ____ sq ft (sq m).....EACH
type slope

* Mixture type

The cost of reinforcing steel, 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 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.

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.

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, pavement replacement, 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. 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 steel, 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.

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 all in accordance with 105.03.

The techniques included are auger boring, guided boring, horizontal directional drilling, micro-tunneling, pipe jacking, and pipe ramming. Other methods may be utilized when approved.

The size of installations by the directional drilling method shall be limited to those that can be accomplished by using a 24 in. (600 mm) maximum sized reamer unless otherwise approved.

MATERIALS

716.02 Materials

The materials shall be in accordance with the following.

Cement .....901.01(b)
Clay Pipe, Extra Strength.....907.08
Fine Aggregate.....904
Fly Ash.....901.02
Foam Concentrate .....ASTM C 869
Polyvinyl Chloride Pipe.....907.23
Reinforced Concrete Pipe 907.02
Smooth Wall Polyethylene Pipe.....907.21
Steel Pipe.....908.11
Water.....913.01

Concrete pipe shall be class IV or stronger and shall have tongue and groove joints. All reinforced concrete pipes shall have steel reinforcement concentric with the pipe wall, and where required, additional reinforcement at the ends of the pipe.

Steel pipe used as a carrier pipe shall have the following minimum wall thickness.

Outside Diameter, in. (mm)	Wall Thickness, in. (mm)
18 or less (457 or less)	1/4 (6)
19 – 20 (483 – 508)	5/16 (8)
21 – 26 (533 – 660)	3/8 (10)
27 – 30 (686 – 762)	1/2 (13)
31 – 42 (787 – 1070)	1/2 (13)
43 – 48 (1092 – 1219)	9/16 (14)

The cellular concrete grout shall be designed and produced in accordance with ASTM C 796 except as herein modified.

Admixtures, retarders, and plasticizers used shall be in accordance with the foam concentrate supplier's specifications.

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 by the foam concentrate supplier certified or licensed grouting contractor to the Engineer for approval prior to use on the project. The mix shall have a minimum 28 day compressive strength of 150 psi (1040 kPa). The mix shall be tested and will be approved based on the test results or will be approved based on prior acceptance and suitable performance on Department projects.

Grout mixed off site shall be delivered to the job site in a truck mixer in accordance with 702.09 filled to a capacity recommended by the foam manufacturer. The foam concentrate 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 a similar device. Small batches of approximately 1 cubic yard (1 cubic meter) shall be mixed and pumped in a continuous operation.

For each day worked or for each 100 cubic yards (100 cubic meters) placed, four test cylinders measuring 3 in. by 6 in. (75 mm by 150 mm) shall be cast at the point of placement of the grout. The cylinders shall be prepared, cured, and transported in accordance with ASTM C 31.

The compressive strength shall be determined in accordance with ASTM C 39, except as modified herein. Initial curing shall be at room temperature and shall be from 2 to 5 days. After the initial curing, the test specimens shall be placed in a moist closet or moist room. All specimens shall be kept in their molds in the moist closet or moist room for the remainder of the curing period. The specimens shall be tested at 28 days. At that time the specimens shall be stripped, capped, and tested in compression as rapidly as possible to minimize drying. If more than one specimen is removed from the moist closet or moist room at the same time, these specimens shall be covered with a damp cloth until time of testing. The test results shall be submitted to the Engineer with a type D certification in accordance with 916.

CONSTRUCTION REQUIREMENTS

716.03 General Requirements

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.

When ground water is known or anticipated, 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.

When 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.

Joints in steel pipe shall be water tight. Where welded joints are utilized, they shall be welded in accordance with 711.32. Joints in concrete pipe shall be designed to withstand the additional forces that are created in the joints during the installation process. The joints in concrete pipe 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.

When installation is to be performed under railroads, highways, or streets, care shall be taken to prevent interference with the operations of the railroads, highways, or streets. The Contractor shall submit a QC plan of the installation process including, as a minimum, the chosen method of installation, the equipment to be used, and the materials to be utilized, for review and acceptance, at least seven calendar days prior to the start of the operations.

Pavement or ground surface heave or settlement above the installation will not be permitted. To confirm if heave or settlement is occurring, the Contractor shall undertake surface monitoring. The plan for monitoring the surface shall be included in the Contractor's QC plan.

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. (25 mm), grouting shall be used to fill such voids. The Contractor's QC plan shall address the method of grouting.

When the installation is 4 in. (100 mm) or larger and the casing is used as the carrier pipe, a visual or a video inspection shall be performed using high resolution, high sensitivity color video camera/recording equipment. The pipe shall be cleaned of debris prior to the inspection. Cleaning shall be accomplished by water jetting or other approved methods.

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 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. The recording equipment shall be a minimum four head industrial grade VHS recorder or a digital archiving and reviewing system. A color video printer shall be included in the equipment for printing observations during inspection. A copy of the video inspection shall be submitted to the Engineer.

All sections of pipe found to be damaged or where joint failure is evident shall be repaired as approved by the Engineer or removed and replaced.

For installations not utilizing tunnel shields or tunnel boring machines, 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, and if ordered, operations shall cease and the pipe shall be abandoned in place and filled with grout or other approved materials.

When 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.

716.04 Method of Measurement

Pipe installed by trenchless installation methods will be measured by the meter (linear foot) along the center line of the pipe installed.

716.05 Basis of Payment

Pipe installed by trenchless installation methods will be paid for by the linear foot (meter) for pipe, installation, trenchless of the size specified, complete and in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Pipe Installation, Trenchless, _____ (size)	LFT (m)

The cost of the QC plan, the excavating and backfilling of the entrance and receiving pits, video inspection, camera/recording equipment, bentonite or other lubricant, grout, and the casing when 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.

For installations where unknown obstructions such as boulders, concrete, and other unforeseen obstructions are encountered, and the crossing cannot be abandoned or where tunnel shields or tunnel boring machines are being utilized, the additional cost as a result of encountering the unforeseen conditions will be paid for as differing site conditions in accordance with 104.02(a).

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 these specifications and in reasonably close conformance with the lines, grades, and details shown on the plans or as directed.

717.02 Materials

Materials shall be in accordance with the following:

Bituminous Mastic Pipe Joint Sealer	906.05
Concrete, Class A	702
Flowable Backfill	213
Grouted Riprap	904
Reinforcing Steel	910.01
Structure Backfill	904
Structural Plate Arches	908.09
Structural Plate Pipe and Pipe-Arches	908.09

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.

CONSTRUCTION REQUIREMENTS

717.03 General Requirements

Forming, punching, and assembling shall be in accordance with AASHTO Standard Specifications for Highway Bridges, Division II, Sections 23.2 and 23.3. 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 steel 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 (4.3 m), or the skew angle is more than 20 degrees, 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. (5 mm) in thickness with the horizontal leg securely anchored to the substructure on 24 in. (610 mm) 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 shown on the plans, or otherwise required, the flowline of arches shall be paved with grouted riprap in accordance with 616.04 or paved with class A concrete.

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. (300 mm) nor more than 24 in. (610 mm). 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

Where shown on the plans or when directed, structure backfill or flowable backfill shall be used in backfilling around pipe and pipe-arch structures. Arch structure 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. The finished backfill grade shall be as shown on the plans.

After the pipe or pipe-arch has been assembled and is in place, backfill material shall be placed in accordance with 211.04 or 213.07.

An adequate earth cover shall be provided over the structure, as shown on the plans, before heavy construction equipment is driven over it. This earth cover shall be free of stones.

When 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.

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.

Compaction by saturation will not be permitted, 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

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 welded wire fabric and sealed with bituminous mastic pipe joint sealer 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

Structural plate pipe and pipe-arch, both new and re-laid, will be measured in accordance with 715.13. Structural plate arches will be measured by the linear foot (meter), 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 steel used in substructures will be measured in accordance with 703.07. Concrete or grouted riprap paved flowline for structural plate arches will be measured by the square yard (square meter). Concrete anchors will be measured in accordance with 715.13. Reinforcing steel, 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

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 714.08. Reinforcing steel in substructures will be paid for in accordance with 703.08. Concrete or grouted riprap paved flowline placed in structural plate arch structures will be paid for at the contract unit price per square yard (square meter) for concrete paved flowline, arch, structural plate; or riprap, grouted. 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. Structure backfill will be paid for in accordance with 211.10. 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 (sq m)	LFT (m)
Concrete Paved Flowline, Arch, Structural Plate	SYS (m2)
Riprap, Grouted	SYS (m2)

The cost of excavation, concrete field paved inverts, disposal of surplus materials, reinforcing steel, straps, and hook bolts used in anchors, and necessary incidentals shall be included in the cost of the pay items.

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

Materials shall be in accordance with the following:

Coarse Aggregate, Class E or Higher, Size No. 8 or 9	904
Concrete, Class A	702
Geotextile for Underdrains	918.03
Reinforcing Steel	910.01
Sod, including Nursery Sod	621
Structure Backfill	904
Underdrain Pipes	715.02(d)
Underdrain Outlet Pipes	907.22, 907.24

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. (150 mm) underdrain installations. Coarse aggregate No. 9 shall be used for 4 in. (100 mm) underdrain installations.

The mixture for HMA for underdrains shall be Intermediate OG19.0 mm in accordance with 401. An ESAL Category 5 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.

CONSTRUCTION REQUIREMENTS

718.03 Pipe Installation

Trenches shall be excavated to the dimensions and grade shown on the plans. Pipes shall be secured to ensure that the required grade and horizontal alignment of the pipe 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. 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, no joint width shall not exceed 1/4 in. (6 mm).

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 1.0 ft (0.3 m). 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).

718.05 Underdrain Outlets

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

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 (140 m) into the pipes and shall be designed to 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. The recording equipment shall be a minimum four head industrial grade VHS recorder or a digital archiving and reviewing system. 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.

Damage discovered by the video inspection shall be repaired. Damage shall include but is not limited to; crushed or partially crushed pipes that impedes the progress of the camera, blockages, vertical pipe sags filled with water to a depth of d/2 or greater, 90 degree 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

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

Underdrain and outlet pipe will be measured in accordance with 715.13. Outlet protectors will be measured by the number and type of units installed.

Structure backfill will be measured in accordance with 211.09. HMA for underdrains will be measured by the ton (megagram).

Aggregate for underdrains will be measured by the cubic yard (cubic meter), complete in place. The pay limits will not extend beyond the neat lines shown on the plans.

Geotextiles will be measured by the square yard (square meter) based on the neat line limits shown on the plans.

Video inspections for underdrains will be measured by the linear foot (meter) as determined by the electronic equipment.

Patching of underdrains will not be measured.

Rodent screens, elbows, increaser or decreaser connections, and other incidentals will not be measured for payment.

Concrete, reinforcing steel, or sod for underdrain outlet protectors will not be measured for payment.

718.10 Basis of Payment

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 (cubic meter). Geotextile for underdrains will be paid for at the contract unit price per square yard (square meter). 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 (megagram).

Underdrain patching for structure installation will be paid for at the contract unit price per linear foot (meter) 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 (meter).

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Aggregate for Underdrains	CYS (m3)
Geotextile for Underdrains	SYS (m2)
HMA for Underdrains	TON (Mg)
Outlet Protector, ____ type	EACH
Underdrain, Patching	LFT (m)
Video Inspection for Underdrain	LFT (m)

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 steel, concrete, curing materials, and sod shall be included in the cost of outlet protector.

The cost of providing the video inspection equipment, technician, videotapes, or computer disks shall be included in the cost of the underdrain video inspection. The cost of repair of underdrain pipes, aggregates, backfill, outlet protectors, geotextile fabric of providing video re-inspection of the repairs, etc. 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 the Contractor's expense.

The cost of disposal of unsuitable excavated materials, installation of pipe end caps, rodent screens, elbows, increaser or decreaser connections, and other incidentals shall be included in the cost of other pay items.

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:

Concrete, Class A	702
Drain Tile Terminal Pipe	907.24
Flowable Backfill	213
Reinforcing Steel	910.01
Riprap	616.02
Structure Backfill	904
Rodent Screen	718.02

Drain tile materials shall be in accordance with 715.02(d).

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 no trench details are shown on the pans, the trench shall be of sufficient width to provide ample working space on each side of the drain tile to permit compaction of the backfill around the tile. Recesses shall be cut into the trench bottom to accommodate any projecting hubs or bells.

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 planking which is not less than 1 in. (25 mm) thick, 10 in. (250 mm) wide, and 10 ft (3 m) long.

If rock is encountered at or above the required trench bottom grade, the trench shall be excavated at least 8 in. (200 mm) 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.

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. (6 mm) shall be covered with pieces of broken tile. If laid on 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).

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 ft (3.0 m) 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 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).

719.05 Backfilling

Pipe replacing drain tile shall be backfilled in accordance with 715.09.

719.06 Blank

719.07 Method of Measurement

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 (meter). 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 (1.5 m) of the smaller diameter pipe will be made for making such connections.

Elbow connections will be measured along the centerline of such connection. An additional allowance of 2 lft (0.6 m) 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 (meter) as the larger diameter pipe over the length of the connection.

719.08 Basis of Payment

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 (meter) 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 (1.5 m) of the smaller pipe at the connection. Elbow connections will be paid for by means of the allowance of an additional 2 lft (0.6 m) of the pipe at the connection.

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. (mm) diameter	LFT (m)

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.

720.02 Materials

Materials shall be in accordance with the following:

Castings	910.05
Clay or Shale Brick	905.01
Clay Pipe	907.08
Concrete	702
Concrete Brick	905.02
Concrete Masonry Blocks	905.03
Hydrated Lime	913.04
Joint Filler	906.01
Joint Mortar	901.08, 906.03
Non-Reinforced Concrete Pipe	907.01
Precast Units	907.04
Reinforced Concrete Pipe	907.02
Reinforcing Steel	910.01
Water	913.01

CONSTRUCTION REQUIREMENTS

720.03 General Requirements

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. (150 mm) further and backfilled with approved material tamped to the required elevation.

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. (6 mm) 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 one part cement to two parts No. 23 fine aggregate, by volume. Castings shall be set to the finished pavement elevation so that subsequent adjustments are not necessary.

Iron hood traps in catch basins shall be installed in walls as shown on the plans and so placed that a 6 in. (150 mm) seal is formed. Joints between hoods and walls shall be made gas tight.

Mortar for laying brick and masonry units shall be composed of one part masonry cement and two parts mortar sand. Mortar for plastering may be the same or it may be composed of one part of a combination of portland cement and hydrated lime and two 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.

Required plaster coats on the inside and outside shall be at least 1/2 in. (13 mm) 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.

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. (10 mm) 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.

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. (M10 UNC x 90 mm) 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 (160 Nm).

Steel grating type 12 shall be an approved, galvanized grating which shall be of sufficient strength to support a 12,000 lb (5440 kg) wheel load with a maximum fiber stress of 20,000 lb/in^2 (138 MPa). 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. (10 mm) 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.

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. (170 mm) and a bearing plate for such casing will not be required.

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. (10 mm) in width. All units shall be wetted thoroughly immediately prior to being laid. Broken or chipped units will not be permitted 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 half 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.

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.

If the completed structure is partially or completely under or at its nearest point is within 5 ft (1.5 m) 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.

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. (100 mm) 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. (150 mm). Holes formed or cut in the wrong place shall be plugged satisfactorily with a class A concrete mixture.

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. (75 mm) 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.

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. 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. (300 mm) average height of the upper portion of the masonry.

When 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. (10 mm) 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.

On resurface contracts the castings shall, unless otherwise permitted or directed, be adjusted to grade after the last binder course has been laid and before placing the surface course.

720.05 Method of Measurement

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. (300 mm). If corrections to the structure involve portions exceeding an average adjustment height of 12 in. (300 mm), the additional work will be measured by the linear foot (meter) for the type of structure involved.

720.06 Basis of Payment

The accepted quantities of manholes, inlets, spring boxes, catch basins, castings adjusted to grade not exceeding 12 in. (300 mm), and castings furnished and adjusted to grade not exceeding 12 in. (300 mm) will be paid for at the contract unit price per each, complete in place.

That portion of a reconstructed structure which exceeds 12 in. (300 mm) in average height will be paid for at the contract unit price per linear foot (meter), for structure, of the type specified, reconstruct, complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Casting, ____, Adjust to Grade (type)	EACH
Casting, ____, Furnish and Adjust to Grade (type)	EACH
Catch Basin, ____ (type)	EACH
Inlet, ____ (type)	EACH
Inlet, type H, with Slotted Drains	EACH

Inlet, type HA, with Slotted Drains.....EACH
Manhole, ____.....EACH
type
Pipe Catch Basin, ____ in. (mm) .....EACH
size
Spring Box .....EACH
Structure, ____, Reconstructed .....LFT (m)
type

The cost of both inlets, the 12 in. (300 mm) pipe connecting the two inlets, the type 5 castings, the concrete filler between the barrier wall and the inlet, and other miscellaneous materials shall be included in the cost of the inlet, type H. The cost of the inlet, the type 5 casting, the concrete filler between the barrier wall and the inlet, and other miscellaneous materials shall be included in the cost of the inlet, type HA.

The cost of both inlets, the 12 in. (300 mm) pipe connecting the two inlets, the type 5 castings, the concrete filler between the barrier wall and the inlets, the slotted drain pipe, the concrete collar around the slotted drain pipe, and other miscellaneous materials shall be included in the cost of the inlet, type H, with slotted drains. The cost of the inlet, the type 5 casting, the concrete filler between the barrier wall and the inlet, the slotted drain pipe, the concrete collar around the slotted drain pipe, and other miscellaneous materials will be included in the cost of the inlet, type HA, with slotted drains.

The cost of excavation, backfill, reinforcing steel, structure backfill, concrete collar required for pipe connection to structures, removal, disposal and replacement of pavement, or surface material, and necessary incidentals shall be included in the cost of the pay items.

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).

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. (13 mm) 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 (3 m).

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.

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:

Pay Item	**Pay Unit Symbol**
Automatic Drainage Gate, _____ in. (mm) x _____ in. (mm) width height	EACH

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 – LATEX MODIFIED CONCRETE BRIDGE DECK OVERLAYS

722.01 Description

This work shall consist of the construction of a latex modified portland cement concrete overlay on an existing or new bridge deck, or it shall consist of patching an existing latex modified portland cement concrete overlay on a bridge deck in accordance with 105.03.

722.02 Materials

Materials shall be in accordance with the following:

Admixtures	912.03
Coarse Aggregate, Class A or Higher, Size No. 11*	904
Epoxy Penetrating Sealer	909.09
Epoxy Resin Adhesive	909.11
Fine Aggregate	904
Fly Ash	901.02
Latex Modifier	912.04
PCC Sealer/Healer	901.06
Portland Cement	901.01(b)
Water	913.01

* Crushed stone only

722.03 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 stored in weatherproof enclosures which protect the cement from dampness. Cement shall not have developed lumps.

The latex modifier 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.

722.04 Proportioning

The amount of fine aggregate shall be 60% ± 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 (391 kg/m^3) 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 (13.3 L per 43 kg) of cement. The net water added shall produce a slump of 5 in. ± 1 in. (125 mm ± 25 mm) at 4 to 5 min after discharge from the mixer. The moisture content of the aggregates shall be controlled such that the slump is within the specified limits. 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 (0.2 m^3) 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 (0.2 m^3) of concrete has been produced. The contents of the box shall be consolidated and struck off. If 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 shall be run on the first load of each truck and every third load per truck thereafter. 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 min 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 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. A concrete mix design shall be submitted in accordance with 702.05. If 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.

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 lbs/cu yd (335 kg/m^3) of portland cement type III or type IIIA, or 846 lbs/cu yd (503 kg/m^3) of portland cement type I or type IA.

(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 4 in. (100 mm).

722.05 Preparation of the Bridge Floor

(a) Concrete Removal

1. Deck Surface

The top 1/4 in. (6 mm) of the entire bridge deck surface shall be removed if the overlay is to be placed on a bridge deck constructed under a previous contract. 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, an additional 1/4 in. (6 mm) of surface removal may be required on part or all of the bridge deck as directed.

Surface removal shall be performed with a power operated mechanical milling machine. The equipment 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. All surface removal residue, including water, dust and concrete, shall be immediately removed.

2. Bridge Floor

Following the clean up from the surface removal operation, areas of unsound concrete to be removed will be marked. Removal of the unsound concrete shall be performed by handchipping or hydrodemolition. Handchipping tools may be hand or mechanically driven. Jack hammers shall not be heavier than nominal 45 lb (20.5 kg) class and chipping hammers shall not be heavier than nominal 15 lb (6.8 kg) class. Only handchipping tools shall be used when removing concrete within 1 in. (25 mm) of reinforcing steel. Mechanically driven tools shall be operated at a maximum angle of 45 degrees from the bridge floor surface.

The hydrodemolition machine shall utilize a high pressure water jet system and shall be approved prior to use. Hydrodemolition equipment shall be calibrated to remove only unsound concrete. The pressure of the water jet shall be calibrated for each structure prior to use. All water used in the hydrodemolition operation shall be potable, and stream or lake water will not be permitted. Precautions shall be taken, during the hydrodemolition operations, to prevent damage to surrounding property and traffic. Waste water shall not be discharged into a stream.

Regardless of the method of removal, the removal operation shall be stopped if it is determined that sound concrete is being removed. Appropriate recalibration, or changes in equipment and methods shall be performed prior to resuming the removal operation.

Where the bond between the existing concrete and reinforcing steel has been destroyed, the concrete adjacent to the steel shall be removed to a minimum clearance of 1 in. (25 mm) around the entire periphery of the exposed steel. If the concrete is unsound

down to the top layer of bottom reinforcing steel, all of the concrete within the marked area shall be removed and the cavity shall require full depth patching in accordance with 722.06(a). 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 722.06(b). Prepared partial depth cavities shall be made full depth when directed. Exposed reinforcing steel shall not be damaged by the removal operation. Any damaged reinforcing steel shall be repaired as directed with no additional payment.

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. (25 mm) vertical surface shall remain, or be cut, one inch outside and around the entire periphery of each removal area after removal of all loose and unsound concrete.

(b) Cleaning

After the concrete removal operation is completed and just prior to placing 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 steel and the concrete under and around the exposed steel shall be thoroughly cleaned by sandblasting. The surface shall be then cleaned free of all dust, chips and water. The final surface shall be free of oil, grease and water. The air lines for sandblasting and air cleaning shall be equipped with oil traps.

722.06 Patching of the Bridge Floor

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 or latex modified concrete. Full depth patching shall be performed prior to the overlay operation unless otherwise permitted. 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 (3800 kPa). Curing of the patch shall be as directed.

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 steel within the cavities. The epoxy coating shall be tacky at the time that the patching concrete is placed. If 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.

2. Patching with Latex Modified Concrete

The surfaces of the prepared cavities shall be coated with a bond coat in accordance with 722.09. The cavities shall then be filled with the latex modified concrete to the level of the adjacent deck surface.

(b) Partial Depth Patching

The material used for partial depth patching shall be either bridge deck patching concrete or latex modified concrete. The patching material shall be consolidated by internal vibration at the time of placement. Curing of the patch shall be as directed.

1. Patching with Bridge Deck Patching Concrete

Partial depth patching with bridge deck patching concrete shall be in accordance with 722.06(a) and 722.06(a)1.

2. Patching with Latex Modified Concrete

The surfaces of the prepared cavities shall be coated with a bond coat in accordance with 722.09. The cavities shall then be filled with the latex modified concrete at the time that the overlay is placed.

722.07 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 722.04.

The existing concrete shall be removed as required in accordance with 722.05(a). Exposed reinforcing steel shall not be cut or otherwise damaged.

Power driven hand tools for removal by handchipping will be permitted. Pneumatic hammers with a maximum weight of 69 lb (31 kg) may be used for the tops of mudwalls. If, 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 shall not resume until the Engineer is assured the tools or methods being used will not cause further damage.

The surface to be repaired, the reinforcing steel, and the concrete under and around the steel shall be thoroughly cleaned in accordance with 722.05(b). The cavity shall be epoxy coated in accordance with 722.06(a)1 then filled with class A concrete in accordance with 702.

722.08 Mixing

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 722.12. Sufficient mixing capacity or mixers shall be provided to permit the intended pour to be placed without interruption. The mixer shall carry sufficient quantities of unmixed ingredients to produce at least 6 cu yd (4.6 m^3) of latex modified concrete at the site.

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 (43 kg) of cement.

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. If the water is applied by the mixer, it shall be dispensed ahead of the water flow meter.

722.09 Placing and Finishing

Existing expansion joints shall be maintained throughout the overlayment. A 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 not be placed unless the ambient temperature is 45°F (7°C) and rising, unless otherwise approved in writing. Placement may be required during early morning hours, at night, or during other limited work periods if the prevailing daytime temperature exceeds 85°F (29°C). The overlay shall not be placed if rain is expected. 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 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 latex modified concrete. 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 3/4 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 latex modified concrete overlay shall be placed to an elevation approximately 1/2 in. (13 mm) 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. (300 mm) 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. (1.1 m) in length, or a vibrating oscillating metal faced screed of 4 in. (100 mm) 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.

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 anytime 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. The finished surface shall be in accordance with 504.03.

722.10 Texturing

Immediately after the finishing is complete and before the surface film has formed, the surface of the overlay shall be textured by transverse grooving. 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 approximately 18 in. (450 mm) from vertical faces such as curbs and concrete railing.

All areas of hardened grooved overlay 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.

722.11 Curing

When fly ash is used, the requirement for additional wet and/or dry curing time will 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. Unless otherwise directed, 702.22 shall apply except that the membrane forming curing compound shall not be used to cure the bridge deck overlay.

The minimum curing shall be 24 h of wet cure followed by 72 h of dry cure. An overlaid bridge deck may be opened to traffic during the minimum curing duration when the compressive strength of test cylinders is 4,000 psi (27 500 kPa) or greater. The strength requirements, and the making and curing of the cylinders, shall be in accordance with 702.24. After texturing, 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. Approximately 1 h after placing the first layer of wet burlap, a second layer shall be placed and the entire covering shall be maintained in a wet condition for a minimum of 24 h. Polyethylene film may be used in lieu of the second layer of wet burlap. If the polyethylene film is used for the second covering, then the burlap already in place shall be wetted just before placing the polyethylene film and shall be maintained in a wet condition. After the 24 h elapse, all layers of covering material shall be removed.

If the ambient temperature falls below 50°F (10°C) during either the wet or dry curing periods, the time that the temperature is below 50°F (10°C) shall not be considered as part of the total 96 h curing period. If 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 72 h dry cure period.

Immediately upon the start of the dry cure period, the surface shall be checked for cracks. If 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 (10 mm) in depth shall be sealed with an epoxy penetrating sealer followed by an application of an approved sand. The sealing and sand application shall be repeated as needed to ensure that the voids remain completely filled. Alternate methods of surface crack sealing may be used if approved. Cracks exceeding 3/8 in. (10 mm) in depth shall not be sealed at this time. Corrective procedures for repairing cracks exceeding 3/8 in. (10 mm) in depth will be determined after further investigation which may include additional cores. The method of repair shall be as directed in writing and may include removal and replacement or complete filling with an approved sealer/healer and a sand application on the surface. The Department will maintain a list of approved Sealer/Healers.

If 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.

722.12 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.

(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 set of balance beam platform scales graduated in at least 1/4 lb (0.10 kg) intervals with a minimum capacity of 500 lb (230 kg). Samples shall be obtained and handled by the

Contractor. Normal testing equipment such as aggregate sieves and containers shall also be furnished.

(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.

(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 (43 kg) of cement. At least 3760 lb (1700 kg) of cement shall be placed in the cement bin.

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. It 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 (41 kg) 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.

The following formulas shall be used to calculate the number of counts per 94 lb (43 kg) of cement and the time required to discharge 94 lb (43 kg) of cement.

$$43\ (94) \div \frac{A}{B} = \text{Counts per 94 lb (43 kg) of cement}$$

$$43\ (94) \div \frac{A}{C} = \text{Time in seconds per 94 lb (43 kg) of cement}$$

A = Total weight (mass) of cement in pounds (kilograms) 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

The accuracy of the water flow meter shall be verified by adjusting the flow to 2 gal. (7.6 L) 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 (mass in kilograms) of the discharged water shall be divided by 8.33 (1.0) to determine the number of gallons (liters). This procedure shall be repeated with the flow meter adjusted to 3 gal. (11.4 L) per minute.

3. Aggregate Bin Gates

The gate opening shall be adjusted to provide the required amount of aggregate to produce a cubic yard (cubic meter) of the designated mix. The ratio of fine aggregate to total aggregate shall be verified by stopping the cement discharge and collecting the aggregate discharged in a container. A representative sample of the discharged aggregate shall be selected and separated on a No. 4 (4.75 mm) sieve. The fine aggregate will be considered as the amount passing the No. 4 (4.75 mm) sieve. The percentage shall be computed on a dry weight basis.

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 (43 kg) of cement. With the unit operating at the required revolutions per minute for the calculated time in seconds per 94 lb (43 kg) 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 (0.23 kg) of the amount required for each 94 lb (43 kg) 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.

722.13 Patching an Existing Bridge Deck Overlay

(a) Materials

Materials shall be in accordance with 722.02.

(b) Storage and Handling of Materials

Storage and handling of materials shall be in accordance with 722.03.

(c) Proportioning

Proportioning shall be in accordance with 722.04.

(d) Preparation of the Bridge Floor

Preparation of the bridge floor shall be in accordance with the applicable provisions of 722.05.

(e) Patching

Patching shall be in accordance with 722.06 except as modified herein. If 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

Mixing shall be in accordance with the applicable provisions of 722.08.

(g) Placing and Finishing

Placing and finishing shall be in accordance with the applicable provisions of 722.09. Machine finishing shall be required when directed.

(h) Texturing

Texturing shall be in accordance with 722.10. In addition, the surface texturing shall match the pattern of the adjacent overlay.

(i) Curing

Curing shall be in accordance with 722.11.

(j) Calibration of Continuous Mixers

Calibration shall be in accordance with 722.12.

722.14 Method of Measurement

Surface milling will be measured by the square yard (square meter) for the initial 1/4 in. (6 mm) depth. Additional surface removal required below the initial 1/4 in. (6 mm) depth will be measured by the square yard (square meter) for each required 1/4 in. (6 mm) depth. Only the portion of the bridge deck which is to remain in place will be measured for payment. The undefined areas requiring full depth deck removal will be measured for payment. The areas of the bridge floor which are shown on the plans to be removed will not be measured for payment.

Full depth patching will be measured by the square yard (square meter). The patching material used in full depth patching will not be measured for payment.

Partial depth patching will be measured by the square yard (square meter). The measurement of bridge deck patching concrete used in partial depth patching will be based on a theoretical quantity determined by multiplying the area of the appropriate partial depth patches by an assumed average depth of 2 in. (50 mm) and converting the resulting volume into cubic yards (cubic meters). Overlay material used in partial depth patching will be measured by the cubic yard (cubic meter). The quantities of patching material used in partial depth patching will be included in the measurement of additional bridge deck overlay.

Overlay material used to fill surface irregularities will be measured by the cubic yard (cubic meter). Such quantity will be included in the measurement of additional bridge deck overlay.

Bridge deck overlay will be measured by the square yard (square meter) for the specified thickness. If there is no specified thickness shown on the plans, the specified thickness shall be 1 3/4 in. (45 mm).

Overlay dams and patching an existing overlay will be measured by the square foot (square meter).

Epoxy resin adhesive and bond coat will not be measured for payment. Blasting, cleaning, finishing, texturing, and curing will not be measured for payment.

722.15 Basis of Payment

Milling of the initial 1/4 in. (6 mm) depth of surface will be paid for at the contract unit price per square yard (square meter) for surface milling. Additional surface removal below the initial 1/4 in. (6 mm) depth will be paid for at the contract unit price per square yard (square meter) for surface milling for each required 1/4 in. (6 mm) depth.

Full depth patching will be paid for at the contract unit price per square foot (square meter) for bridge deck patching, full depth.

Partial depth patching will be paid for at the contract unit price per square foot (square meter) for bridge deck patching, partial depth.

Prepared partial depth cavities exceeding 2 in. (50 mm) in average depth, which are subsequently directed to be made full depth, will be paid for at the contract unit price per square foot (square meter) for bridge deck patching, partial depth. Additional payment will be made at 80% of the contract unit price per square foot (square meter) for bridge deck patching, full depth.

Prepared partial depth cavities of 2 in. (50 mm) or less in average depth, which are subsequently directed to be made full depth, will be paid for at the contract unit price per square foot (square meter) for bridge deck patching, full depth.

Patching material used for partial depth patching will be paid for at the contract unit price of $330 per cubic yard ($434.50 per cubic meter) for bridge deck overlay, additional.

Overlay material used to fill surface irregularities will be paid for at the contract unit price of $330 per cubic yard ($434.50 per cubic meter) for bridge deck overlay, additional.

Bridge deck overlay will be paid for at the contract unit price per square yard (square meter).

Patching an existing bridge deck overlay will be paid for at the contract unit price per square foot (square meter) for bridge deck overlay patching.

Overlay dam will be paid for at the contract unit price per square foot (square meter), complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Bridge Deck Overlay	SYS (m2)
Bridge Deck Overlay, Additional	CYS (m3)
Bridge Deck Overlay Patching	SFT (m2)

Bridge Deck Patching, Full Depth ..... SFT (m2)
Bridge Deck Patching, Partial Depth ..... SFT (m2)
Overlay Dam ..... SFT (m2)
Surface Milling..... SYS (m2)

The cost of milling, handchipping, removing debris and water, and necessary incidentals shall be included in the cost of surface milling.

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 furnishing and placing patching material 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 blasting, cleaning, furnishing, and applying epoxy resin adhesive or bond coat shall be included in the cost of other pay items.

Coring of the bridge deck, patching core holes, and all corrective measures required in accordance with 722.11 shall be performed with no additional payment.

The cost of bond coat, furnishing and placing the overlay material, and necessary incidentals shall be included in the cost of bridge deck overlay or bridge deck overlay patching.

SECTION 723 – BLANK

SECTION 724 – STRUCTURAL EXPANSION JOINTS

724.01 Description

(a) Structural Expansion Joint

This work shall consist of furnishing and placing, for new construction, structural expansion joints of the type specified, in accordance with the plans and these requirements.

(b) Replacement of Existing Structural Expansion Joint

This work shall consist of the removal and replacement of an existing structural expansion joint with a joint of the type shown on the plans and in accordance with these requirements.

(c) Replacement of Existing Structural Expansion Joint Seal

This work shall consist of the replacement of the joint seal in an existing structural expansion joint of the type shown on the plans.

724.02 Materials

Materials shall be in accordance with the following:

Expansion Joint BS .....906.07(b)
Expansion Joint M.....906.07(c)
Expansion Joint SS.....906.07(a)
Inorganic Zinc Primer .....909.02(a)1
Structural Steel 910.02

(a) Expansion Joint SS

The sliding cover plate required over that portion of expansion joint SS located in a sidewalk shall be the same material as the extrusion and shall be galvanized in accordance with ASTM A 123.

(b) Expansion Joint M

This joint shall consist of prefabricated, multiple elastomeric seals, separator beams, and support bars. The structural design of expansion joint M shall be in accordance with the current AASHTO Standard Specifications for Highway Bridges and shall be for the same design loading as the bridge structure at which it is installed, but in no case less than HS 20 – 44 truck loading and impact. The joint shall be designed to accommodate the movement shown on the plans. The sliding cover plate required over that portion of expansion joint M located in a sidewalk or concrete rail shall be the same material as the extrusion and shall be galvanized in accordance with ASTM A 123.

CONSTRUCTION REQUIREMENTS

724.03 General Requirements

The manufacturer shall prepare and submit four sets of detailed shop drawings for approval, prior to the manufacture of joint assemblies SS and M. The shop drawings shall be a minimum of 22 in. by 34 in. (560 mm by 860 mm) in overall size. Expansion joints SS and M shall not be fabricated until the shop drawings are approved. Joint installation and the replacement of existing joints shall be in accordance with the manufacturer's recommendations, the plans, and the approved shop drawings. If there is a dispute between the plans and the approved shop drawings, the approved shop drawings shall govern. The manufacturer shall furnish a copy of the installation instructions prior to the placement of these joints.

The fabrication and installation of the joint assembly, where changes in joint direction are required, shall be in accordance with the plans and the approved shop drawings. 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. All exposed structural steel surfaces, except for polytetrafluoroethylene coated surfaces and stainless steel, shall be shop painted in accordance with 619.11. 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.

(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. A sliding cover plate shall be required over that portion of expansion joint SS located in a sidewalk. The strip seal shall be sized to accommodate a minimum of four inches 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 permitted. Miter cut, vulcanized shop splices will be required in the strip seal as shown on the plans. The shop vulcanizing 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.

The extrusion and plate assemblies with anchors shall be shop fabricated, delivered, and installed in one continuous length except as otherwise permitted for crown breaks in the roadway, stage construction, or impractical shipping lengths exceed 46 ft (14 m). Extrusion and plate assemblies with anchors, permitted to be furnished in sections, shall have shop prepared ends for field welding. This work shall be in accordance with 711.03.

(b) Expansion Joint BS

This type of joint shall be in accordance with the details shown on the plans for the size specified. The joint seal shall be furnished in one continuous length for the limits as shown on the plans. Miter cut, vulcanized shop splices will be required in the joint seal at those locations where a change in direction is required as shown on the plans. Field splicing of the joint seal will not be permitted. The distance from the top of the bridge deck to the joint seal, as shown on the plans, shall be in accordance with the joint manufacturer's recommendations. The distance from the top of the bridge deck to the top of the joint seal, when the joint is at its minimum width, shall be as shown on the plans.

(c) Expansion Joint M

The joint manufacturer shall submit the material specifications and joint setting data with the shop drawings as required elsewhere herein. This joint setting data shall be applicable to the particular bridge structure at which the joint is to be installed. The joint and anchor assembly shall be prefabricated and preset by the manufacturer in accordance with the approved shop drawings, joint setting data and the manufacturer's specifications. The assembly shall contain provisions for final field adjustment at the time of installation. All movements due to such factors as shrinkage, creep, and midslab deflection shall be properly accounted for prior to this final adjustment. Final adjustment of the assembly shall be made as directed at the time of installation.

The joint and anchor assembly shall be delivered and installed as a continuous unit for lengths up through 46 ft (14 m). Joints longer than 46 ft (14 m) shall be furnished in continuous units or in appropriate shorter sections as shown on the shop drawings and as approved. Joints used in stage construction shall be furnished in sections appropriate to accommodate the work. All joints furnished in sections shall have shop prepared ends for field splice welds. All work, both shop and field, shall be in accordance with 711.03. A

sliding cover plate shall be required over that portion of expansion joint M located in a sidewalk or concrete rail.

(d) Replacement of Existing Structural 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.

(e) Replacement of Existing Structural 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.

724.04 Method of Measurement

Structural expansion joints will be measured by the linear foot (meter) along and parallel to the plane of the finished joint surface. Replacement of existing structural expansion joints will be measured by the linear foot (meter) along and parallel to the plane of the finished joint surface. Concrete removal and new concrete required for the replacement of existing structural expansion joints will not be measured for payment. Sliding cover plates will not be measured for payment. Replacement of existing structural expansion joint seals will be measured by the linear foot (meter) along and parallel to the plane of the finished seal installation.

724.05 Basis of Payment

Structural expansion joint will be paid for at the contract unit price per linear foot (meter) of the type specified, complete in place. Replacement of existing structural expansion joint will be paid for at the contract unit price per linear foot (meter) for structural expansion joint, of the type specified, replace, complete in place. Replacement of existing structural expansion joint seal will be paid for at the contract unit price per linear foot (meter) for structural expansion joint seal, of the joint type specified, replace.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Structural Expansion Joint, ____ (type)	LFT (m)
Structural Expansion Joint, ____ (type), Replace	LFT (m)
Structural Expansion Joint Seal, ____ (type), Replace	LFT (m)

The cost of sliding cover plates shall be included in the cost of structural expansion joint or structural expansion joint, replace, as applicable. The cost of concrete removal and new concrete for the replacement of existing structural expansion joint shall be included in the cost of structural expansion joint, replace.

SECTION 725 – SLIP LINING OF EXISTING PIPE

725.01 Description

This work shall include installing a thermoplastic liner into an existing pipe and filling the space between the liner and the existing pipe with cellular concrete grout all in accordance with 105.03.

MATERIALS

725.02 Materials

Materials shall be in accordance with the following.

Cement	901.01(b)
Fine Aggregate	904
Fly Ash	901.02
Flowable Backfill	213
Foam Concentrate	ASTM C 869
Profile Wall HDPE Pipe Liner	907.25(b)
Profile Wall PVC Pipe Liner	907.25(c)
Solid Wall HDPE Pipe Liner	907.25(a)
Water	913.01

Individual liner section lengths shall be a minimum of 19 ft (5.8 m), but shall not exceed 55 ft (16.7 m) unless approved.

Liner joints shall be bell and spigot, screw type, or thermal welded. Grooved press-on joints shall be used only when approved by the Engineer. All joints shall have sufficient mechanical strength to withstand the liner installation and grouting operations. Joints shall not reduce the hydraulic capacity of the liner.

Only pipe liners selected from the Department's list of approved Thermoplastic Pipe Liners shall be used.

The cellular concrete grout shall be designed and produced in accordance with ASTM C 796 except as herein modified.

The admixtures, retarders, and plasticizers used in the grout shall be in accordance with the foam concentrate supplier's specifications.

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 the foam concentrate supplier 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 (1040 kPa). The

mix shall be tested and verified in accordance with these specifications or shall be approved based on prior acceptable performance on Department contracts.

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 foam concentrate 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 cubic yard (1 cubic meter) shall be mixed and pumped in a continuous operation.

For each day worked or for each 100 cubic meters (100 cubic yards) placed, four test cylinders measuring 3 in. by 6 in. (75 mm by 150 mm) shall be cast at the point of placement of the grout. The cylinders shall be prepared, cured, and transported in accordance with ASTM C 31, except as modified herein.

The compressive strength shall be determined in accordance with ASTM C 39, except as modified herein. Initial curing shall be at room temperature and shall be from 2 to 5 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 stripped, capped, and 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.

Existing circular pipe structures shall be lined with solid wall high density polyethylene, HDPE, pipe liner; profile wall HDPE pipe liner; or profile wall polyvinyl chloride, PVC, pipe liner. Existing deformed pipe structures shall be lined with solid wall HDPE pipe liner.

CONSTRUCTION REQUIREMENTS

725.03 Construction Requirements

(a) Right-of-Entry Areas

If the right-of-way does not provide sufficient room for performance of the work, rights-of-entry from all necessary adjacent property owners shall be obtained 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.

(b) Filling of Cavities Outside the Existing Pipe

All obvious cavities outside the existing pipe shall be filled with flowable backfill in accordance with 213 prior to the liner installation or with grout placed in conjunction with the grouting operation after the liner is installed.

(c) Liner Installation

Prior to commencing the liner installation, all jagged existing pipe edges or other deformities shall be repaired. All foreign material shall be removed from the existing pipe.

100 The inside diameter of the liner shall be in accordance with the following:

EXISTING CIRCULAR CMP STRUCTURES	
PAY ITEM DIAMETER in. (mm)	MINIMUM LINER INSIDE DIAMETER in. (mm)
12 (300)	10.0 (250)
15 (375)	11.7 (290)
18 (450)	14.3 (355)
21 (525)	16.8 (420)
24 (600)	18.5 (460)
27 (675)	20.7 (515)
30 (750)	23.5 (585)
33 (825)	26.1 (650)
36 (900)	29.5 (735)
42 (1050)	33.6 (840)
48 (1200)	39.2 (980)
54 (1350)	42.0 (1050)
60 (1500)	48.0 (1200)
66 (1650)	51.6 (1350)
72 (1800)	59.1 (1475)
78 (1950)	60.0 (1500)
84 (2100)	66.0 (1650)
90 (2250)	72.0 (1800)
96 (2400)	78.0 (1950)
102 (2550)	78.0 (1950)
108 (2700)	84.0 (2100)
114 (2850)	90.0 (2250)
120 (3000)	96.0 (2400)
126 (3150)	96.0 (2400)
132 (3300)	108.0 (2700)
138 (3450)	108.0 (2700)
144 (3600)	120.0 (3000)

EXISTING CIRCULAR STRUCTURAL PLATE PIPE STRUCTURES	
PAY ITEM DIAMETER ft – in. (mm)	MINIMUM LINER INSIDE DIAMETER in. (mm)
5 – 0 (1500)	48.0 (1200)
5 – 6 (1655)	51.7 (1290)
6 – 0 (1810)	59.1 (1475)
6 – 6 (1965)	59.1 (1475)
7 – 0 (2120)	59.1 (1475)
7 – 6 (2275)	72.0 (1800)
8 – 0 (2430)	78.0 (1950)
8 – 6 (2585)	84.0 (2100)
9 – 0 (2740)	90.0 (2250)
9 – 6 (2895)	96.0 (2400)
10 – 0 (3050)	96.0 (2400)
10 – 6 (3205)	96.0 (2400)
11 – 0 (3360)	108.0 (2700)
11 – 6 (3515)	108.0 (2700)
12 – 0 (3670)	120.0 (3000)

EXISTING DEFORMED PIPE STRUCTURES	
PAY ITEM END AREA ft^2 (m^2)	MINIMUM LINER INSIDE DIAMETER in. (mm)
CORRUGATED METAL PIPE-ARCH	
2 2/3 in. x 1/2 in. (68 mm x 13 mm) Corrugations	
1.1 (0.10)	12.0 (300)
1.6 (0.15)	14.9 (370)
2.2 (0.20)	16.8 (420)
2.9 (0.27)	18.5 (460)
4.5 (0.42)	24.0 (600)
6.5 (0.60)	29.5 (735)
8.9 (0.83)	33.6 (840)
11.6 (1.08)	39.2 (980)
14.7 (1.37)	42.0 (1050)
18.1 (1.68)	48.0 (1200)
21.9 (2.03)	51.6 (1290)
26.0 (2.42)	59.1 (1475)
3 in. x 1 in. (75 mm x 25 mm) Corrugations	
15.6 (1.45)	42.0 (1050)
19.3 (1.79)	48.0 (1200)
23.2 (2.16)	51.6 (1290)
27.4 (2.55)	59.1 (1475)
32.1 (2.98)	60.0 (1500)
37.0 (3.44)	66.0 (1650)
42.4 (3.94)	72.0 (1800)

48.0 (4.46)	78.0 (1950)
59.2 (5.04)	78.0 (1950)
60.5 (5.62)	84.0 (2100)
67.4 (6.26)	90.0 (2250)
74.5 (6.92)	96.0 (2400)
STRUCTURAL PLATE STEEL PIPE-ARCH	
22 (2.0)	48.0 (1200)
24 (2.2)	51.7 (1290)
26 (2.4)	51.7 (1290)
28 (2.6)	59.1 (1475)
31 (2.9)	59.1 (1475)
33 (3.1)	59.1 (1475)
35 (3.3)	59.1 (1475)
38 (3.5)	59.1 (1475)
40 (3.7)	59.1 (1475)
43 (4.0)	59.1 (1475)
46 (4.3)	72.0 (1800)
49 (4.6)	72.0 (1800)
52 (4.8)	78.0 (1950)
55 (5.1)	84.0 (2100)
58 (5.4)	84.0 (2100)
61 (5.7)	90.0 (2250)
64 (5.9)	90.0 (2250)
67 (6.2)	96.0 (2400)
71 (6.6)	96.0 (2400)
74 (6.9)	96.0 (2400)
78 (7.2)	96.0 (2400)
81 (7.5)	96.0 (2400)
85 (7.9)	96.0 (2400)
97 (9.0)	108.0 (2700)
102 (9.5)	108.0 (2700)
105 (9.8)	108.0 (2700)
109 (10.1)	120.0 (3000)

Prior to commencing the liner installation operation, steps shall be taken to verify that a liner meeting the minimum inside diameter requirements can be successfully placed inside the existing pipe. If it is discovered prior to installation that a liner with the required inside diameter cannot fit, the inside and outside diameters of a substitute liner shall be submitted to the Engineer for approval. If this discovery is not made until after the liner installation has begun, the partially installed liner shall be removed. Inside and outside diameters for a substitute liner shall then be submitted to the Engineer for approval.

After the liner installation is complete and the liner has cooled to approximately the temperature of the existing pipe, the liner shall be cut so that each end is no more than 3 in. (75 mm) outside the end of the existing pipe.

Grout shall be injected into the space between the existing pipe and the liner. The injection operation shall provide sufficient grout to fill all voids between the existing pipe and the liner over the entire structure length, but shall also be performed in a manner that does not distort the liner. The pressure developed in the space between the liner and the existing pipe shall not exceed the liner 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. Grout shall not leak through the liner at these connections.

725.04 Method of Measurement

Thermoplastic liner will be measured by the linear foot (meter), complete in place. An allowance of 5 ft (1.5 m) of liner will be made for the perpetuation of an existing pipe through the liner.

725.05 Basis of Payment

The accepted quantities of pipe liner, thermoplastic, will be paid for at the contract unit price per linear foot (meter) for the size of the existing pipe in which the liner is installed, complete in place. Perpetuating the direct connection of an existing pipe through the liner will be paid for by means of an allowance of 5 ft (1.5 m) of liner for each such connection.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Pipe Liner, Thermoplastic, _____ in. (mm) diameter	LFT (m)
Pipe Liner, Thermoplastic, ____ sft (m2) area	LFT (m)

The cost of repairing jagged edges or deformities to existing pipe, filling cavities around the existing pipe with flowable backfill or grout, acquisition and restoration of required right-of-entry areas, erection, maintenance, and removal of temporary fence, removing foreign material from the existing pipe, grouting the space between the existing pipe and the liner, and other incidentals will not be paid separately, but shall be included in the cost of the pay items in this section.

In situations where the condition of the existing pipe requires that a substitute liner be utilized, there will be no reduction in payment for the installation of the substitute liner. There will be no additional payment for the additional grout required to fill the larger void between the existing pipe and the smaller liner.

There will be no payment for the installation or removal of any liner that cannot be successfully installed due to the condition of the existing pipe.

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 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

801.02 Materials

Materials shall be in accordance with the following:

Coarse Aggregate, Class D or Higher, Size No. 73	904
Construction Warning Lights	923.03
Delineator Posts	910.15
Delineators	926.02
Field Paint	909.04
Flashing Arrow Sign	923.04
Flexible Delineator Posts	926.01
Pavement Marking Materials	921
Steel Posts	910.14
Temporary Barrier Delineator	926.02(d)
Temporary Highway Illumination Materials	807
Temporary Panel Signs	919.01
Traffic Signal Materials and Equipment	922
Traffic Signs	802
Tubular Marker	923.06
Wood Sign Posts	911.02(e)
Worksite Speed Limit Sign Assembly	923.05

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. Roll-up materials will not be allowed. A copy of the FHWA acceptance letter shall be provided to the Engineer upon request.

The background of construction signs shall be reflective sheeting in accordance with 919.01(b)1. The sheeting type used for construction signs shall be the same for the entire project. Reflective sheeting for drums shall be in accordance with 919.01(b)1. Effective on project lettings after July 1, 2006, the background for all construction signs shall be fluorescent orange reflective sheeting.

Steel sign posts need not be galvanized.

Wood posts for temporary panel signs shall be dense southern yellow pine or design computations 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.

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 (827 MPa). The spacers used between adjoining sections of temporary barrier wall shall be in accordance with ASTM A 36 (ASTM A 36M) with a tensile strength of 58,000 psi (400 MPa).

CONSTRUCTION REQUIREMENTS

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, maintenance, and removal of temporary traffic control devices. The certified worksite traffic supervisor, CWTS, shall ensure 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 concurred with 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 and maintenance of 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.

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.

Temporary traffic control devices shall be maintained continuously, except as described herein, 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 a "Traffic Control Device Report" weekly. This report is supplied in the Proposal Book for the contract and is to insure that the traffic control devices are looked at daily. The report does not always need to be filled out by the CWTS but must be reviewed by the CWTS for completeness and accuracy. The report shall be signed by the person who filled it out and 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. If the CWTS feels that a situation exists where the temporary traffic control devices do not need to be checked daily for a certain period of time, the CWTS and the Engineer must agree on how often they should be checked.

Except for construction warning lights and temporary signals, the ATSSA brochure titled Quality Standards For Work Zone Traffic Control Devices will be used as a guide to determine if temporary traffic control devices are Acceptable, Marginal, or Unacceptable as defined in the brochure. 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.

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.

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.

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

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.

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).

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 permitted 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.

Temporary mounted construction signs shall not be used for operations which affect traffic lanes or paved shoulders. Temporary mounted construction signs shall not be used or left in place during nighttime hours.

(a) Type A

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 (0.84 m^2) 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 (0.84 m^2) 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 (0.84 m^2) or more but less than 33 sq ft (3 m^2) in area.

(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 (0.84 m^2).

(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 (3 m^2). 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.

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

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.

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.

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

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 (3.0 m) 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

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 permitted during daylight hours unless otherwise directed.

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 permitted.

801.09 Drums

Drums shall be molded orange polyethylene.

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.

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 (80 km/h) and gusts created by traffic. The weight (mass) of the ballast shall be 45-55 lb (20-25 kg). 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.

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. (900 mm). The height of two tire base collars at the outside edge shall not exceed 5 in. (125 mm). 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.

Upon impact by a vehicle traveling at a speed of 55 mph (90 km/h), the drum and ballast device shall be of a type that permits the body of the drum to separate from the base, thus allowing vehicles to easily pass over the base.

Flexible encapsulated lens reflective sheeting shall be used to achieve reflectorization. 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

Temporary traffic barrier shall be one of the following four types as shown on the plans.

Type 1

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 0.25 in. (6 mm) in 10 ft (3 m) 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 0.25 in. (6 mm) across the joint, as measured from a 10 ft (3 m) 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.

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 prior to 2003 shall not be used after January 1, 2012.

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 NCHRP 350 crash test standards and shall be approved for use by the FHWA. A 350 crash test letter of approval from the FHWA shall be provided 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.

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.

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 NCHRP 350 crash test standards and shall be approved for use by the FHWA. A 350 crash test letter of approval from the FHWA shall be provided the Engineer prior to placing the unit.

(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 (6 m) 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 (6 m) 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 (3 m). The use of flare rates sharper than those shown on the plans may require additional traffic control devices as directed.

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:

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.

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. (25 mm) 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. (30 mm) bolt.

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 (18 m) of a bridge, and along tapered alignments. Anchoring at locations in addition to those described herein will be required when directed.

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 (44.5 kN) and an ultimate pullout strength of 6,500 lb (29 kN).

Non-ferrous mechanical anchors shall be installed such that the top end of the sleeve is a minimum of 2 1/2 in. (60 mm) 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.

(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 (± 20 ft or 6 m spacing). 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).

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 (number of meters equal to 0.3 times) the number of miles per hour in the posted speed limit with a minimum spacing of 20 ft (6 m). 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.

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.

(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 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 results and a copy of the FHWA approval letter shall be furnished to the Engineer prior to the installation of the unit. The Contractor may also use the Guard Rail Energy Absorbing Terminal cz, manufactured by Energy Absorption Systems, Inc.

The unit’s nose cover shall be reflectorized to provide improved visibility.

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 original copies of all necessary current manufacturer's installation manuals and shop drawings prior to beginning installation work. Shop drawings shall be a minimum of 22 in. x 34 in. (560 mm x 865 mm) in size. No installation work shall begin prior to the Department's receipt of such manuals and drawings. Such manuals and drawings will remain the property of the Department. If there is a discrepancy between shop drawings and the plans, the shop drawings shall govern.

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

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. When required to maintain median drainage, a 15 in. (375 mm) 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.

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.

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

Temporary pavement markings shall be in accordance with 808.04 and 808.05. However, the dashed line pattern used on center line and lane lines may be 4 ft (1.2 m) line segments on 40 ft (12 m) centers. Gore areas shall be marked by outline only and may be 5 in. (125 mm) wide lines. All temporary markings shall be maintained and replaced until they are no longer applicable.

Temporary markings placed on the final surface course shall be temporary marking tape type 1.

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.

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.

If a pavement course is to be in place for a period greater than 14 calendar days, all temporary pavement markings shall be placed in accordance with 808.04 and stop lines shall be placed in accordance with 808.05. No-passing zones on all undivided two-way roadways shall be identified with signs and centerline markings.

If the temporary pavement markings are to be in service from December 1 through the following March 31, 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.

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.

(a) Temporary Pavement Marking Methods

Pavement markings shall be installed in accordance with 808.07.

1. Paint

Painted lines on new HMA courses shall require a second application of paint as soon as practical after the first application is dry.

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.

All temporary pavement marking tape shall be removed prior to placement of an HMA overlay or final pavement markings.

a. Type I

Type I tape is a removable material. It may be used for longitudinal and transverse markings. It shall be used for longitudinal and transverse markings on the final surface.

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

Type II tape is a non-removable material. It may be used on PCCP to be removed or overlaid with an HMA course greater than 110 lb/sq yd (60 kg/m^2). If it is placed on HMA pavement, the tape shall be removed prior to the recycling of the HMA material.

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 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

Temporary buzz strips shall be a set of transverse markings. Durable marking material shall be used in accordance with 808.07(b). Temporary buzz strips shall be removed in accordance with 808.10 when no longer required or as directed.

(b) Quality Assurance Unit

A quality assurance unit for longitudinal line shall be 500 lft (150 m) on marked pavement in any combination or pattern, or portion thereof. A quality assurance unit for transverse marking shall be each. If a marking fails to be in accordance with the marginal standard as defined in the ATSSA Quality Standards for Work Zone Traffic Control Devices, the quality assurance assessment will be assessed in accordance with 801.03.

801.13 Temporary Illumination

The temporary highway illumination shall be in accordance with applicable requirements of 807 except as modified herein.

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

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. (900 mm) 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

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 (900 m) 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 (300 m) when viewed without the sun directly on or behind the light.

(c) Type C

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 (900 m) 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 (300 m).

801.15 Electronic Devices

(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) Changeable Message Signs

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 (200 m).

A malfunctioning sign shall be repaired or replaced within 24 h.

(c) Temporary Worksite Speed Limit Sign Assembly

This shall consist of furnishing and placing portable speed limit signs as shown on the plans or as directed in areas of work activity. 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 deg when viewed facing the sign and shall have a minimum effective luminance of 2100 cd effective according to the manufacturer's literature, which shall be provided to the Engineer prior to use.

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 next to the permanent signs.

The worksite speed limit shall not be used for the entire length of a roadway under construction unless there is actual work activity for the entire length of such roadway. It shall not be activated at the beginning of the day, for the entire day, if actual work is not being done all day in the work area.

The worksite speed zone signage shall be placed and maintained by the Contractor. The worksite speed limit will be 45 mph, or 10 mph below the posted speed limit for the roadway under construction, whichever is lower.

A worksite "Reduced Speed Ahead" sign shall be placed in advance of the first sign assembly when the reduction in speed limit is greater than 15 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.

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.

Two signal heads shall be displayed for each approach. Signals shall be displayed overhead on a span, catenary, and tether utilizing an aircraft cable, unless otherwise directed.

Electric energy necessary to power the 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 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.

The location, spacing, and timing of signals will be determined by the Engineer.

An IMSA certified level II technician shall be available 24 h a day to respond within 2 h for the maintenance of the traffic signal equipment.

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.

The controller shall be solid state digital. When detection is required, the controller shall be traffic actuated solid state, digital.

Vehicle detection, if required, shall be installed as shown on the plans or as otherwise directed and shall be operational prior to signal activation.

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 (1.6 km) or the length of one-half day's operation, whichever is less, or as shown on an approved alternate traffic control plan.

(a) Temporary Traffic Control Signs

Temporary traffic control signs (TTCS) are construction signs in a temporary traffic control zone.

Trailer mounted TTCS shall be positioned such that the tongue and the method of pinning shall minimize the hazard to motorists. Wheel chocks other than sandbags shall not be used. During non-working hours, trailers with signs that do not apply to existing conditions shall be stored in accordance with 107.08.

TTCS shall not be mounted on barricades or other non-approved supports. When the vertical mounting height for TTCS is between 12 in. and 18 in. (300 mm and

450 mm) to the bottom of the sign, tripod supports may be used. When permitted for use, the signs on tripod supports shall be installed so that the angle from vertical does not exceed 30 degrees.

(b) Maintenance of Traffic for 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.

(c) Traffic Control for Temporary Traffic Stoppage

Traffic shall not be permitted to pass directly beneath personnel or equipment working on an overhead structure. Traffic stoppage during an overhead operation shall not exceed 20 min at one time. There shall be enough time between consecutive stoppages to permit 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

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

Construction signs, detour route marker assemblies, detour route marker assemblies-multiple routes, temporary worksite speed limit sign assemblies, road closure sign assemblies, temporary changeable message signs, 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 (square meter). Temporary panel sign supports, when required, will be measured by the linear foot (meter), complete and in place.

Type III-A, type III-B, and permanent type III barricades will be measured by the linear foot (meter) of the width of closure.

Temporary traffic barrier will be measured by the linear foot (meter) per the type specified. Anchored traffic barrier will be measured by the linear foot (meter), 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 (meter) as part of the barrier.

Construction zone energy absorbing terminals, cz will be measured by the number of terminals placed.

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 (megagram) 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 (meter). 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 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.

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 markings will be measured by the linear foot (meter) of material actually placed. Temporary buzz strips will be measured by the linear foot (meter) for each strip, without regard to the number of passes required to attain the specified height.

If, due to a Department initiated change or an approved expedited construction schedule, it is necessary to remove temporary non-removable pavement markings, such removal will be measured in accordance with 808.12. The removal of existing pavement markings which are in conflict with temporary markings, will be measured in accordance with 808.11.

The removal and replacement of reflectors on existing snowplowable raised pavement markers will be measured in accordance with 808.12.

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, temporary traffic signals, and maintaining traffic will not be measured for payment.

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, and temporary raised pavement markers will be paid for at the contract unit price per each. Payment for temporary worksite speed limit assemblies and temporary changeable message signs 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 (meter).

Temporary traffic barrier and anchored temporary traffic barrier will be paid for at the contract unit price per linear foot (meter) 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.

Construction zone energy absorbing terminal, cz 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. 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. Due to the nature of the TRACC-350 unit, the Engineer must agree that the in-service unit has been damaged to the extent that it is non-repairable before a standby TRACC-350 unit will be considered for payment.

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 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 (megagram) in accordance with 402.20. Temporary drainage pipe for temporary crossovers will be paid for at the contract unit price per linear foot (meter). 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 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.

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 one 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 (square meter) as shown on the plans. Temporary panel sign supports will be paid for at the contract unit price per linear foot (meter), complete and in place.

Flashing arrow signs and patrollers will be paid for at the contract unit price per day per each.

Temporary pavement markings and temporary buzz strips, will be paid for at the contract unit price per linear foot (meter) of material, complete in place, except as set out below.

Permanent tubular markers will be paid for at the contract unit price per each.

The removal of temporary non-removable pavement markings caused by a Department initiated change or an approved expedited construction schedule, and the removal of existing pavement markings which are in conflict with temporary markings will be paid for in accordance with 808.13.

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.

Temporary illumination will be paid for at the contract lump sum price.

All traffic control devices and construction materials 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 traffic control devices will be paid for at the contract lump sum price for maintaining traffic.

The accepted temporary traffic signal, 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**
Barricade, _____ type	LFT (m)
Barricade, III, Permanent	LFT (m)
Barrier, Direction Indicator	EACH
Construction Sign, _____ type	EACH
Detour Route Marker Assembly	EACH
Detour Route Marker Assembly, Multiple Routes	EACH
Drum, Permanent	EACH
Energy Absorbing Terminal, CZ, TL - _____ test level	EACH
Flashing Arrow Sign	DAY
Maintaining Traffic	LS
Patroller	DAY
Road Closure Sign Assembly	EACH

Road Closure Sign Assembly, Permanent .....EACH
Temporary Buzz Strips .....LFT (m)
Temporary Traffic Barrier, _____.....LFT (m)
type
Temporary Traffic Barrier, Anchored, _____.....LFT (m)
type
Temporary Crossover, _____.....EACH
type
Temporary Crossover, _____, Refurbish.....EACH
type
Temporary Crossover Drainage Pipe.....LFT (m)
Temporary Changeable Message Sign.....EACH
Temporary Illumination .....LS
Temporary Panel Signs .....SFT (m2)
Temporary Panel Sign Supports.....LFT (m)
Temporary Pavement Marking, _____ in. (mm) .....LFT (m)
width
Temporary Pavement Marking, Removable, _____ in. (mm) .....LFT (m)
width
Temporary Pavement Message Marking, _____ .....EACH
description
Temporary Pavement Message Marking, Removable, _____ .....EACH
description
Temporary Raised Pavement Marker, _____.....EACH
grade
Temporary Traffic Signal.....LS
Temporary Traffic Signal with Detectors .....LS
Temporary Transverse Pavement Marking, _____ in. (mm).....LFT (m)
width
Temporary Transverse Pavement Marking,
Removable, _____ in. (mm) .....LFT (m)
width
Temporary Worksite Speed Limit Sign Assembly .....EACH
Tubular Marker, Permanent .....EACH

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.

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.

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.

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 furnishing, installing, maintaining, and subsequent removal shall be included in the cost of temporary raised pavement marker.

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.

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 should the failure to complete the work as scheduled be due to conditions beyond the Contractor's control.

The cost of the second application of temporary painted lines on new HMA courses shall be included in the cost of temporary pavement markings.

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.

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 furnishing all materials, erection, maintenance, removal, and necessary incidentals shall be included in the cost of barricades.

Each construction sign, barricade, temporary worksite speed limit sign assembly, temporary changeable message sign, 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. Payment will not be made for signs or barricades used for the convenience of the Contractor.

If a temporary worksite speed limit sign assembly 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.

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.

The cost of necessary flaggers; protection of traffic at structure foundations; and furnishing, erecting, placing, maintaining, relocating, and removing lights, cones, flexible channelizers, tubular markers, drums, delineators, temporary pavement markings, or other devices as directed shall be included in the cost of maintaining traffic.

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.

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 108.03 shall be included in the cost of maintaining traffic.

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.

Electric energy necessary to power luminaires and temporary traffic signals will not be paid for.

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.

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 Department's list of approved Sign Sheeting Materials. 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.

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 Steel	910.01
Sign Posts	910.14
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

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 Shop Drawings

Prior to fabrication, six sets of shop drawings in accordance with 711.05 shall be submitted 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 shop drawings. Notice of all discrepancies shall be provided to the Engineer so necessary design revisions can be made prior to preparation of the shop drawings. If the no-load camber is not shown on the plans, the Contractor shall furnish this camber in the shop drawings.

802.05 Excavation and Backfill

The finished pavement or shoulder section shall not be damaged during excavation.

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

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.

802.07 Installing Supports

(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 permitted.

In locations where class X excavation is encountered, the Engineer will determine the design for the installation of foundations. 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. (150 by 150 by 13 mm), 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. (75 to 100 mm) of concrete at the bottom of the foundation.

(b) Structural Frames

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.

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:

a. Lower nuts and washers shall be in full contact with the base plate,

b. The top nuts shall be tightened to one-sixth 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.

Field welding of aluminum shall be in accordance with 803. Field welding of steel shall be in accordance with 711.32.

The grounding connection shall be located 12 in. (300 mm) 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

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. (1.5 mm) on any flange assembly. The total of the gaps in any one connection shall not exceed 1/8 in. (3 mm). Gaps shall be shimmed with tapered shims before tightening the flange bolts.

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 recommendation as detailed on the shop drawings.

3. Cantilever Arms

Cantilever arms shall fit together at the flange connections between sections with a minimum gap of 1/16 in. (1.5 mm) on any flange assembly. The total of the gaps in any one connection shall not exceed 1/8 in. (3 mm).

4. Bridge Brackets

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 structural frames, 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 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 permitted. 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. (750 mm). Signs 7ft (2.1 m) or less in height shall have sign support bracket assemblies mounted at a maximum spacing of 7 ft (2.1 m). Signs greater than 7 ft (2.1 m) in height shall have sign support bracket assemblies mounted at a

maximum spacing of 5 ft (1.5 m). Sign overhang beyond the end bracket assembly shall be not more than half the spacing of the bracket assemblies.

(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.

(b) Panel Signs

Panel signs shall be mounted as follows:

1. Up to and including 24 ft (7300 mm) 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.

2. Over 24 ft (7300 mm) 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. (600 mm) centers with an allowable gap of no more than 1/16 in. (2 mm) between units. Panels shall be temporarily braced in accordance with the panel manufacturer's recommendations.

802.09 Removal or Relocation of Signs or Support Assemblies

Signs to be relocated shall be installed in accordance with the MUTCD and on new 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 (0.3 m) 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 (7.5 m) 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 (square meter). 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 (meter). 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 (kilogram). Such measurement will include the weight (mass) of breakaway sections such as stubs, stiffeners, base plates, and fuse plates. For rigid sections, the weight (mass) of the base plate will be included.

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 and bridge bracket assemblies 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.

802.12 Basis of Payment

The accepted quantities of sheet signs and panel signs will be paid for at the contract unit price per square feet (square meter), 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 (meter) for the type specified.

Structural steel, breakaway, will be paid for at the contract unit price per pound (kilogram).

Ground mounted sign support foundations will be paid for at the contract unit price per each type specified.

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.

The removal of signs, overhead structures, and sign assemblies, will be paid for at the contract unit price per each.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Box Truss Sign Structure Foundation, _____ (type)	EACH
Bridge Bracket Assembly	EACH
Cable Span Sign Structure Foundation, _____ (type)	EACH
Cantilever Sign Support Foundation, _____ (type)	EACH
Overhead Balanced Cantilever Sign Structure Foundation, _____ (type)	EACH
Overhead Sign Structure, _____ (type)	EACH
Overhead Sign Structure, _____ (type), Remove	EACH
Reference Post	EACH
Sign and Supports, Wide Flange, Remove	EACH
Sign Post, _____ (type)	LFT (m)
Sign Post, Square, _____ (type), Reinforced Anchor Base	LFT (m)
Sign Post, Square, _____ (type), Unreinforced Anchor Base	LFT (m)
Sign, Double Faced, Sheet, _____ (type), With Legend, _____ (thickness)	SFT (m2)
Sign, Overhead, Remove	EACH
Sign, Panel, With Legend	SFT (m2)
Sign, Panel, Relocate	EACH
Sign, Panel, Remove	EACH
Sign, Sheet Assembly, Rotate	EACH
Sign, Sheet, _____ (type), With Legend, _____ (thickness)	SFT (m2)

Sign, Sheet, and Supports, Remove .....EACH
Sign, Sheet, Relocate.....EACH
Sign, Sheet, Remove .....EACH
Sign, Sheet, With Legend.....EACH
Structural Steel, Breakaway .....LBS (kg)
Wide Flange Sign Post Support Foundation, _____ .....EACH
type

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.

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 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 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.

The cost of modifying existing hardware to mount a new sign shall be included in the cost of the new sign.

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.

The cost of identification markings for signs shall be included in the cost of the sign.

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 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 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.

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 replacement of posts damaged by the Contractor's activities shall be without additional payment.

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 cutting the reinforcing steel 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.

No additional payment will be made if square sign posts are used in lieu of type A or type B posts.

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.

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. The welding symbols to be used on shop drawings shall be those shown in the Standard Welding Symbols, AWS A2.0. Special conditions shall be fully explained by added notes or details.

The aluminum alloys to be welded under these specifications may be any of the following ASTM alloy designations:

1. wrought non-heat-treatable alloys 3003, 3004, 5052, 5083, 5086, 5456;

2. wrought heat-treatable alloys 6061, 6063; or

3. cast heat-treatable alloy 356.0

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.

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.

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.

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.

Welding shall not be done on anodically treated aluminum unless the condition is removed from the joint area to be welded.

(b) Welding Procedure

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.

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.

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 (0.3 m) 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.

Where preheat is needed, the temperature of preheat shall not exceed 350°F (177°C) for heat-treated alloys and 600°F (316°C) 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 min.

(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 permitted by Appendix IV, Section VIII, of the ASME Boiler and Pressure Vessel Code.

Lack of fusion, incomplete penetration, or tungsten or oxide inclusions will be acceptable only if small and well dispersed.

Undercut shall be no more than 0.01 in. (0.3 mm) 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. (0.8 mm) 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

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 E 165, method B, procedures B-2 or B-3. 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

In lieu of rejection of an entire piece or member containing welding which is unacceptable, the corrective measures listed below may be permitted 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

Determine the full extent of cracks by dye penetrant method or other positive means. Remove the cracks throughout their length and depth, and reweld.

2. Excessive Porosity and Lack of Fusion

All defective portions are to be removed and rewelded.

3. Copper or Tungsten Inclusions

All defective portions are to 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

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

Joint welding procedures shall be qualified previously by tests prescribed in Part B, Section IX, of the ASME Boiler and Pressure Vessel 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 Part B, Section IX, of the ASME Boiler and Pressure Vessel 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

804.02. Materials

Materials shall be in accordance with the following:

Delineator Posts 910.15
Flexible Delineator Posts 926.01
Delineators 926.02

The types of delineators shall be:

(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. (4.8 mm) diameter.

CONSTRUCTION REQUIREMENTS

804.03 Delineator Visibility

Delineator reflector units shall be positioned so as to be visible for a distance of 1000 ft (300 m) 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.

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. (13 mm) from any vertical plane through the bottom.

804.06 Method of Measurement

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 flexible delineator post, if set out as a separate pay item, will be paid for at the contract unit price per each for the type specified, complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Delineator	EACH
Delineator Post	EACH
Delineator Post, Flexible	EACH
Delineator with Post, _____ (type)	EACH

Where new delineator posts are installed to replace existing delineator posts, the cost of the removal of the existing post shall be included in the cost of the new post.

SECTION 805 – TRAFFIC SIGNALS

805.01 Description

This work shall consist of furnishing miscellaneous materials, not furnished by the Department, and installing traffic signals in accordance with these specifications and in reasonably close conformance with the lines, grades, and locations shown on the plans or as directed.

MATERIALS

805.02 Materials

Materials shall be in accordance with the following:

Castings for Handhole.....910.05(b)
Coarse Aggregate, Class E or Higher, Size No. 8.....904
Concrete, Class A, B, or C.....702
Reinforced Concrete Pipe 907.02
Traffic Signal Materials and Equipment.....922
Treated Lumber.....911.02

The proposed work shall be examined in order to determine what materials not furnished by the Department are required to complete the contract. The Department will furnish only the materials specified on the Department Furnished Materials special provision. If materials to be furnished by the Contractor are listed, the list is only a guide for estimating purposes. All additional materials required to complete an operating installation as specified shall be furnished.

Signal handholes shall be class III reinforced concrete pipe as shown on the plans.

Wood 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 922.05(b), and dry. Minimum circumference at the top and at a point 6 ft (1.8 m) from the butt shall be in accordance with ANSI specifications.

Steel strain poles greater than 24 ft (7.3 m) in length shall be in accordance with 922.05(a).

CONSTRUCTION REQUIREMENTS

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 must 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. When a new span, catenary, and tether are to be installed on an existing structure, the work shall be done so as not to damage the structure. Tether cable will not be required on a flasher installation. If an existing structure is damaged, it shall be repaired or replaced as directed with no additional payment. 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.

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, any existing signal equipment and materials including wood 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, these items shall be stored at a secure site and salvaged by the appropriate governmental agency. The Contractor shall be responsible for any damage or loss of this equipment and shall repair or replace the same with no additional payment.

All existing painted signal equipment to be reused, such as pedestals, bases, controller cabinets, signal heads, signal weatherheads, pipe arms, shall be cleaned and painted with two coats of highway yellow enamel. Aluminum poles and mast arms 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. (100 mm) 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. (100 mm) 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 a Level II Traffic Signal Electrician certification which has been granted by the International Municipal Signal Association. Supervision of non-electrical, traffic signal related construction work and traffic control shall be done by a person holding a Level I Work Zone Traffic Safety Specialist certification which has been granted by the International Municipal Signal Association, or an equivalent certification approved by the Department.

Before starting work, the Contractor shall provide the names of the Level II Traffic Signal Electricians and Level I Work Zone Traffic Safety Specialists 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 Electricians or Level I Work Zone Traffic Safety Specialists 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.

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.

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.

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.

805.04 Pole Installation

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 mast arm or span, catenary, and tether. Signal cables shall be brought up inside the poles. Any steel pole, mast arm, or hardware not galvanized or painted with baked enamel shall be painted with two coats of rust inhibiting aluminum paint. Paint shall be applied in accordance with 619 with the exception that commercial blast cleaning of the steel will not be required. 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. Wood poles shall be set a minimum of 7 ft (2.1 m) in the ground and raked 12 in. (300 mm).

805.05 Placing Signal Heads

Mast arm and span mounted signal heads shall have 17 ft (5.2 m) minimum and 19 ft (5.8 m) 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 (4.6 m). 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 (3 m) nor more than 15 ft (4.6 m) 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. Pedestrian signal faces shall be mounted with the bottom of the housing at not less than 7 ft (2.1 m) nor more than 10 ft (3 m) 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 (1.1 to 1.2 m) above the sidewalk as shown on the plans. A pedestrian actuated signal sign shall be mounted immediately above the push-button.

Signal heads shall be assembled and wired with one conductor, THW, stranded wire. Where splices are made, a 2 ft (0.6 m) 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.

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 permitted 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.

805.06 Grounding

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

All cable runs attached to utility poles shall have code clearance relative to utility cables. They shall be no less than 18 ft (5.5 m) above the ground level except over railroad tracks when a minimum of 27 ft (8.2 m) 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 gage shall be as shown on 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. (300 mm) 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.

Coded cable conductors shall be used throughout the installation. Cable conductors shall be tagged at all detector housing, handholes, pole signal bases, and controller cabinets. Tags shall consist of an aluminum blank of sufficient size to be stamped with not less than 3/16 in. (5 mm) high all upper case letters which identify the cables by their use and phase. The following are the uses which shall be indicated by the tags:

(a) Power

(b) Pedestrian Signal

(c) Pedestrian Actuation

(d) Signal-Phase Identification

(e) Detection Loop Identification

Loop identification shall consist of the following:

Inside of the Detector Housing, the loop wires of each loop shall be tagged with, in _____, out _____, as shown on the plans.
Loop Number Loop Number

Inside of the Controller Cabinet, each lead-in cable shall be tagged within 6 in. (150 mm) of the terminal strip connection with: Lane designation, Phase Number, Loop Number, and when applicable with loop system number, and speed trap according with the plans.

Phase identification shall consist of the single number “1”, “2”, “3”, etc., which corresponds to the phase diagram for the respective intersection. Tags shall be securely fastened to the cable with a non-corroding material. 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

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. ± 2 in. (970 mm ± 50 mm). Pole mounted controller cabinets shall be fastened with two stainless steel bands as shown in 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 (1.2 m) 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 and any service connection or miscellaneous charges shall be assumed by the Contractor.

A minimum of 12 in. (300 mm) and a maximum of 18 in. (450 mm) of loop wire duct will be permitted in the detector housing for each loop lead. Concrete used in the installation of detector housings shall be in accordance with 506, except 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

This work shall consist of placement and testing of loop wire detectors in accordance with the installation details shown on the plans.

MATERIALS

Loop wire shall be in accordance with 922.06(e)7b. Loop detector sealant shall be in accordance with 922.06(e)7c.

Loops shall be of a regular octagon shape with side of 2.5 ft (0.75 m) in length. An outline shall be laid out and painted where the loops shall be sawed. The loop locations shall be subject to the review and approval of the District Traffic Engineer. The District Traffic Engineer shall be notified 48 h prior to such field review.

The slots shall be saw-cut as shown on the plans. Slots shall be thoroughly cleaned and dried before the installation of loop wires. The specified number of turns shall be placed in the slot and gently tamped with a blunt non-metallic tool. A sash cord or backer rod shall be placed above the wire after tamping. The number, size, arrangement, and locations of loops shall be as shown on the plans. Loop spacing shall be adjusted to avoid pavement joints. Loop wire shall be pressed into the saw slot with a blunt non-metallic tool. Loop wire shall only be bent at angles of 120° or greater. All loops shall be wired clockwise as viewed from above. Loops shall be wired with four turns and in a series unless otherwise specified. Joints shall be overlapped such that the saw cut at the corner is full depth. The sealant shall be poured into the saw cut making a water tight seal. The splice of the loop wire and lead-in cable shall be soldered and waterproofed at the detector housing. 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. Loop wire and lead-in cable shall be tagged according to the plans and 805.07. 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 “In/Loop (No.)”.

TESTING

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 A.C. 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.

(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

The two wires of the lead-in cable at the cabinet shall be twisted together and taped. The shield of the lead-in cable shall be grounded in the cabinet. At the detector housing, one megohm probe shall be connected to ground and the other probe shall be connected to one of the lead-in wires. The remaining lead-in wire shall be isolated. The test shall then be performed.

(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 (15 ml) of baking soda per pint (0.5 L) 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 min. With the splice submerged, the megohm test shall be performed at the cabinet on the end of the lead-in cable.

(d) Vehicle Simulator Test

This test shall be performed after all other tests are completed and after all connections have been made at the controller in the cabinet. 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 (2.4 m) length of No. 6 bare copper wire formed into a circle. The two ends shall then be electrically spliced. The detector unit amplifier shall record a call as the test vehicle is dragged across the loop. It shall cancel the call as the test vehicle leaves the loop.

(e) 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.

In order for the loop detector installation to be accepted, the electrical values shall be as follows:

1. Inductance shall be between 80 and 800 µH. Inductance shall be determined by means of digital readout meter which drives the field loop system.

2. Resistance shall be less than or equal to 8 ohms.

3. Voltage shall be less than or equal to 3 V.

4. Induced A.C. voltage and leadage resistance shall be greater than 100 megohms.

Loop wire and/or lead-in cable failing to meet this requirement shall be replaced at no cost to the State.

805.10 Magnetometer and Microloop Detectors

Before installation of Magnetometer or Microloop probes the Contractor shall confirm the adequacy of the magnetic field intensity, to be sure that the range is suitable for their operation. Arrangement of probes shall be located at maximum distance from steel support under bridges. Probes shall be installed with their long dimension vertical, and with the cable end at the top. Probes shall be firmly supported, so the lateral and vertical motion is restricted. Probes shall be connected in series. The splice shall be soldered by means of hot iron, or pouring or dripping without flames, with rosin core solder and shall be insulated and waterproofed in accordance with the manufacturer's specifications.

805.11 Steel Conduit

Conduit shall be installed to a depth of no less than 2 ft (0.6 m) or more than 5 ft (1.5 m) 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 without permission. If permission is granted, cuts in pavement areas shall be no greater than 24 in. (600 mm) 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 (0.6 m) 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. Continuous conduit runs shall not exceed 250 ft (76 m) in length, unless otherwise indicated 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 permitted. 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 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 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 Conduit

The method of installing PVC conduit underground shall be the same as for steel conduit where applicable except trenches for the conduit shall be backfilled with 2 in. (50 mm) of 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 shall be placed over the conduit to a depth of 12 in. (300 mm) and the remainder of the trench shall be filled with excavated material.

805.13 Foundations

Foundations for traffic signal poles, 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.

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

When the installation is completed, all disturbed portions of sidewalk, pavement, shoulders, driveways, sod, etc., 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. (300 mm) in width.

805.15 Method of Measurement

Traffic signal head, pedestrian signal head, pedestrian push button, controller cabinet foundation, M foundation modified to P-1 foundation signal steel strain pole, signal wood pole, signal cantilever structure, signal support foundation, signal service, disconnect hanger, magnetometer detector, microloop detector, loop detector delay amplifier, signal handhole, signal detector housing, span catenary and tether, and span catenary for flasher will be measured by the number of units installed.

Conduit of the type specified will be measured by the linear foot (meter) from outside to outside of foundations. Signal cable and signal interconnect cable will be measured by the linear foot (meter).

The accepted quantities for payment for electrical signal or loop lead-in cable will be the quantities shown in the Schedule of Pay Items. Such quantities may be corrected if they are in error by more than 25%.

Saw cut for roadway loop detector and sealant will be measured by the linear foot (meter) for the full depth of slot cut in the pavement as shown on the plans or as directed.

If class X material is encountered during foundation excavation, measurement will be made in accordance with 206.10.

Traffic signal installation or modernization, flasher installation or modernization, miscellaneous equipment for traffic signals, and final cleanup in accordance with 805.14 will not be measured for payment.

805.16 Basis of Payment

Traffic signal installation, flasher installation, traffic signal modernization, and flasher modernization, all of the type and the location number specified, will be paid for at a contract lump sum price.

If specified as pay items, traffic signal controller and cabinet, traffic signal head, pedestrian signal head, pedestrian push button, controller cabinet foundation, M foundation modified to P-1 foundation, signal steel strain pole, signal wood pole, signal cantilever structure, signal support foundation, signal pedestals, signal service, disconnect hanger, magnetometer detector, microloop detector, loop detector delay amplifier, signal handhole, signal detector housing, span catenary and tether, and span catenary for flasher will be paid for at the contract unit price per each. Conduit of the type specified, signal cable, interconnect cable, electrical signal cable, loop lead-in cable, and saw cut for roadway loop detector and sealant will be paid for at the contract unit price per linear foot (meter).

Class X excavation will be paid for in accordance with 206.11.

Miscellaneous equipment for traffic signals will be paid for at a contract lump sum price.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Controller and Cabinet, _____ (type), _____ (no.) Phase	EACH
Controller and Cabinet, Flasher, _____ (type)	EACH
Controller Cabinet Foundation, _____ (type)	EACH

Controller Cabinet Foundation, M, Modify to P-1 .....EACH
Disconnect Hanger .....EACH
Flasher Installation, Location No. _____ .....LS
Flasher Modernization, Location No. _____ .....LS
Handhole, Signal .....EACH
Loop Detector Delay Amplifier, _____ Channel .....EACH
no.
Magnetometer Detector .....EACH
Microloop Detector .....EACH
Miscellaneous Equipment for Traffic Signals .....LS
Pedestrian Push Button .....EACH
Pedestrian Signal Head, _____, _____ .....EACH
type lens size
Saw Cut for Roadway Loop and Sealant .....LFT (m)
Signal Cable, _____, No. _____ Copper, _____ C/ _____ .....LFT (m)
type conductors/size
Signal Cantilever Structure, Mast Arm _____ ft (m) .....EACH
length
Signal Detector Housing .....EACH
Signal Interconnect Cable, ____, No. ____ Copper, ____ C/ ____ .....LFT (m)
type conductors/size
Signal Pedestal, _____ ft (m) .....EACH
length
Signal Pole, Wood, _____, _____ ft (m) .....EACH
class length
Signal Service .....EACH
Signal Strain Pole, Steel, _____ ft (m) .....EACH
length
Signal Support Foundation, _____ in. (mm) x _____ in. (mm)
x _____ in. (mm) .....EACH
Span and Catenary for Flasher .....EACH
Span, Catenary, and Tether .....EACH
Traffic Signal Head, _____ Way, _____ Section, _____ .....EACH
no. no. lens sizes & colors .....EACH
Traffic Signal Installation, _____, Location No. _____ .....LS
type
Traffic Signal Modernization, _____, Location No. _____ .....LS
type

The cost of all wiring, hardware, anchor bolts, and associated equipment required to operate the intersections shall be included in the cost of controller and cabinet, flasher.

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 or pedestrian signal head.

The cost of the push button, pedestrian actuated signal sign, and all hardware required to complete the installation shall be included in the cost of pedestrian push button.

The cost of concrete, conduits, grounding bushings, ground rod, ground wire, drainage, and all hardware required to complete the installation shall be included in the cost of controller cabinet foundation.

The cost of the base plate, metal skirt base plate, anchor bolts, handhole and cover grounding lug, 2 in. (50 mm) pipe cable entrance, J hook, and top cover as shown on the plans shall be included in the cost of signal strain pole, steel.

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, wood.

The cost of 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 signal cantilever structure.

The cost of concrete, reinforcing steel, conduits, ground rod, ground wire, grounding bushings, and all hardware required to complete the installation shall be included in the cost of signal support foundation.

The cost of the pedestal metal base, pedestal pole, pole cap when necessary, anchor bolts, and all hardware required to complete the installation shall be included in the cost of signal pedestal.

The cost of weatherhead, 1 in. (25 mm) conduit riser, entrance switch, 1 in. to 2 in. (25 mm to 50 mm) 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 the detector unit, lead-in cable, and all work necessary for proper installation shall be included in the cost of magnetometer detector or microloop detector.

The cost of the slot cut on the pavement, sash cord, 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 as shown on the plans or as directed shall be included in the cost of signal cable and signal interconnect cable.

The cost of the independent shelf mount unit or card-rack unit, and power module shall be included in the cost of loop detector delay amplifier.

The cost of concrete reinforcing pipe, ring and cover eye bolts, hardware, handhole bottom, and aggregate under the handhole bottom as shown on the plans shall be included in the cost of handhole, signal.

The cost of aluminum casting, enclosure concrete, steel conduit and elbow, and all hardware required to complete the installation shall be included in the cost of signal detector housing.

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 for signal, or span and catenary for flasher.

The cost of excavation, backfill, final cleanup in accordance with 805.14, 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.

807.02 Maintenance of Highway Illumination

Existing highway illumination shall be maintained on all projects unless discontinuance of the highway illumination is specifically permitted.

MATERIALS

807.03 Materials

Materials shall be in accordance with the following:

Casting for Handholes.....922.08
Coarse Aggregate, Class D or Higher, Size No. 53 904
Concrete, Class A.....702
Conduit.....922.10
Highway Illumination Materials 920.01
Line Hardware.....922.06(a)
Paint.....909
Reinforced Concrete Pipe 907.02
Reinforcing Steel.....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.

All flexible conduit shall be galvanized steel, polyvinyl jacketed, and watertight.

Reinforcing steel shall be epoxy coated.

CONSTRUCTION REQUIREMENTS

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 (0.6 m). 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. (13 mm). 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. (700 mm) and backfilled with a 3 in. (75 mm) compacted layer of sand or earth containing no particles that would be retained on a 1/4 in. (6.3 mm) sieve. No extra payment will be made for this additional excavation or backfill.

(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).

(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.

807.05 Backfilling

Wherever practicable, 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. (150 mm), loose measurement. The first layer shall be sand or earth containing no particles or lumps that would be retained on a 1/4 in. (6.3 mm) sieve. The second layer shall contain no particles or lumps that would be retained on a 1 in. (25 mm) sieve. Subsequent layers shall contain no particles or lumps that would be retained on a 3 in. (75 mm) sieve. The second layer and each subsequent layer shall be compacted with pneumatic hand tamps to the satisfaction of the Engineer to prevent any future settlement of the backfilled area. Backfilling of cable-duct and conduit trenches around lighting standard 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.

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 permit the passage of the cable-duct being used.

Conduit installed under pavement shall extend a minimum of 2 ft (0.6 m) beyond the edge of the paved surface or improved shoulder. The ends of such conduit shall terminate a nominal 2 ft (0.6 m) 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.

Conduits installed in bridge railing concrete sections shall terminate a minimum of 2 ft (0.6 m) beyond the end of the bridge railing outside of the paved surface and a minimum of 2 ft (0.6 m) 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 permitted. Pipe straps of the proper size shall be installed 4 ft (1.2 m) center to center along the conduit. When fastening pipe straps to concrete, a 3/8 in. by 2 1/2 in. (9.5 mm by 63 mm) 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.

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 (0.6 m) below ground level with a threaded grounding bushing fitting. Unless otherwise directed, the weatherhead shall be

24 ft (7.3 m) above the ground. However, the actual elevation of the weatherhead shall meet the requirements of the utility concerned.

807.07 Connections in Base of Lighting Standards

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 permitted. 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.

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" 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:

(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";

(d) a spring loaded, 90% minimum conductivity, contact suitable for gripping the "KTK" 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;

(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.

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 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 Through Cable-duct

All underground distribution conductors shall be continuous runs between splice points. Unless otherwise authorized, splice points shall be inside the bases of lighting standards, 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. Cable-duct

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 permit withdrawal of a conductor and the installation of new conductor without additional excavation or backfill.

Plowed cable-duct shall be installed at a minimum depth of 2 ft (0.6 m) 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 permitted. Where two ducts are to be installed parallel to each other, the distance between them shall be no less than 12 in. (300 mm) nor more than 24 in. (600 mm).

The plastic duct of the cable-duct shall be terminated 4 in. (100 mm) above the top of foundations or 4 in. (100 mm) inside handholes with sufficient excess conductors as directed. All terminations of this plastic duct shall be beveled free from any sharp edges or burrs. Insulation of the electrical conductor shall not be damaged when cutting the duct.

2. 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 (122 m) intervals on straight runs. Cable markers shall be a slab of concrete 2 ft (0.6 m) square by 4 in. (100 mm) thick, with the word "Cable" die impressed into the surface of the marker, a minimum depth of 3/8 in. (10 mm) with letters a minimum of 2 in. (50 mm) high. Arrows showing the direction of the cable shall be die impressed or sawcut a minimum depth of 3/8 in. (10 mm) 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) Underground Through 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.

1. Cable-duct

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 permit the duct to be cut away and the conductors installed in the conduit with a minimum of 2 ft (0.6 m) 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.

2. Cable Markers

Cable markers shall be in accordance with 807.08(a)2.

(c) 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.(75 mm) 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 with sufficient excess to make the required connections.

(d) 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 (0.6 m) of duct extended into the conduit. The conductors, through this transition, shall be continuous between authorized splice points. Where more than one lighting standard is to be installed on the same side of the bridge structure and connected to the same distribution circuit, the cables pulled between these lighting

standards shall be of the same type and size used in the cable-duct underground distribution circuit.

(e) 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 (5.5 m).

807.09 Lighting Handholes

Handholes shall not be placed in areas subject to flowing or ponding water. 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.

Heavy weave fiberglass reinforced polymer concrete service boxes will be permitted as an acceptable substitute for a street and alley handhole providing that they 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

(b) it is located a minimum of 15 ft (4.6 m) from the edge of pavement, unless it is protected by guardrail, unmountable curb, a structure, or an untraversable ditch.

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 Lighting Standards

Foundations shall be class A concrete in accordance with 702. Footings may be either round or square in shape as shown on the plans.

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 lighting standard is perpendicular to the center line of the roadway.

Each foundation installation shall have provisions for grounding the lighting standard in accordance with 807.12. The tops of the concrete foundations shall be constructed level and only shims used to rake the lighting standard will be permitted. Shims will not be permitted 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.

Foundations for high mast towers shall be constructed prior to constructing foundations for conventional roadway lighting.

(a) Cast-in-Place Foundations

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. (150 mm) 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. (150 mm) 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. (300 mm) 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 lighting standard after installation. The grounding coil, as shown on the plans, may be used for grounding lighting standards set on precast foundations. Foundation backfill shall consist of coarse aggregate No. 53.

(c) Grading of Foundations

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 Lighting Standards

(a) Lighting Standards Under 80 ft (24 m) in Height

The lighting standard 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 mars, 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 will not be permitted for lifting devices. If damage to the factory finish occurs, repair or replacement shall be as directed.

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 Standard Specifications for Structure 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 will not be permitted with breakaway couplings. Shimming will be permitted 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 permit the 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 Lighting Standards of 80 ft (24 m) Height and Over

High mast light 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 (44.5 kN) per side. Field assembly procedures and assembly apparatus requirements shall be submitted for approval. Field welds will not be permitted except where shipping 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. (6.5 mm) within any 10 ft (3 m) of height.

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 (0.9 m) 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.

807.12 Grounding

Ground wire shall be No. 6 solid bare copper. Ground rods shall be 1/2 in. (13 mm) diameter by 8 ft (2.4 m) long copper weld ground electrodes except where larger sizes are specified. The top of the ground rod shall be driven at least 6 in. (150 mm) below grade. Ground rods shall not be installed within the lighting standard, sign structure, or high mast tower foundations.

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 contaminates 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.

Luminaire standards 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.

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 Luminaire Installation

Luminaire installation shall consist of the physical placing of the luminaire. Each installation shall include the furnishing and placing of the lamp as designated.

(a) Roadway Luminaires

Each luminaire shall be leveled in both directions in the horizontal plane after the light standard 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. Lamp socket positions may be shown on the plans by type of Illuminating Engineering Society of North American (IES) light pattern. The specified lamp socket position shall be used to obtain the desired light pattern delivery. Proper connections shall be made to provide ballast operation at the voltage being supplied. Replacements needed because of faulty or incorrect voltage connections shall be made with no additional payment.

(b) 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 receive one coat of inorganic zinc primer followed by one coat of aluminum paint. All paint shall be permitted to dry 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. (180 mm). 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 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.

(c) 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 to

balance the load. Conductor splicing will only be allowed in junction boxes, in-ground handholes, and circuit breaker enclosures.

(d) High Mast Luminaires

The aiming of the luminaires shall be as shown on the plans. When the aiming process is being done the luminaire shall be oriented to conform to its raised position and the ring properly tethered to prevent rotation during the aiming adjustment. The long axis of the luminaire shall be parallel to the aiming direction indicated on the plans.

807.14 Sign, Underpass, Roadway, and High Mast Lighting Location Identification

All high mast towers, roadway light standards, 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.

The code number shall be displayed on the light standard, 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 lighting standard 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.

807.15 Service Point Power Entry

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 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.

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

This service point installation shall consist of class 5 wood pole, 2 3/4 in. (70 mm) galvanized steel conduits, weatherhead, photo cell 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 (1.2 m). The conductors outside of the weatherhead shall be ringed to prevent moisture from entering the conduit enclosure.

2. Type II Service Point

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 807.07(c). 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

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.

(c) Multiple Relay Switches

Unless otherwise specified, wood pole, multiple relay switches, service cabinet, photocells, photocell receptacles, weatherhead, conduit, and other miscellaneous items shall be furnished and installed as a part of the service point.

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. 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.

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.

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.

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 permitted for each complete circuit.

(b) Testing and Inspecting Luminaires

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.

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 delivered to the pavement by roadway and high mast 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.

807.17 Pay Item and Installation Summary Sheets

Prior to final inspection, two sets each of shop drawings, installation summary, and pay item summary marked Final Record shall be furnished for the light standards as installed. The installation summary shall show the effective mounting height, arm length, foundation elevation, pay item, type of base, and catalog number or drawing for each light standard furnished. The pay item summary shall indicate the pay item, quantity, effective mounting height, arm length, and type of base for each type of lighting standard furnished.

807.18 Method of Measurement

Luminaire, light standard with mast arm, high mast standard, 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 (meter). Pole circuit conductor will be measured from the base of the lighting standard 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 (meter) from end to end of conduit or from the end of conduit to the last bridge light pole foundation entry. An allowance of 5 lft (1.5 m) will be made for each foundation entry. An allowance of 2 lft (0.6 m) 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 (meter) as follows:

(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 (1.5 m) will be made for each entry at foundations. An allowance of 2 lft (0.6 m) will be made at handholes for connection purposes.

(b) From lighting standard bases or handholes to switch boxes at underpasses. An allowance of 4 lft (1.2 m) will be made at the switch box for electrical connections.

(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 of 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 and wattage 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.

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.

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.

Wire will be paid for at the contract unit price per linear foot (meter) for the designation, copper gage, housing, and number of conductors specified. Pole circuit cable, THWH, stranded will be paid for at the contract unit price per linear foot (meter) for the copper gage and number of conductors specified. Conduit, steel, galvanized, 2 in. (50 mm) diameter will be paid for at the contract unit price per linear foot (meter).

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Cable-Duct Marker	EACH
Cable, Pole Circuit, THWH, No. _____ Copper Stranded, _____ _____/C	LFT (m)
Circuit Installation, Str. No. _____, _____ Luminaires (no.)	EACH
Conduit, Steel, Galvanized, 2 in. (50 mm)	LFT (m)
Connector Kit, Fused	EACH
Connector Kit, Unfused	EACH
Handhole, Lighting	EACH
High Mast Tower Winch Drive	EACH
Insulation Link, Non-waterproofed	EACH
Insulation Link, Waterproofed	EACH
Lighting Foundation, Concrete, with Grounding, _____ in. (mm) x _____ in. (mm) x _____ in. (mm)	EACH
Light Pole, High Mast, _____ ft (m) E.M.H.	EACH
Light Pole, Roadway, _____ ft (m) E.M.H., _____ ft (m) Mast Arm, _____ Base	EACH
Light Structure, Remove	EACH
Luminaire, High Mast, _____, _____ Watt (type)	EACH
Luminaire, Roadway, _____, _____ Watt (type)	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, _____ (designation), No. _____ Copper, in _____ (housing), _____ _____ /C	LFT (m)

The cost of lamps, ballast, optical systems, weatherproof housings, and electrical connections shall be included in the cost of luminaire.

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 on the foundation with the pole circuit, and luminaire installation shall be included in the cost of light pole.

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 light pole, high mast. The cost of excavation, concrete, sleeves for cable-duct, non-metal pipe, reinforcing steel, backfill, finish grading, and sodding shall be included in the cost of lighting foundation.

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, wood poles, and incidentals required to complete the pole line extension shall be included in the cost of cable, pole circuit.

The cost of snap-on covering in light pole base and waterproof covering in underground handhole shall be included in the cost of multiple compression fitting.

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.

The cost of maintaining highway illumination during the life of the contract shall be included in the cost of other pay items.

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.

MATERIALS

808.02 Materials

Materials shall be in accordance with the following:

Cones.....801.08
Epoxy .....921.02(c)

Glass Beads .....921.02(e)
Preformed Plastic .....921.02(b)
Snowplowable Raised Pavement Markers .....921.02(d)1
Thermoplastic.....921.02(a)
Traffic Paint 909.05

CONSTRUCTION REQUIREMENTS

808.03 General Requirements

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. The markings shall be of the same material as the existing pavement markings or any durable pavement marking material.

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 epoxy markings may be applied over sound existing markings of the same type if permitted 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.

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 (30 m). 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

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 (3 m) line segments with 30 ft (9 m) gaps.

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.

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) 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. (100 mm) 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. (100 mm) from the geometric centerline.

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. (200 mm) apart and shall be equally offset on opposite sides of the geometric centerline.

The center line of a 2-lane, 2-way roadway, where passing is allowed in both directions, shall be marked with a broken line.

The center line of a 2-lane, 2-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. (200 mm) 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 permitted.

(b) Lane Lines

Lane lines shall be used to separate lanes of traffic moving in the same direction. Normal lane line markings shall be white in color and shall be 5 in. (125 mm) wide on freeways, interstates and toll roads, and 4 in. (100 mm) wide on all other roads. They shall be offset 4 in. (100 mm) to the right of longitudinal pavement joints or divisions between traffic lanes. Normal lane lines shall be marked with white broken lines. White solid lines shall be used to mark lane lines only when specified or directed.

(c) Edge Lines

Edge lines shall be used to outline and separate the edge of pavement from the shoulder. Edge line markings shall be 4 in. (100 mm) in width and shall be placed such that the edge of the marking nearest the edge of the pavement shall be offset 4 in. (100 mm) 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.

(d) Barrier Lines

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.

808.05 Transverse Markings

(a) Transverse marking lines shall be used as specified or directed to delineate channelizing lines, stop lines, crosswalk lines, and parking limit lines. The markings shall consist of all necessary lines, of the width specified or directed and shall be in accordance with the MUTCD.

(b) Pavement message marking shall be used as specified or directed for railroad crossing approaches, intersection approaches, crosswalk approaches, handicap parking spaces, 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.

808.07 Pavement Marking Material Application and Equipment

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.

Stop lines and crosswalk lines for new or modernized traffic signal installations shall be durable pavement marking material. For this application, preformed plastic may be used on concrete if permitted by manufacturer's recommendations. However, for contract completion dates in winter months when conditions do not permit application of durable markings, traffic paint markings may be substituted with an appropriate unit price adjustment if approved by the Engineer.

(a) Traffic Paint

1. Application

Standard dry and fast dry traffic paint shall be applied only when the pavement temperature is 40°F (5°C) or above. Waterborne traffic paint shall be applied only when the pavement temperature is 50°F (10°C) or above. Standard dry or fast dry traffic paint will only be permitted between October 1 and the following April 30.

The wet film thickness of the traffic paint shall be a minimum of 15 mils (380 µm). Painted lines and markings shall be immediately reflectorized by applying glass beads at a uniform minimum rate of 6 lb/gal. (0.7 kg/L) of traffic paint.

Painted markings on newly constructed surfaces shall receive two applications of paint and glass beads. The second application shall be applied as soon as practical after the first application dries.

2. Equipment

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 machine shall be equipped with the following: an air blast device for cleaning the pavement ahead of the painting operation; a guide pointer to keep the machine on an accurate line; at least two spray guns which can be operated individually or simultaneously; paint agitator(s); 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 glass bead dispenser which is synchronized with the marking application. When fast drying traffic paint or

waterborne traffic paint is used, the machine shall be capable of heating the paint to application temperatures in accordance with 909.05.

A brush or small hand propelled machine, designed for that purpose, may be used if approved to apply some painted markings.

(b) Durable Pavement Marking Material

Durable pavement marking material consists of thermoplastic, preformed plastic, or epoxy.

1. Thermoplastic

a. Application

Thermoplastic marking material shall be used on asphalt pavements unless otherwise specified or directed. The pavement surface shall be primed with a binder material in accordance with the manufacturer's recommendations. Thermoplastic marking shall be applied in molten form by spray, extrusion, or ribbon type extrusion airless spray when the pavement temperature is 50°F (10°C) or above. The average thickness of each 36 in. (910 mm) length of thermoplastic marking shall be no less than 3/32 in. (2.5 mm) nor more than 3/16 in. (5 m). Immediately following the application of the thermoplastic markings, additional reflectorization shall be provided by applying glass beads to the surface of the molten material at a uniform minimum rate of 6 lb/100 sq ft (2.9 kg/10 m^2) of marking.

b. Equipment

The machine used for the spray 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 preheating and applying the material shall maintain a uniform material temperature within the specified limits, without scorching, discoloring or overheating any portion of the material.

The 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 glass bead dispenser which is synchronized with the marking application.

2. Preformed Plastic

a. Application

The Contractor shall provide the Department with original copies of all necessary current manufacturer's installation manuals prior to beginning installation work. No installation work shall begin prior to the Department's receipt of these manuals. These manuals will become the property of the Department.

Preformed plastic shall be applied when the air temperature is a minimum of 60°F (16°C) and rising, and the pavement temperature is a minimum of 70°F (21°C). Preformed plastic shall not be applied if the ambient temperature is expected to drop to

below 45°F (7°C) within 24 h after application. The pavement surface shall be primed with a binder material in accordance with the manufacturer's recommendations. The pavement surface shall be primed prior to the placement of preformed plastic transverse markings.

If there is a dispute regarding installation, the manufacturer shall provide a properly trained representative to ensure that the installation is performed in accordance with the manufacturer's recommendations.

b. Equipment

The equipment for applying preformed plastic, furnished in rolls, shall be a portable hand-propelled machine capable of carrying and applying at least two rolls of 4 in. (100 mm) to 16 in. (50 mm) widths. The machine shall be equipped with a guide pointer to keep the machine on an accurate line. The machine shall also be equipped with guide rollers and a pressure roller. The pressure roller may be a separate unit. The machine shall feed the marking material from its original carton through the guide rollers and under the pressure roller onto the pavement. The pressure roller shall be a minimum of 2 in. (50 mm) wider than the width of the marking material and shall weigh a minimum of 200 lb (91 kg). The machine shall also be capable of removing the backing paper from the marking material during the application process. Preformed plastic furnished in strip, symbol, or legend form shall be applied with suitable equipment such as hand rollers.

3. Epoxy

a. Application

Epoxy shall be used on portland cement concrete pavement unless otherwise specified or directed. This material shall be applied only when the pavement temperature is 40°F (5°C) or above. The wet film thickness of the epoxy marking material shall be a minimum of 15 mils (380 µm). Immediately following the application of the epoxy markings, additional reflectorization shall be provided by applying glass beads to the surface of the wet marking at a uniform rate of 20 lb/100 sq ft (9.8 kg/10 m^2) of marking.

b. Equipment

The machine used to apply the epoxy marking material shall precisely meter the two components, produce and maintain the necessary mixing head temperature within the required tolerances, all in accordance with the manufacturer's recommendations. The machine shall be equipped with a high pressure water blast device ahead of a high pressure air blast device, both as an integral part of the gun carriage, for cleaning the pavement ahead of the marking application. The machine shall also be equipped with the following: a guide pointer to keep the machine on an accurate line; at least two spray guns which can be operated individually or simultaneously; an automatic device which will provide a broken line of the required length; and automatic glass bead dispensers which is synchronized with the marking application.

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

Each vehicle in the marking operation shall display the slow moving vehicle emblem when operating at speeds of 25 mph (40 km/h) or less. The slow moving emblems shall be removed when the vehicles are operating at speeds greater than 25 mph (40 km/h). The paint crew signs shall be 24 in. (600 mm) high by 96 in. (2400 mm) wide, with 12 in. (300 mm) 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

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:

	40 MPH or less	Over 40 MPH
Broken Lines	every line segment	every 5th line segment
Solid Lines	20 ft to 30 ft (6 m to 9 m)	

(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 (3 m) above the pavement.

(e) Marking Application Vehicles

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 (3.7 m) 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 (30 to 150 m). If an additional rear escort vehicle is required due to drying time or heavy traffic volume, it shall follow the first rear escort

vehicle at a maximum distance of 1,000 ft (300 m), 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 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. The material shall be warranted to retain its color, reflectivity, adherence to the pavement and shall be free of other obvious defects or failures.

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 (305 m) section of line of specified width in any combination or pattern.

The warranty period shall be 180 days beginning with the last working day for the total contract as defined in the final acceptance letter, 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.

On Federal aid contracts, the 180 day warranty shall apply only to thermoplastic pavement marking material.

808.10 Removal of Pavement Markings

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 permitted. Grinding will only be permitted when removing thermoplastic or epoxy pavement markings. Painting over existing pavement markings to obliterate them will not be permitted.

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 permitted.

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.

(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

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.

(d) Installation

Marker installation shall be in accordance with the manufacturer's recommendations. The pavement surface temperature and the ambient temperature shall be at least 50°F (10°C). 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.

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.

(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 jack hammer or other approved equipment. Care shall be taken so as not to damage the marker base during its removal. The area of the pavement or bridge deck disturbed by the marker removal shall not exceed 3 in. (75 mm) in depth nor 3 in. (75 mm) out from all sides of the marker base. The marker removal operation shall stop if it is determined that excessive damage is occurring to the pavement, bridge deck or marker base.

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 magnesium phosphate concrete patching material. 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 remain the property of the Department unless otherwise specified.

Removed snowplowable raised pavement markers shall be delivered to the District Traffic Division. The markers shall be delivered in 55 gal (210 L) metal containers with lids which may be sealed. The metal containers shall be furnished either by the Contractor or by the District Traffic Division as specified in the contract. Approximately 50 markers shall be placed in each container. Each container shall be labeled as to how many markers it contains.

All metal containers used for delivering removed markers will remain the property of the Department when no longer required for the contract.

(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 lines, placed or removed, will be measured as 1/4 of the total distance in linear feet (meters) of the broken line pattern after excluding gaps for intersections or other openings. Solid lines will be measured as the total distance in linear feet (meters) of

solid lines placed or removed. The material, type, color, or width of broken or solid lines to be removed will not be considered when measuring such lines for payment.

Transverse marking lines will be measured as the total distance in linear feet (meters) of lines placed or removed. Curb markings will be measured by the linear feet (meters) along the front face of the curb. The "No Parking Any Time" sign will be measured in accordance with 802.11. 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 will be measured by the number of lane indication arrowheads placed. Removal of pavement message markings will be measured in square yards (square meters) using areas shown in the following table. The material will not be considered when measuring such markings for pavement.

Pavement Message Markings Table

Description	Area
"Ahead"	3.1 SYS (2.6 m2)
Combo Arrow	3.1 SYS (2.6 m2)
"Exit"	2.5 SYS (2.1 m2)
"Left"	2.5 SYS (2.1 m2)
"Only"	2.5 SYS (2.1 m2)
Railroad "R"	0.6 SYS (0.5 m2)
"Right"	3.2 SYS (2.7 m2)
"RXR"	7.7 SYS (6.4 m2)
"School"	3.9 SYS (3.3 m2)
"Stop"	2.6 SYS (2.2 m2)
Straight Arrow	1.4 SYS (1.2 m2)
"Turn"	2.6 SYS (2.2 m2)
Turn Arrow	1.7 SYS (1.4 m2)
"XING"	2.5 SYS (2.1 m2)

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 2-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

Lines and transverse markings placed will be paid for at the contract unit price per linear foot (meter) for the material, type, color, and width specified. Curb markings will be paid for at the contract unit price per linear foot (meter) for curb painting, of the color specified. The "No Parking Any Time" sign will be paid for in accordance with 808.13. 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 (meter). Pavement message markings removed will be paid for at the contract unit price per square yard (square meter).

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 2-way prismatic reflector will be paid for as one reflector.

If no pay items are shown in the Schedule of Pay Items for the required permanent pavement markings, a change order will be executed.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Curb Painting, _____ (color)	LFT (m)
Line, _____, _____, _____, _____ in. (mm) (material, type, color, width)	LFT (m)
Line, Removed	LFT (m)
Pavement Message Marking, _____, _____ (material, message)	EACH
Pavement Message Marking, Remove	SYS (m2)
Prismatic Reflector	EACH
Snowplowable Raised Pavement Marker	EACH
Snowplowable Raised Pavement Marker, Remove	EACH
Transverse Marking, _____, _____, _____, _____ in. (mm) (material, type, color, width)	LFT (m)
Transverse Marking, Remove	LFT (m)

No additional payment will be made for the second application of traffic paint and glass beads as required in 808.07(a)1.

The cost of metal containers for disposal of removed snowplowable raised pavement markers, if furnished by the Contractor, shall be included in the cost of other pay items. The cost of picking up and returning such metal containers, if furnished by the District Traffic Division, shall be included in the cost of other pay items.

The cost of delivering removed and packaged snowplowable raised pavement markers to the designated location shall be included in the cost of transportation of salvageable materials.

The cost of removal of existing prismatic reflectors shall be included in the cost of prismatic reflectors.

Glass beads, binder material for thermoplastic and preformed plastic, adhesive for snowplowable markers, patching material for snowplowable marker removal, pavement cleaning, removal of excess or loose existing pavement marking material where new

pavement markings are being placed in the same locations, 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

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

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.

One laminated 11 x 17 in. (280 x 430 mm) 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

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 cable shall be routed and bundled separately from shielded control cables: i.e. logic voltage, video cables, RF cables, etc.

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 in the plans.

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 3 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 2 full threads of all terminal screws shall be fully engaged when the screw is tightened. No live parts shall extend beyond the barrier.

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 Contactor shall complete, sign, and date the forms before submitting them to the ITS Electronics Technician. All necessary equipment and personnel shall be provided to ensure the tests are safely conducted. The Electronics Technician must be present to witness the tests. A cabinet must 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

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 conditions.

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

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	EACH
ITS Controller Cabinet Foundation	EACH

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.

SECTION 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.

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.

Different kinds or brands of cement, or cement of the same brand from different mills, even if tested and approved, shall not be mixed during use unless permitted, and then only as directed. They shall not be used alternately in any one pour for any structure, unless otherwise permitted.

(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 ISA
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-Pozzolan Cement	AASHTO M 240, Type IP
Slag Modified Portland Cement, Type ISM	AASHTO M 240

The exceptions to AASHTO M 240 are as follows:

a. The amount of pozzolan shall be limited to 20% ± 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 C 618, class C or class F with the loss on ignition of the pozzolan limited to a maximum of 3%.

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

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 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 Materials and Tests Division prior to supplying such cement. A list of Qualified Manufacturers and Manufacturer/Distributors 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.

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

Cement manufacturers requesting to be qualified to supply cement shall provide the following:

(1) For the initial qualification, the manufacturer shall provide to the Materials and Tests Division 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 years production. A current Material 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 Materials and Tests Division. 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____".

c. Requirements for Foreign Source Qualification

Foreign cement manufacturers or their domestic distributors requesting to be qualified to supply cement shall provide the following:

(1) For the initial qualifications, the manufacturer and distributor shall provide to the Materials and Tests Division 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 must 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, etc.

(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 must fully comply with the required material specifications. If not, this requirement will be continued for subsequent cement shipments until five consecutive 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 Materials and Tests Division. If no cement shipments are received during a given month, the monthly submittal shall state "No cement was received during the month of _____, 20____".

d. Certification

Only qualified manufacturers and manufacturer/distributors as identified by the Department's list of Qualified Manufacturers and Manufacturer/Distributors 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.

(c) Masonry Cement

Masonry cement shall be in accordance with ASTM C 91, except the air content test and the water retention test may be waived.

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 powered 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.

Fly ash will be accepted from one of the sources on the Department's list of approved Fly Ash and Ground Granulated Blast Furnace Slag 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

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), Maximum % 3
Autoclave Expansion or Contraction, Maximum % 0.5
Fineness: Amount retained when wet-sieved on No. 325
(45 µm) sieve, Maximum % 30

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 (1800 Mg) 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 C 311 or other methods approved in writing by the Department.

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.

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 C 114 using NIST Fly Ash reference materials.

3. Documentation

Fly ash suppliers requesting approval shall supply the following:

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.

d. Certification:

(1) For source approval, the supplier shall furnish a certification 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 set out 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.

901.03 Ground Granulated Blast Furnace Slag Used As a Pozzolan

(a) General

Blast furnace slag 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 ground granulated blast furnace slag.

Ground granulated blast furnace slag will be accepted from one of the sources on the Department's list of approved Fly Ash and Ground Granulated Blast Furnace Slag Sources. Ground granulated blast furnace slag from different sources or different grades of ground granulated blast furnace slag shall not be mixed or used alternately in the same construction unless approved in writing. Ground granulated blast furnace slag 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 ground granulated blast furnace slag source approval.

(b) Acceptance Criteria

Ground granulated blast furnace slag 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

The ground granulated blast furnace slag shall be in accordance with ASTM C 989 for grade 100 or 120.

For each 2,000 t (1800 Mg) produced, a complete ASTM C 989 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 C 989 or other methods approved in writing by the Department.

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 analytical balances and scales shall be calibrated each year.

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 C 114 using NIST reference materials.

3. Documentation

Ground granulated blast furnace slag suppliers requesting approval shall supply the following:

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 ground granulated blast furnace slag 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 ground granulated blast furnace slag which is in accordance with the requirements. This QCP will be reviewed to determine its adequacy.

d. Certification:

(1) For source approval, the supplier shall furnish a certification indicating the grade of ground granulated blast furnace slag, the name, location, and type of manufacturing facility. It shall state that the ground granulated blast furnace slag 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 included in ITM 804.

(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 ground granulated blast furnace slag represented by these results.

901.04 Silica Fume Used As a Pozzolanic Mineral Admixture

(a) General

Silica fume will be accepted from one of the suppliers on the Department's list of approved Pozzolanic Suppliers. 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

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 µm) sieve, in accordance with ASTM C 1240, shall be conducted.

c. The oversize, amount retained on the No. 325 (45 µm) sieve, shall not be more than 10%.

d. Accelerated pozzolanic activity index, in accordance with ASTM C 1240, shall be conducted in lieu of strength activity index.

e. The accelerated pozzolanic activity index shall be a minimum of 85% at seven days.

f. The increase of drying shrinkage of mortar bars at 28 days shall be conducted in accordance with ASTM C 1240.

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 (400 Mg) of material produced. Test results for moisture content, and loss on ignition, shall be furnished for each sample.

b. For each 2000 t (2000 Mg) 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.

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.

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 Materials and Tests Division:

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.

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 Materials and Tests Division to determine its adequacy.

d. Certification:

(1) For approval, the supplier shall furnish a certification 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 set out in ITM 804.

(2) For certification of test reports, the results generated in accordance with 901.04(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 silica fume represented by these results.

901.05 Chemical Anchor System

Chemical anchor systems shall be furnished from the Department's list of approved Chemical Anchor Systems. Chemical anchor systems may be added to the approved list by completing the requirements of ITM 806, Procedure F and passing required laboratory testing.

(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 (#22), grade 60 (400), epoxy coated, deformed steel reinforcing bar.

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

PCC sealer/healers shall be furnished from the Department's list of approved PCC Sealer/Healers. PCC sealer/healers may be added to the approved list 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.

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 (3800 kPa).

4. The viscosity of PCC sealer/healers shall be sufficient to penetrate a crack 1/32 in. (0.8 mm) wide and 6 in. (150 mm) in depth.

(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 Department's list of approved Rapid Setting Patch Materials. A rapid setting patch material may be added to the approved list by completing the requirements in ITM 806, Procedure F.

(a) Normal Weather Mixes

Normal weather rapid setting patch materials shall be used for ambient temperatures of 32 - 85°F (0 - 30°C).

(b) Hot Weather Mixes

Hot weather rapid setting patch materials shall be used for ambient temperatures above 85°F (30°C).

(c) Requirements

Rapid setting patch materials shall be capable of being utilized in patches ranging from 1 in. (25 mm) to full depth without bonding agents, no curing material shall be required, and shall be capable of being surface sealed with an epoxy sealer.

These products shall not contain soluble chlorides as an ingredient of manufacture nor shall they 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 – 60 lb (18 – 27 kg) bags with a neat yield of approximately 0.40 cu yd (0.011 m^3) and shall allow at least a 50% extension, by weight (mass) with a 3/8 in. (10 mm) or a 1/2 in. (13 mm) round aggregate. The minimum shelf life shall be twelve 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.

Rapid setting patch materials shall be in accordance with ASTM C 928 with the following exceptions.

Physical Test	Specification	Requirement
Setting Time	ASTM C 266	
Normal Weather		
Initial at 72°F (22°C)		10 – 20 min
Final at 72°F (22°C)		12 – 35 min
Hot Weather		
Initial at 95°F (35°C)		10 – 20 min
Final at 95°F (35°C)		12 – 35 min
Compressive Strength, Min*	AASHTO T 109	72°F (22°C), Normal
1 h		2000 psi (14 MPa)
2 h		3000 psi (21 MPa)
24 h		5000 psi (34.5 MPa)
28 day		8000 psi (55 MPa)

Compressive Strength, Min*	ASTM C 109	95°F (35°C), Hot
3 h		3000 psi (21 MPa)
24 h		5000 psi (34.5 MPa)
28 days		8000 psi (55 MPa)
Relative Dynamic Modulus	ASTM C 666	
Procedure B 300 cycles		95% Min.
Slant Shear Bond Strength, Min.	ASTM C 882	
28 days		2500 psi (17 MPa)
Flexural Strength, 24 h	ASTM C 78	
mortar only		500 psi (3.5 MPa)
mortar – aggregate extension		600 psi (4.0 MPa)
Shrinkage, Max.	ASTM C 157	
28 days		0.03%
Scaling Resistance		ASTM C 157
5 cycles		0 rating, No scale
25 cycles		0 rating, No scale
50+ cycles		1.5 rating, Lt. scale

* Material used shall be neat rapid setting patch material mixed in accordance with the manufacturer's installation instructions.

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 first of the approval year.

901.08 Packaged, Dry, Combined Materials for Mortar and Concrete

These materials shall be in accordance with ASTM C 387. All packages shall be identified as conforming to ASTM C 387. The markings shall also show the kind and type of material, the net weight in each bag, the yield in cubic feet (cubic meters) or yield in square feet per inch (square meters per millimeter) of thickness, and the amount of water recommended for mixing to produce a 2 in. to 3 in. (50 mm to 75 mm) slump.

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

Performance graded asphalt binders shall be supplied by an approved supplier in accordance with ITM 581.

Performance graded, PG asphalt binders shall be in accordance with the following:

GRADE	PG 58-28	PG 64-22	PG 64-28	PG 70-22	PG 70-28	PG 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 OVER 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 (Note 1)	100	100	100	100	100	100
DSR, G*sin δ (delta), maximum, 5000 kPa, Test Temp. @ 10 rad/s, °C	19	25	22	28	25	31
Physical Hardening (Note 2)	Report					
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 min at 10°C above the minimum performance temperature. The 24 h stiffness and m-value are reported for information purposes only.

1. Appeals

If the Contractor does not agree with the acceptance test results for the lot, a request may be made in writing for additional testing. The appeal shall be submitted within 30 calendar days of receipt of the Department's written results. The basis of the appeal shall include complete AASHTO M 320 test results for the specific sublot in question plus test values from all other sublots for the parameters being disputed.

If an appeal is accepted, the Department will randomly select two additional sublot samples if available from the lot in question. The additional sublot samples if available and the backup sample will be tested in an AASHTO accredited laboratory for the failing test parameters. The backup and additional test results for each test will be averaged. The average value for each test will be considered the final lot value. The

Contractor will be notified in writing of the additional test results, the final lot values, and the appeal conclusions.

If the appeal is not accepted, the Department will respond to the Contractor stating the grounds for the denial.

(b) Asphalt Emulsions

Asphalt emulsions shall be composed of an intimate homogeneous suspension of a base asphalt, an emulsifying agent, and water. 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.

AE-90 is a medium breaking, low-penetration, high-asphalt content type, intended for hot and cold plant mixing, road mixing, and seal coats or as otherwise specified.

AE-90S is a rapid setting, anionic type emulsion for seal coat applications.

AE-150 is a medium breaking, moderately soft penetration type, intended for use in surface treating, tack coats, and coating open and dense graded aggregate, or as otherwise specified.

AE-150-L is a medium-breaking, relatively low-viscosity type. It may be specified in lieu of AE-T or AE-150 when a softer asphalt or greater aggregate penetration is desired. AE-150-L is suitable for sand seals.

AE-PL is a medium-slow-breaking, low-viscosity, low-asphalt content type, intended for use as a prime or as dust palative.

AE-T is a medium-breaking, comparatively low penetration type, intended for tack coats, seed mulching, or as otherwise specified.

HFRS-2 is a quick-breaking, high-viscosity, high-float, relatively high asphalt content type, intended for seal coats.

RS-2 is a quick-breaking, high-viscosity, relatively high-asphalt content type, intended for seal coats.

AE-PMP is a polymerized modified asphalt emulsion intended for use as a prime coat material.

AE-PMT is a polymerized modified asphalt emulsion intended for use as a tack coat material.

The requirements for asphalt emulsions shall be in accordance with the following:

Characteristic [1] [2]	Test Method	RS-2	HFRS-2	AE-90	AE-90S	AE-T	AE-150	AE-150L	AE-PL	AE-PMT [6]	AE-PMP [6]
Test on Emulsion											
Viscosity, Saybolt Furol at 25°C, min.	AASHTO T 72			50			50				20+
Viscosity, Saybolt Furol at 25°C, max.	AASHTO T 72					100		100	115	100	
Viscosity, Saybolt Furol at 50°C, min.	AASHTO T 72	75	75		50		75				
Viscosity, Saybolt Furol at 50°C, max.	AASHTO T 72	400	400				300				
Demulsibility w/35 mL, 0.02N CaC12, %, min.	AASHTO T 59	50	50		30						
Demulsibility w/50 mL, 0.10N CaC12, %, min.	AASHTO T 59			75		75				25+	25+
Oil Distillate by Distillation, mL/100 g Emul [3]	AASHTO T 59	4.0	4.0	4.0	3.0	4.0	7.0	7.0	3.0	3.0	3.0
Residue by Distillation, %, min.	AASHTO T 59	68	68	68	65 [5]	54	68	60	30		
Residue by Distillation, % max.	AASHTO T 59					62		65			
Sieve Test, %, max.	AASHTO T 59	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Penetrating Ability, mm, min.	902.02(w)								6		
Stone Coating Test, %	902.02(t)3a			90			90	90			
Settlement, %, max.	AASHTO T 59	5	5	5							
Storage Stability, %, max.	AASHTO T 59				1						
Asphalt Content by Distillation at 204°C, %, min.										54	45
Asphalt Content by Distillation at 204°C, %, max.										62	
Tests on Residue											
Penetration (0.1 mm) at 25°C, 100g, 5 s, min. [4]	AASHTO T 49	100	100	100	90	50				50	300+
Penetration (0.1 mm) at 25°C, 100g, 5 s, max. [4]	AASHTO T 49	200	200	200	150	200				200	
Penetration (0.1 mm) at 25°C, 50g, 5 s, min. [4]	AASHTO T 49						100	100			
Penetration (0.1 mm) at 25°C, 50g, 5 s, max. [4]	AASHTO T 49						300	300			
Ductility at 25°C, mm, min.	AASHTO T 51	400	400	400		400					
Solubility in Org. Sol., %, min.	AASHTO T 44	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
Float Test at 50°C, s, max. [4]	AASHTO T 50										
Float Test at 60°C, s, min. [4]	AASHTO T 50		1200	1200	1200	1200	1200	1200			
Force Ratio	AASHTO T 300				0.3						
Elastic Recovery, at 4°C	AASHTO T 301				58						
Polymer Content by Infrared										1.5+	1.5+

Notes:
(1) Broken samples or samples more than 10 days old will not be tested.
(2) Combined percentage of the residue and oil distillate by distillation shall be at least 70% (note the different units – ml for oil and % for residue).
(3) Oil distillate shall be in accordance with ASTM D 396, table 1, grade no. 1
(4) The Engineer may waive the test.
(5) Maximum temperature to be held for 15 minutes 200 ± 5°C.
(6) Asphalt shall be polymerized prior to emulsification.

(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 AASHTO T 55, 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.

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+

(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.
(3) If the ductility at 25°C is less than 100, the material will be acceptable if its ductility at 16°C is 100+.
(4) Flash point by Cleveland Open Cup may be used for products having a flash point greater than 80°C.

2. Slow Curing Asphalts With and Without Additives

Slow curing asphalts with and without additives shall be in accordance with the following:

110

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) Saybolt-Furol Viscosity at 60°C (s) Saybolt-Furol Viscosity at 83°C (s)	60-120	125-250	100-200	300-600
Distillation(1) Total Distillate to 360°C (% by volume) Float Test of Distillation Residue at 50°C (s)	10-30 20-100	4-20 25-110	2-12 50-140	5 75-200
Ductility of Asphalt Residue at 25°C (10mm)(1)	100+	100+	100+	100+
Solubility in organic solvents, %(1)	99.5+	99.5+	99.5+	99.5+

(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 (177°C). 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. at 25°C, 100 g, 5 s at 46°C, 50 g, 5 s	 10 50-100 100 Min.	 10 25-45 130 Max.	 10 15-35 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 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.

120

(e) Asphalt for Coating Corrugated Metal Pipe

Asphalt for coating corrugated metal pipe shall be in accordance with the following:

Physical Properties	Minimum	Maximum
Softening Point (Ring & Ball), °C	93	110
Penetration of Original Samples (0.1 mm) at 4°C, 200 g, 60 s, Min. at 25°C, 100 g, 5 s	 20 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.

902.02 Sampling and Testing Asphalt Materials
The tests and AASHTO references are as follows:

(a) Sampling Bituminous Materials ..... AASHTO T 40
The following exceptions to AASHTO T 40 shall apply:

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. (1.9 L). The size of samples of other liquid material may be 1 qt (1.0 L).

3. Samples of liquid materials shall be obtained at one of the following:

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

(b) Water in petroleum products, except the solvent or carrier may be toluene ..... AASHTO T 55

(c) Density, Specific Gravity, or API Gravity of Crude Petroleum and Liquid Products by Hydrometer Method..... AASHTO T 227

(d) Specific Gravity of Semi-Solid Bituminous Materials ..... AASHTO T 228

(e) Specific Gravity of Solid Pitch and Asphalt ..... AASHTO T 229

(f) Flash and Fire Points (Open Cup)

1. When the flash point is higher than 175°F (79°C), "Flash and Fire Points by Cleveland Open Cup" ..... AASHTO T 48

2. When the flash point is 175°F (79°C) or lower, "Flash Point with Tagliabue Open Cup"..... AASHTO T 79

(g) Softening Point of Bituminous Materials,
Ring and Ball ..... AASHTO T 53

(h) Penetration of Bituminous Materials ..... AASHTO T 49

(i) Loss of Heating ..... AASHTO T 47

(j) Solubility in Organic Solvents, except the
solvent may be 1,1,1,-Trichloroethane ..... AASHTO T 44

(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 min. It shall then be trimmed and placed in the water bath for a period of 60 to 90 min before testing. In case of failure or dispute, three normal tests will be required and specimens shall be conditioned as in AASHTO T 51.

(n) Distillation of Cutback Asphaltic Products, except the
length of condenser tube may be 400 mm ± 24 mmAASHTO T 78

(o) Float Test for Bituminous Materials ..... AASHTO T 50

(p) Kinematic Viscosity of Asphalts ..... AASHTO T 201

(q) Absolute Viscosity of Asphalts ..... AASHTO T 202

(r) Effect of Heat and Air on Asphalt Materials,
Thin-Film Oven Test ..... AASHTO T 179

(s) Effect of Heat and Air on a Moving Film of
Asphalt, Rolling Thin Film Oven Test ..... AASHTO T 240

(t) Testing Asphalt Emulsions ..... AASHTO T 59
The following exceptions to 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 percent of residue for emulsion grades RS-2, AE-60, AE-90, and AE-T only, may be determined by the Residue by Evaporation test of AASHTO T 59. The percent of residue shall be determined by the Residue of Distillation test in all cases of failure or dispute.

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 min. 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.

   b. For AE-150 and AE-150-L, the mixture of stone and asphalt shall be mixed vigorously for 5 min and then allowed to stand for 3 h. At the end of this time, the mixture shall again be mixed vigorously for 5 min. 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 for AE-150 and AE-150-L.

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.

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 3000, the jar and contents shall be immersed in a 115°F (46°C) water bath for 5 min to bring the contents of the jar to a temperature of approximately 100°F (38°C). 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.

(v) Stripping tests for HMA mixtures using binder materials, with or without additives, shall be performed as follows:

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 min. The aggregate shall retain a minimum of 90% of its asphalt film compared with the remainder of the sample, upon completion of this procedure.

2. Test 2. Approximately 500 g of produced mixture shall be heated to 250°F (121°C) in a laboratory oven for 2 h; stirred and cooled to 200°F (92.5°C). 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 min. The aggregate shall retain a minimum of 90% of its asphalt film compared with the remainder of the sample, upon completion of this procedure.

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.

1. Apparatus and Equipment:

a. Sand mixture:

(1) Dry Ottawa Sand (AASHTO T 106).....90 parts

(2) Dry Reference Limestone Dust, portion passing #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 (2.3 kg) of Reference Limestone Dust upon request.....10 parts

(3) Water.....3 parts

b. Container, 6 oz (170 g) ointment tin

c. Ruler or other measuring device

d. Timing device readable in seconds

e. Compacting Device. Rimac Spring Tester or other device suitable for compacting sand by applying a 20 psi (140 kPa) load. The compacting device shall include an adapter consisting of two metal discs slightly smaller in diameter than a 6 oz (170 g) ointment tin separated by a spacer 1 to 2 in. (25 to 50 mm). The 2.5 in. (65 mm) diameter discs used in determining weight of coating in AASHTO T 65 or ASTM A 90 are satisfactory.

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 (170 g) 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 (140 kPa) load is achieved, which is approximately 100 lb (45 kg) 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. (100 mm) onto top of sand mixture. Start timer at start of pour. Stop timer when all emulsion penetrates into sand mixture. Delay 2 min. 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. (6 mm) or more.

(x) Flow Test for Asphalt for Coating Corrugated Metal Pipe ..... AASHTO T 190

(y) Shock Test for Asphalt for Coating Corrugated Metal Pipe ..... AASHTO T 190

(z) Viscosity Determinations of Unfilled Asphalts Using the Brookfield Thermosel Apparatus ..... AASHTO T 316

(aa) Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer ..... AASHTO T 315

(bb) Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel ..... AASHTO R 28

(cc) Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer ... AASHTO T 313

902.03 Application Temperatures

Binder materials for the several applications indicated in the specifications shall be applied at temperatures not to exceed those shown in the following:

Type and Grade of Material	Maximum Application Temperature °F (°C)	
	Spray	Mix
MC-70, MCA-70	150 (66)	
MC-250, MCA-250	225 (107)	200 (93)
MC-800, MCA-800	250 (121)	225 (107)
MC-3000, MCA-3000	275 (135)	250 (121)
SC-70, SCA-70	200 (93)	
SC-250, SCA-250	225 (107)	225 (107)
SC-800-3000, SCA-800-3000	250 (121)	250 (121)
All Emulsions	160 (71)	180 (82)
All Penetration and Viscosity, Utility and Pipe Coating	350 (177)	325 (163)
PG Binders	Note (1)	Note (1)

Note (1): 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:

10

Classification	Percent Sand and Gravel	Percent Silt	Percent 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"

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	Percent Gravel	Percent Sand	Percent Silt	Percent 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 & 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

The following classification system shall be used for organic soils in accordance with AASHTO T 267.

Classification	Percentage
With Trace Organic Matter	1 to 6
With Little Organic Matter	7 to 12
With Some Organic Matter	13 to 18
Organic Soil (A-8)	19 – 30
Peat (A-8)	More than 30

903.06 Marly Soils

The following classification system shall be used for marly soils with calcium and magnesium carbonate content.

Classification	Percentage
With Trace Marl	1 to 9
With Little Marl	10 to 17
With Some Marl	18 to 25
Marly Soil (A-8)	26 to 40
Marl (A-8)	More than 40

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.

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.

Ledge samples will be obtained from bedrock units as they naturally occur in the proposed working face of the quarry. Ledges will be identified by their differences in color, texture, geological formation, etc.

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.

(a) Specific gravity quality control tests shall be completed at a frequency of one test per 2000 t (2000 Mg) 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.

(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.

(f) If it is determined that a new target is necessary, a request shall be made in writing to the District Materials and Tests 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 Department's list of approved Polish Resistant Aggregates.

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 Materials and Tests Division will determine identification of sandstone.

Steel furnace (SF) slag shall only be used in aggregate shoulders, HMA surface or SMA surface mixtures, dumped riprap, and snow and ice abrasives.

Adjustments in weight (mass) shall be made to compensate for the difference in specific gravity of slag compared to natural aggregate when payment is on a weight (mass) 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 (500 Mg).

When slag is furnished as an aggregate, the approximate quantity of tons (megagrams) to be supplied will be determined by multiplying the pay item quantity of tons (megagrams) by the specific gravity of slag divided by 2.6. The adjusted contract quantities will be determined by multiplying the accepted quantity of tons (megagrams) 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.

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 0.10 for the bulk specific gravity (dry) and a range of 1.0% for the absorption. The range of bulk specific gravity (dry) and absorption values shall be the difference between the highest and lowest value, respectively, of the fine aggregate sources within the stockpile. A written request for the composite stockpiling shall be made to the Materials and Tests Division.

904.02 Fine Aggregates

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)		40	
Soundness			
Freeze and Thaw, AASHTO T 103, Method 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 colormetric 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. For ABCF or GBF slag sands, the minimum acid insoluble content shall be 25%. Acid insoluble requirements shall not apply to crushed 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.

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

Fine aggregates for use in HMA shall be natural sand or crushed limestone, dolomite, gravel, sandstone, SF, or ACBF. SF sand may be used only in HMA surface mixtures. The amount of crushed limestone sand shall not exceed 20% 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 Department's list of approved Polish Resistant Aggregates 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:

FINE AGGREGATE ANGULARITY		
TRAFFIC ESAL	DEPTH FROM SURFACE	
	≤ 100 mm	> 100 mm
< 300,000		
300,000 to < 3,000,000	40	40
3,000,000 to < 10,000,000	45	40
10,000,000 to < 30,000,000	45	40
≥ 30,000,000	45	45

Fine Aggregate Angularity, Method A .....AASHTO T 304

The clay content of the blended aggregate material from the fine and coarse aggregates shall meet or exceed the minimum values for the appropriate ESAL category as follows:

CLAY CONTENT	
TRAFFIC ESAL	SAND EQUIVALENT, MINIMUM
< 300,000	40
300,000 to < 3,000,000	40
3,000,000 to < 10,000,000	45
10,000,000 to < 30,000,000	45
≥ 30,000,000	50

Clay Content, Sand Equivalency.....AASHTO T 176

(c) For SMA Mixtures

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

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. Mineral filler shall be in accordance with ITM 203 or from an ABF 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.

(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

(i) Sampling and Testing

Sampling and testing shall be conducted in accordance with the following AASHTO and ITMs.

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
*Soundness..... AASHTO T 103, T 104
Specific Gravity and Absorption, Fine Aggregate..... AASHTO T 84

* Except as noted in 904.06.

904.03 Coarse Aggregates

Course 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.

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 permitted when requested in writing. Blending of aggregate products to improve the quality classification of the finished product will not be permitted.

(a) Classification of Aggregates

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	
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 4)	30	30	30	30	40	40	50	60
Absorption, % Max. (Note 5)	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 6)	4.0	4.0	4.0	4.0	6.0	8.0		
Coke					(See	Note 7)		
Iron					(See	Note 7)		
Chert (Note 8)	3.0	3.0	3.0	5.0	8.0	10.0		
Weight per Cubic Foot for Slag, (lbs), Min.	75.0		75.0	75.0	70.0	70.0	70.0	
(Mass per Cubic Meter for Slag, (kg))	(1200)		(1200)	(1200)	(1120)	(1120)	(1120)	
Crushed Particles, % Min. (Note 9)								
Asphalt Seal Coats			70.0	70.0				
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 subjected to 50 cycles of freezing and thawing in accordance with AASHTO T 103, Procedure A, and may be accepted, provided they do not have a loss greater than specified for Sodium Sulfate Soundness.
4. Brine freeze and thaw soundness requirements are subject to the conditions stated in Note 3.
5. 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.
6. 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.
7. ACBF and SF coarse aggregate shall be free of objectionable amounts of coke, iron, and lime agglomerates.
8. 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.
9. Crushed particle requirements apply to gravel coarse aggregates used in compacted aggregates, and seal coats except seal coats used on shoulders. 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 D 5821.

(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. (100 mm)	> 4 in. (100 mm)
< 300,000	55	
300,000 to < 3,000,000	75	50
3,000,000 to < 10,000,000	85/80*	60
10,000,000 to < 30,000,000	95/90*	80/75*
≥ 30,000,000	100/100*	100/100*

* Denotes two faced crush requirements.

For SMA mixtures, the total blended aggregate shall be 100% one face and 95% two face crushed.

Coarse Aggregate Angularity.....ASTM D 5821

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 five. 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.

Flat and Elongated.....ASTM D 4791

Flat and elongated requirements do not apply to 4.75 mm HMA mixture designation.

(d) Surface Aggregate Requirements for HMA and SMA

The surface mixture aggregates selection shall be based on the ESAL category as follows.

1. HMA Coarse Aggregate

Coarse 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	Yes	No	No
Gravel	Yes	No	No

Note 1. Polish resistant aggregates or crushed dolomite may be used when blended with ACBF or sandstone but cannot exceed 50% of the coarse aggregate by weight (mass), or cannot exceed 40% of the coarse aggregate by weight (mass) when blended with steel furnace slag.

2. SMA Coarse Aggregate

Coarse Aggregate Type	Traffic ESALs		
	< 3,000,000	< 10,000,000	≥ 10,000,000
Air-Cooled Blast Furnace Slag	No	No	No
Steel Furnace Slag	Yes	Yes	Yes
Sandstone	Yes	Yes	Yes
Crushed Dolomite	No	No	No
Polish Resistant Aggregates	No	No	No
Crushed Stone	No	No	No
Gravel	No	No	No

(e) Sizes of Coarse Aggregates

Sieve Sizes	COARSE AGGREGATE SIZES (PERCENT PASSING)									
	COARSE GRADED								DENSE GRADED	
	2	5	8	9	11	12	43(1)	91	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	35-50		55-80	60-90
3/8 in. (9.5 mm)		15-45	20-50	30-60	75-95	95-100				
No. 4 (4.75 mm)		0-15	0-15	0-15	10-30	50-80	20-40		35-60	35-60
No. 8 (2.36 mm)		0-10	0-10	0-10	0-10	0-35	15-35		25-50	
No. 30 (600 µm)						0-4	5-20		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		

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 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 µm) sieve shall be 10.0 to 12.0.

(f) Sampling and Testing

Sampling and testing will be in accordance with the following AASHTO, ASTM, and ITMs.

Abrasion ..... AASHTO T 96
*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 D 5821
Dolomite Aggregates ..... ITM 205
Flat and Elongated Particles ..... ASTM D 4791
Freeze and Thaw Beam Expansion ..... ITM 210
*Lightweight Pieces in Aggregates ..... AASHTO T 113
Polished Resistant Aggregates ..... ITM 214
*Sampling Aggregates ..... AASHTO T 2
Sampling Stockpiled Aggregates ..... ITM 207
Scratch Hardness ..... ITM 206
*Sieve Analysis ..... AASHTO T 27
*Soundness ..... AASHTO T 103, 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 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.

(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

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

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 C 139 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 2500 psi (17 MPa) for an average of three units and 2300 psi (16 MPa) for individual units. The maximum water absorption shall be 12 lb/cu ft (190 kg/m^3) for an average of three units.

(f) Sizes of Riprap

GRADATION REQUIREMENTS					
Percent Smaller					
Size, in. (mm)	Revetment	Class 1	Class 2	Uniform A	Uniform B
30 (750)			100		
24 (600)		100	85-100		
18 (450)	100	85-100	60-80		
12 (300)	90-100	35-50	20-40		
8 (200)				100	
6 (150)	20-40	10-30	0-20	35-80	95-100
3 (75)	0-10	0-10	0-10		35-80
1 (25)				0-20	0-20
Depth of Riprap, minimum	18 in. (450 mm)	24 in. (600 mm)	30 in. (750 mm)		

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.

360 **904.05 Structure Backfill**

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. Coarse aggregate used for backfilling end bents on beam structures shall be No. 8 or No. 9 crushed stone or BF slag, class D or higher, in accordance with 904. Structure backfill shall be in accordance with one of the following gradations.

Sieve Sizes	NOMINAL SIZES AND PERCENTS 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

370 **(a) Exceptions to AASHTO T 2**

Stockpile sampling shall be in accordance with ITM 207, unless otherwise permitted.

(b) Exceptions to AASHTO T 11, T 27, and T 37

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 (mass).

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:

Aggregate Size	Minimum Weight (Mass) of Test Sample
No. 2	25 lb (11.3 kg)
No 5, 8, 43, 53, 73, and 91	13-18 lb (6-8 kg)
No. 9	9-13 lb (4-6 kg)
*Structure Backfill	9-13 lb (4-6 kg)
*Subbase	9-13 lb (4-6 kg)

* The minimum weight (mass) of the test sample for No. 4 (4.75 mm) and No. 30 (600 µm) structure backfill shall be 10 oz (300 grams).

(d) Exceptions to AASHTO T 85

The in-water weight (mass) shall be determined following the 15 h soaking period prior to determining the SSD weight (mass).

(e) Exceptions to AASHTO T 103 and 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 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.

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 AASHTO M 91.

(b) Manhole Brick

Manhole brick shall be in accordance with AASHTO M 91.

(c) Building Brick

Building brick shall be in accordance with AASHTO M 114, 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 C 55, Grade S-II.

905.03 Concrete Masonry Blocks

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 C 139. Hollow load-bearing masonry units shall be in accordance with ASTM C 90, Grade N-II.

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.

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 Elements

Detectable warning bricks used in sidewalk curb ramps shall be in accordance with ASTM C 902, Class SX, type II. The color shall approximate 30109 or 30166 in accordance with Federal Standard No. 595a. The color shall be consistent throughout the brick. The truncated domes shall be as shown on the plans. The minimum dimensions of the brick shall be 2 1/4 in. (60 mm) thick by 3 5/8 in. (90 mm) wide by 7 5/8 in. (195 mm) long. The minimum thickness shall not be measured within the area of the domes.

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 (20.7 MPa) 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.

SECTION 906 – JOINT MATERIALS

906.01 Joint Fillers

Joint fillers shall be preformed materials intended to be used in PCCP and bridge joints or as otherwise specified. Joint fillers shall be in accordance with AASHTO M 213.

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 D 5893.

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 list of approved Joint Sealant materials, 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 (32°C). The sealant shall be placed when the ambient temperature is above 40°F (4°C). 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.

The approved sealants which are self leveling shall be identified as such on the Department's list of approved Joint Sealant materials, and will not require tooling. Sealants not identified as self leveling on the approved list shall be tooled or applied in such a manner which causes them to wet the joint faces. Such sealants which are not formulated for self leveling will not position properly in the joint under its own weight (mass). 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 permitted over sealed joints until the sealer is tack free.

The sealant shall be delivered in containers plainly marked with manufacturer's name or trade mark.

2. Hot Poured Joint Sealant

a. General Requirements

The sealant shall be in accordance with AASHTO M 301. The material shall be tested in accordance with ASTM D 5329 except that after blotting, the surface of the blocks shall be blown dry with compressed air.

b. Packaging and Marking

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.

c. Requirements for Installation

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.

d. Sampling and Testing

Samples may be taken prior to delivery provided the plant or warehouse is located in the geographical area serviced by the Department's inspectors. If not sampled prior to delivery, it will be sampled at the job site. Scheduling shall provide two weeks after delivery to the Materials and Tests Division for testing. The basis for use will be the applicable laboratory number.

3. Preformed Elastomeric Joint Seals

This joint shall be in accordance with AASHTO M 220. Joint seals furnished under this specification shall be covered by a type A certification in accordance with 916.03(b). The lubricant-adhesive shall be covered by a type C certification in accordance with 916.03(d).

4. Asphalt Rubber Sealant

a. Requirements

The asphalt rubber sealant shall be a single component asphalt sealant that contains a minimum of 18% recycled rubber by weight of asphaltic components Seventy percent of the rubber shall be ground reclaimed rubber. The asphalt rubber sealant shall be in accordance with ASTM D 6690, type I.

b. Packaging

The asphalt rubber sealant shall be delivered in the manufacturer's original sealed packaging. Each container shall be marked legibly with the manufacturer's name, name of material, the batch or lot number, the expiration date, the recommended pouring temperature, and the safe heating temperature.

c. Installation

The rubber asphalt sealant shall be installed in accordance with manufacturer's recommendations. The backer rod shall be in accordance with manufacturer's specifications and 906.02(b) if a backer rod is required.

d. Certification

The Contractor shall supply a type A certification in accordance with 916 for each batch or lot of material furnished.

(b) Backer Rod

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

Backer rod furnished under this specification shall be covered by a type C certification in accordance with 916.

906.03 Joint Mortar

Pipe joint mortar shall consist of one part portland cement and two parts sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 min after its preparation.

906.04 Rubber Type Gaskets

Ring gaskets for pipe shall be in accordance with AASHTO M 315. Material furnished under this specification shall be covered by a type B certification in accordance with 916.

906.05 Bituminous Mastic Pipe Joint Sealer

This is a cold applied, mineral filled, joint sealing compound for joints of bell and spigot or tongue and groove concrete or clay pipe. Joint sealing compound shall be in accordance with AASHTO M 198.

(a) General Requirements

This sealer shall be a smooth uniform mixture, not thickened or livered, and shall show no separation which cannot be overcome easily by stirring. The material shall be of such consistency and proportions that it can be applied readily with a trowel, putty knife, or caulking gun without pulling or drawing. It shall exhibit good adhesive and cohesive properties when applied to metal, concrete, or vitrified clay surfaces. It shall not be damaged by exposure to below freezing temperatures and shall be applicable when the temperature of the air is between 20°F and 100°F (-7°C and 38°C).

(b) Certification

Material furnished under this specification shall be covered by a type C certification in accordance with 916.

906.06 Joint Membrane System for Precast Reinforced Concrete Box 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	TEST METHOD	REQUIREMENTS
Thickness	ASTM D 3767 Procedure A	1.5 mm Min.
Tensile Strength	Grab Tensile Strength, ASTM D 4632	650 N Min.
Elongation	Grab Tensile Strength, ASTM D 4632	20% Min.
Bursting Strength	Mullen Burst, ASTM D 3786	2.0 MPa Min.
Peel Strength	ASTM D 903	850 N/m Min.
Permeance	ASTM E 96, Water Method	60 ng/m^2 Pa Max.

The membrane system shall be supplied in roll widths of at least 12 in. (300 mm). 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.

Material furnished under this specification shall be covered by a type B certification in accordance with 916.

906.07 Bridge Expansion Joints

(a) Type SS

Structural steel shall be in accordance with ASTM A 36 (A 36M), A 588 (A 588M), A 570 (A 570M), A 242 (A 242M), or Merchant Quality 1010, 1020.

Sealant and grouts shall be in accordance with Federal Specifications TT-S-00230 or as recommended by the manufacturer.

The elastomer shall be neoprene in accordance with ASTM D 5973 except that the physical requirements in Table 1 for low temperature recovery, high temperature recovery, and compression-deflection properties will not apply.

The structural steel and polyurethane sealant shall be covered by a type C certification, and the elastomer shall be covered by a type B certification, both in accordance with 916.

(b) Type BS2, BS6, BS8, BS9, and BS11

Materials shall be in accordance with ASTM D 3542. The dimension and tolerance requirements shall be as specified in the following table for the type or types of joints specified.

EXPANSION JOINT TYPE	SEAL WIDTH	SEAL HEIGHT	JOINT WIDTH @ INSTALLATION
BS2	1 5/8 in. (41 mm) ± 1/8 in. (± 3 mm)	1 5/8 in. (41 mm) ± 1/8 in. (± 3 mm)	7/8 in. (22 mm) + 1/8 in., - 1/4 in. (+ 3 mm, - 6 mm)
BS6	2 1/2 in. (64 mm) - 0, + 1/4 in. (-0, + 6 mm)	2 1/2 in. (64 mm) +3/8, - 1/8 in. (+ 10 mm, - 3 mm)	1 1/2 in. (38 mm) + 1/8 in., - 1/4 in. (+ 3 mm, - 6 mm)
BS8	3 in. (76 mm) - 0, + 1/4 in. (- 0, + 6 mm)	3 1/4 in. (83 mm) ± 1/4 in. (± 6 mm)	1 7/8 in. (48 mm) + 1/8 in., - 1/4 in. (+ 3 mm, - 6 mm)
BS9	4 in. (100 mm) - 0, + 1/4 in. (- 0, + 6 mm)	4 3/8 in. (111 mm) ± 3/8 in. (± 10 mm)	2 1/2 in. (64 mm) + 1.8 in., - 1/4 in. (+ 3 mm, - 6 mm)
BS11	5 in. (127 mm) - 0, + 1/4 in. (- 0, + 6 mm)	5 1/8 in. (128 mm) ± 1/4 in. (± 6 mm)	3 in. (75 mm) + 1/8 in., - 1/4 in. (+ 3 mm, - 6 mm)

The material shall be covered by a type A certification in accordance with 916 and sampling of the material will be required. Satisfactory test results shall be obtained from the samples prior to the installation of the seal. The lubricant-adhesive shall be covered by a type C certification in accordance with 916.

(c) Type M

Structural steel shall be in accordance with ASTM A 36 (A 36M), A 570 (A 570M), A 242 (A 242M), A 588 (A 588M), or Merchant Quality 1010, 1020.

Sealant and grout shall be in accordance with Federal Specification TT-S-00230 or as recommended by the joint manufacturer.

Elastomer shall be neoprene in accordance with ASTM D 3542.

The structural steel and sealant shall be covered by a type C certification and the elastomer by a type B certification, both in accordance with 916.

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 supplied and installed in one piece;
2. have corner locked edges for a watertight fit;
3. not be any part of the load bearing riding surface;
4. be installed using seal lubricant-adhesive or be mechanically clamped in position to produce a watertight seal;
5. have a shape which promotes self removal of foreign material during normal joint operation;
6. be recessed 1/2 in. (13 mm) below the riding surface throughout the normal limits of joint movement;
7. be held in position by the separator beams;
8. 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 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;
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 or through a positive horizontal mechanical linkage or proportioning bar.

The support bars shall be in accordance with the requirements as follows:

1. incorporate stainless 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.

All support bar boxes and joint housings shall have top, bottom, and sides made of steel plate with 1/2 in. (13 mm) minimum thickness. Anchorages shall consist of looped No. 5 reinforcing bars welded to 1/2 in. (13 mm) steel plates spaced at 9 in. (230 mm) centers. No unwelded steel to steel contact will be permitted.

SECTION 907 – CONCRETE, CLAY, AND PLASTIC DRAINAGE COMPONENTS

907.01 Non-Reinforced Concrete Pipe

This pipe shall be in accordance with AASHTO M 86 (M 86M) for the specified diameter and strength classes. When used for underdrain, each section of pipe shall not exceed 3 ft (0.9 m) in length.

907.02 Reinforced Concrete Pipe

This pipe shall be in accordance with AASHTO M 170 (M 170M) for the specified diameters and strength classes. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

When the pipe listed below is specified or permitted, 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 extend to which they apply.

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 (meter) of pipe is in accordance with or exceeds the specification requirements.

(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 (M 207M). Certification shall be in accordance with 907.02.

907.04 Precast Concrete Manholes, Inlets, and Catch Basins

These units shall be in accordance with AASHTO M 199 (M 199M). 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. Certification shall be in accordance with 907.02.

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 (M 199M), the manhole steps shall be permanently marked with the specific step designation, and the manufacturer's identification. This marking shall remain exposed after installation.

Steps shall be selected from the list of approved Manhole Steps. Requests for adding steps to the list shall be accompanied by: a certified test report demonstrating compliance with AASHTO M 199 (M 199M); 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 list which are not furnished with ancillary installation equipment.

907.05 Precast Reinforced Concrete Box Sections

Box sections with 2 ft (0.6 m) of cover or greater shall be in accordance with AASHTO M 259 (M 259M) and box sections with less than 2 ft (0.6 m) of cover which are subject to highway loadings shall be in accordance with AASTHO M 273 (M 273M). Box sections furnished in accordance with AASHTO M 259 (M 259M) or AASHTO M 273 (M 273M) shall have a minimum 28 day compressive strength of 5,000 psi (34.5 MPa), as determined by concrete cores. Certification shall be in accordance with 907.02.

Not more than four holes may be cast or drilled, or otherwise neatly made in the shell of each piece of box section for the purpose of handling or laying. The holes shall be tapered unless drilled, and the tapered holes shall be filled with portland cement mortar or with precast concrete plugs, which shall be secured with portland cement mortar or other approved adhesive, before backfilling. Drilled holes shall be filled with portland cement mortar.

907.06 Blank

907.07 Blank

907.08 Clay Pipe

This pipe shall be in accordance with AASHTO M 65 for the specified diameters and strength classes for circular unperforated 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 AASHTO M 65 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.

907.10 Blank

907.11 Drain Tile

This pipe shall be in accordance with AASHTO M 178 (M 178M) for concrete or M 179 for clay for the specified material, diameters, and quality classes. 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.

907.12 Blank

907.13 Blank

907.14 Blank

907.15 Blank

907.16 Plastic Pipe Manufacturer Requirements

A list of approved Plastic Pipe, Fittings, Solvent Cement, and Elastomeric Seals will be maintained by the Department. The list will specify the manufacturer, plastic pipe, solvent cement, or elastomeric seals designation. All of these materials shall comply with the applicable AASHTO or ASTM requirements and will only be accepted from qualified manufacturers. The manufacturer is defined as the plant which produces the plastic pipe, fittings, solvent cements, or elastomeric seals. 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.

Manufacturers requesting to be qualified to supply plastic pipe, fittings, solvent cements, or elastomeric seals shall submit the following to the Materials and Tests Division.

(a) a quality control plan which encompasses all aspects of the production process starting with the raw materials and concluding with the shipment of the finished product. The quality control plan shall provide for a 95% or greater statistical assurance that the materials will be in accordance with the specifications, and include type and frequency of sampling and testing;

(b) documentation indicating that the manufacturer's testing laboratory is in accordance with the provisions of AASHTO R 18;

(c) a monthly summary of all test results for the previous 12 months production for each type of plastic pipe, fittings, solvent cements and elastomeric seals;

(d) a material safety data sheet for each material produced; and

(e) to maintain qualification, the manufacturer shall submit to the Materials and Tests Division a monthly summary of all tests for each type of pipe, pipe fittings, solvent cements, and elastomeric seals produced. If a specific type of pipe, pipe fitting, solvent cement, or elastomeric seals is not

manufactured in a given month, the monthly submittal shall state: "No type _____ pipe, pipe fitting, solvent cement, or elastomeric seals was manufactured during the month of _____, 20__".

The manufacturer shall provide the type of certification specified in the Frequency Manual and in accordance with 916 which designates that hydrostatic design basis, HDB, rated resins or non-HDB rated resins were used in the manufacture of the pipe and fittings.

907.17 Corrugated Polyethylene Drainage 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 907.16.

907.18 Perforated Polyvinyl Chloride Semicircular Pipe

Perforated polyvinyl chloride semicircular pipe may be used as an alternate to 6 in. (150 mm) or less diameter pipe or tile. Pipe shall be in accordance with ASTM D 3034, SDR 35. This semicircular pipe shall have a smooth top and a smooth, semicircular bottom, nominally 4 5/8 in. (118 mm) 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. (13 mm) beyond the top of the semicircular section. The top section shall be approximately 6 3/8 in. (162 mm) wide including the sloping overhangs on each side. Qualification requirements for the manufacturers shall be in accordance with 907.16.

907.19 Corrugated Polyethylene Pipe

Pipe and fittings shall be in accordance with AASHTO M 294. The compound used in manufacturing this pipe shall have a minimum cell class in accordance with 335420C as shown in ASTM D 3350. Qualification requirements for the manufacturers shall be in accordance with 907.16.

907.20 Ribbed Polyethylene Pipe

Pipe and fittings shall be in accordance with ASTM F 894 for the specified sizes. Qualification requirements for the manufacturers shall be in accordance with 907.16.

907.21 Smooth Wall Polyethylene Pipe

Pipe shall be in accordance with ASTM F 714 for nominal diameters of 39 in. (1000 mm) or less. Fittings shall be in accordance with ASTM F 1055. The pipe sizes shall be in accordance with ISO sizing system. The pipe dimension ratio shall be 26 or less. The compound used in manufacturing this type of pipe shall have a minimum cell class in accordance with 335434C as shown in ASTM D 3350. Qualification requirements for the manufacturers shall be in accordance with 907.16.

907.22 Profile Wall Polyvinyl Chloride Pipe

Pipe and fittings shall be in accordance with AASHTO M 304 for nominal diameters of 36 in. (900 mm) or less. 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 907.16.

907.23 Smooth Wall Polyvinyl Chloride Pipe

Pipe and fittings shall be in accordance with AASHTO M 278 for pipe sizes 4 in. through 15 in. (100 mm through 375 mm), and ASTM F 679 for pipe sizes 18 in. through 27 in. (450 mm through 675 mm). The compound used in manufacturing pipe shall have a minimum cell class in accordance with 12454C as shown in ASTM D 1784. Qualification requirements for the manufacturers shall be in accordance with 907.16.

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 907.16.

(a) Type PSM Polyvinyl Chloride Pipe and Fittings

Pipe and fittings shall be in accordance with ASTM D 3034, SDR 23.5.

(b) Schedule 40 Polyvinyl Chloride Pipe

Pipe shall be in accordance with ASTM D 1785 and shall have a minimum pipe stiffness of 150 psi (1030 kPa) at 5% deflection when determined in accordance with ASTM D 2412.

907.25 Thermoplastic Pipe Liners

Thermoplastic pipe liners shall be high density polyethylene or polyvinyl chloride pipe with sufficient rigidity to withstand the installation operation and shall exhibit a minimum amount of distortion. The liner shall be free from visible cracks, holes, foreign inclusions, or other defects. Thermoplastic pipe liners may be added to the Department's approved list by completing the requirements of ITM 806, Procedure A.

(a) Solid Wall HDPE Pipe Liner

Solid wall HDPE pipe liner shall be in accordance with ASTM F 714. The maximum standard dimension ratio, SDR, for the liner as defined in ASTM F 412 shall be 32.5. The resin used in the fabrication of the liner shall have a minimum cell classification of 345464C as shown in ASTM D 3350.

A 12 in. (300 mm) section of the liner shall show no evidence of splitting, cracking, or breaking when compressed between parallel plates to 40% of its outside diameter within 2 to 5 min.

(b) Profile Wall HDPE Pipe Liner

Profile wall HDPE pipe liner shall be in accordance with ASTM F 894. The minimum liner ring stiffness constant, RSC, shall be 100. The resin used in the fabrication of the liner shall have a minimum cell classification of 345434C as shown in ASTM D 3350.

(c) Profile Wall PVC Pipe Liner

Profile wall PVC pipe liner shall be in accordance with ASTM F 949, with the exception that PVC material with a minimum cell classification of 12454B as shown in ASTM D 1784 is added to the list of acceptable PVC materials.

907.26 Solvent Cements for Polyvinyl Chloride Pipe and Pipe Fittings

Solvent cement for polyvinyl chloride pipe and fittings shall be in accordance with ASTM D 2564. Qualification requirements for the manufacturers of this material shall be in accordance with 907.16.

907.27 Elastomeric Seals

Elastomeric seals for joining plastic pipe shall be in accordance with ASTM F 477. Qualification requirements for the manufacturers of this material shall be in accordance with 907.16.

SECTION 908 – METAL PIPE

908.01 Blank

908.02 Corrugated Steel Pipe and Pipe-Arches

This pipe or pipe-arch and the coupling bands shall be zinc coated steel or aluminum coated steel in accordance with AASHTO M 36 (M 36M), except as noted herein. They may be fabricated with circumferential corrugations and riveted lap joint construction or with helical corrugations 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 permitted to allow use of circumferential corrugated coupling bands. 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 nor a plane of weakness created.

The pipe shall be type I, IA, II, or IIA.

Band couplers for type I and type II pipe shall have corrugations that mesh with the corrugations of the pipes sections being joined or the annuar rerolled ends of those pipe sections. Band couplers for type IA and IIA pipe shall have corrugations that mesh with the corrugations of the pipe or shall be gasketed flat bands.

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.

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.

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 (mass) 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

(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 (M 196M). 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.

The sheet manufacturer's certified mill report and the fabricator's certification shall be in accordance with 908.02, except the documents shall be in accordance with the applicable requirements of AASHTO M 196 (M 196M).

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

The end section's metal shall be in accordance with AASHTO M 36 (M 36M) or M 196 (M 196M), whichever is applicable. The sheet metal manufacturer's certified mill report and the fabricator's certification shall be in accordance with 908.02 or 908.04, whichever is applicable.

End sections consisting of multiple panels shall have lap seams which shall be tightly jointed with 3/8 in. (M10) galvanized rivets or bolts.

All steel pipe end sections shall have a toe plate anchor constructed of 0.138 in. (3.5 mm) 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. (M10) diameter galvanized bolts.

Straps for pipe end sections shall be either galvanized No. 6 (20M) reinforcing bars or zinc coated 3/8 in. (10 mm) 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. 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 2-piece type when used with coated pipe of 36 in. (900 mm) diameter or larger.

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 (204°C ± 3°C). The duration of the immersion in the asphalt shall be in accordance with the following:

Thickness	0.052 in. (1.32 mm)	0.064 in. (1.63 mm)	0.079 in. (2.01 mm)	0.109 in. (2.77 mm)	0.138 in. (3.51 mm)	0.168 in. (4.27 mm)
Minimum Immersion Time for first Dip (min)	2.0	2.5	3.0	5.0	6.5	8.0

(b) When the pipe is preheated it shall be brought to a temperature of 300°F (149°C) and the asphalt shall be heated to a temperature of 380°F ± 5°F (193°C ± 3°C) 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. (1.3 mm).

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. (3 mm) 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

The pipe or pipe-arch and coupling bands shall be in accordance with AASHTO M 245 (M 245M) with additions in accordance with 908.02. The polymer precoated galvanized steel sheets shall be in accordance with AASHTO M 246 (M 246M), Grade 10/10 (250/250).

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. (7.11 mm), 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 (M 167M) and Section 26 of the AASHTO Standard Specifications for Highway Bridges, Division II.

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. (457 mm) for openings up to and including 131 sq ft (12.2 m^2) and 31 in. (787 mm) for openings over 131 sq ft (12.2 m^2). The minimum radius of the arc shall be 31 in. (787 mm) for openings from 98 sq ft (9.1 m^2) up to and including 214 sq ft (19.8 m^2).

2. Assembly bolts shall be in accordance with AASHTO M 164 (M 164M), ASTM A 325 (A 325M), or ASTM A 449. Nuts shall be in accordance with ASTM A 563 (A 563M), grade C (class 8S); AASTHO M 164 (M 164M); or ASTM A 325 (A 325M). Assembly bolts, nuts, and washers shall be galvanized in accordance with ASTM A 153, or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

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 (M 167M).

(b) Aluminum Alloy

Aluminum alloy structural plate pipe, pipe-arches, and arches shall be in accordance with AASHTO M 219 (M 219M). 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 A 74. Markings shall be in accordance with ASTM A 74 or ANSI A 40.1.

908.11 Steel Pipe

This item shall be electric-fusion, arc-welded steel pipe in accordance with ASTM A 139, grade B, or electric-resistance welded pipe in accordance with ASTM A 53, Type E, Grade B, as applicable. Material furnished under this specification shall be covered by the type of certification specified in the Frequency Manual and in accordance with 916.

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 A 767 (A 767M), class I. Aircraft cable used for straps shall be made of zinc coated steel wire, 3/8 in. (9.5 mm) nominal diameter, consisting of seven 19 wire flexible steel strands, with a minimum breaking strength of 14,000 lb (62.3 kN). The cable shall be in accordance with Military Specification MIL-W-1511.

Hook bolts and nuts shall be of the size shown on the plans, shall be in accordance with ASTM A 307, and shall be galvanized in accordance with ASTM A 153. 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. (0.4 mm).

908.13 Blank

908.14 Slotted Drain or Slotted Vane Drain Pipe

Slotted drains shall be manufactured from helically corrugated steel pipe in accordance with AASHTO M 36 (M 36M). At the end of the pipe there shall be two annular corrugations to permit the corrugated band to fully mesh with the pipe.

The grated assembly shall be made of structural steel in accordance with AASHTO M 183 (M 183M), 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. (5 mm) fillet weld.

The size and thickness of the corrugated steel slotted drain pipe shall be as shown on the plans.

Slotted vane drain pipe shall be polyvinyl chloride 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 (mass) of 155 lb (70 kg).

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. Material Safety Data Sheets shall be provided.

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. 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.

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 weight per gallon (mass per volume) lb per gal. (kg/L) of the paint shall be accurately determined at 77°F (25°C). The container shall be so filled that the net weight (mass) of the material in the container shall be the product of the weight per gallon (mass per volume) at 77°F (25°C) and the stated number of gallons (liters) in the container.

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

1. Multi-Component Inorganic Zinc Silicate Primer

These primers shall be 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. The 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.

These inorganic 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 with exceptions as follows.

Table I, total zinc dust, percent by weight (mass) of pigment requirement shall be a minimum of 84% metallic zinc. Table I, total zinc dust, percent by weight (mass) of total solids requirement shall be a minimum of 72% metallic zinc. The viscosity variation in Kreb Units in Section 6.2 shall be ± 10.

The organic zinc primer shall also be in accordance with the requirements as follows.

a. The viscosity shall be 70 to 100 Kreb units.

b. The weight per gallon (mass per volume) shall be a minimum of 17.0 lb/gal. (2.04 kg/L).

c. The dry time shall be a maximum of 1 h set-to-touch and 24 h dry hard when applied at 6 mil (150 µm) blade clearance to a tin coated steel panel at 25°C and 60% ± 5% relative humidity.

d. The infrared spectrum of the vehicle shall match the infrared spectrum of the vehicle of the sample submitted for formulation approval.

e. The organic zinc primer shall not exceed 3.5 lb/gal. (0.419 kg/L) volatile organic compounds. The cured film shall not contain toxic heavy metals above the regulatory levels of 40 CFR 261.24.

f. 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 contract 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.

3. Approval of Formulation

The manufacturer shall obtain approval of the formulation prior to furnishing the primers. Only zinc primers from the Department's list of approved Coating Formulations shall be used. Zinc primers will be placed and maintained on the Department's list of approved Coating Formulations in accordance with ITM 606.

(b) Epoxy Intermediate Paint

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 requirements as follows.

Volatile organic compounds, ASTM D 3960, Max. ..... 336 g/L
Volume solids, ASTM D 2697, Min. 60%
Set-to-touch, ASTM D 1640, 6 mils (150 µm) wet film thickness,
25 ± 1°C, Max. ..... 4 h
Potlife, 25 ± 1°C, Min. ..... 6 h
Weight (mass)/volume variance from the initially approved
batch, ASTM D 1475, 25°C, Max. ..... 0.060 kg/L
Total solids variance from the initially approved batch,
ASTM D 2369, Max. 3.0%

The infrared spectra of each component and of the mixed coating shall essentially 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 requirements as follows.

Volatile organic compounds, ASTM D 3960, Max. ..... 336 g/L
Volume solids, ASTM D 2697, Min. 60%
Set-to-touch, ASTM D 1640, 5 mils (127 µm) wet film thickness,
25 ± 1°C, 50 ± 10% relative humidity, Min. ..... 30 min
Total solids ASTM D 2369, Min. 70%
Specular gloss, 60°, ASTM D 523, Min. 75
Viscosity, ASTM D 562, Kreb Units, Max. 100
Contrast ratio, ASTM D 2805, 5 ± 0.5 mils (127 ± 13 µm)
wet film thickness, dried 24 h @ 25 ± 2°C on Leneta Form 2A
or 2C, Min. 0.95
Dry hard, ASTM D 1640, 5 mils (127 µm) wet film thickness,
25 ± 1°C, 50 ± 10% relative humidity, Max. ..... 24 h

The infrared spectra of each component and of the mixed coating shall essentially match the sprectrums of the initially approved batch.

The color of the dried paint film shall match the color number of Federal Standard 595A as follows.

Color No.	Color
14260	Green
15450	Light Blue
17886	White
13538	Yellow
13711	Buff
17038	Black

(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.

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 D 476, type IV, and non-reactive color retentive tinting pigments. The pigment shall contain extenders and additives as required for proper application.

3. Mixed Paint Properties

The mixed paint shall be in accordance with the requirements as follows:

Viscosity, ASTM D 562, Kreb Units .....80 – 100
Weight (mass)/volume, ASTM D 1475, deviation from
approval formulation, Max. ..... 0.2 lb/gal. (0.024 kg/L)
Pigment grind, ASTM D 1210, Hegman, Min. 5
Total solids, % by weight (mass), ASTM D 2369, Min. 48
Vehicle solids, % of vehicle by weight (mass), Min. 37.5
Dry time, ASTM D 1640, 3 mils (75 µm) wet film thickness on a tin coated steel panel @ 25 ± 1°C and 50 ± 5% relative humidity, Max:
Set-to-touch, h 1
Dry hard, h 24
Contrast ratio, ASTM D 2805, 5 ± 0.5 mils (125 ± 13 µm) wet film thickness dried 24 h @ 25 ± 2°C on Leneta Form 2A or 2C, Min. 0.97
Specular gloss, 60°, 10 mils ± 0.5 mils (250 ± 13 µm) wet film thickness on a tin coated steel panel, dried 48 h @ 25°C and 50 ± 5% relative humidity, ASTM D 523, Max. 30
pH, ASTM E 70 .....7.0 – 9.0
Volatile organic compounds, ASTM D 3960,
Max. ..... 1.50 lb/gal. (0.180 kg/L)

The infrared spectrum of the vehicle when extracted from the mixed paint in accordance with ASTM D 3168 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.

The cured waterborne finish paint shall not contain toxic heavy metals above the regulatory levels of 40 CFR 261.24.

4. Color

The color of the dried paint film shall match the color number of Federal Standard 595a as follows.

Color No.	Color
24227	Green
24466	Light Green
25526	Light Blue
27780	White
23538	Yellow
23717	Buff
27038	Black

5. Approval of Formulation

The manufacturer shall obtain approval of the formulation prior to furnishing the waterborne finish paint. Only waterborne finish paint from the Department's list of approved Coating Formulations shall be used. Waterborne finish paint formulations will be placed and maintained on the list of approved 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. It shall be suitable for use as a finish coat over epoxy intermediate paint. The mixed paint shall be in accordance with the requirements as follows.

Specular gloss, 60°, ASTM D 523, Max.....25.0
Weight (mass)/volume variance from the initially approved
batch, ASTM D 1475, 25°C, Max. .....0.048 kg/L
Total solids variance from the initially approved
batch, ASTM D 2369, Max.....2.0%
Volatile Organic Compounds, ASTM D 3960, Max. .....336 g/L

The dried paint film shall match color number 20045 of Federal Standard 595a.

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.

(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, when tested in accordance with EPA TCLP, or contain any other material which will require characterization as a hazardous waste for the disposal of the dried film.

(b) Resistance

The coating system shall be tested in accordance with the requirements of NEPCOAT, Specification Criteria For Protective Coatings, dated June 6, 1996. The coating system shall be in accordance with all of the acceptance criteria and shall maintain a specular gloss retention of 60% relative of the initial gloss and a maximum color change of 15 ΔE for Test No. 3, Weathering Resistance.

(c) Approval of Structural Steel Coating System

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 Department's list of approved Structural Steel Coating Systems shall be used. Structural steel coating systems will be placed and maintained on the Department's list of approved 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.

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.

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 Traffic Paint

(a) Blank

(b) Fast Dry Traffic Paint

1. General Requirements

The general requirements specified in 909.01 shall apply except as modified herein.

White and yellow traffic paint shall be used on pavements for centerlines, lane lines, or as otherwise specified. In addition to its other requirements, when glass beads are applied, it shall be such that it shows capillary action in the interstices and voids existing between the beads sufficient to cause the level of the paint to be raised approximately 2/3 the diameter of the beads to provide anchorage and refraction. The

capillary action shall be such that it does not cause complete envelopment. The paint, as furnished, shall contain no glass beads.

The paint shall be ground to a uniform consistency, and it shall permit satisfactory application by the pressure spray type of painting machine. This painting equipment is designed to apply reflectorized lines, using a pressurized bead application method, 4 to 6 in. (100 to 150 mm) wide, at a wet film thickness of 0.015 in. (380 µm) on clean dry pavement, with the material being heated at a maintained temperature from ambient air temperature to a maximum of 180°F (82°C), at the atomized spray gun, at a minimum ambient temperature of 40°F (4°C). The material shall be capable of being applied under these conditions at speeds of 10 to 15 mph (16 to 24 km/h). The material shall have physical characteristics which permit it to be pumped at a minimum temperature of 40°F (4°C) through pumps from the shipping container into the paint tank on the paint machine, and then by pumps through the paint machine plumbing system to and through the heat exchanger and to the spray gun at the proper pressure and temperature.

2. Specific Requirements

The paint shall dry to a no tracking condition in no more than 60 s. The no tracking condition shall be determined by actual application on the pavement at a wet film thickness of 15 mils (380 µm) with white or yellow paint covered with glass beads at a rate of 6 lb/gal. (0.7 kg/L). The paint lines for this test shall be applied with the specialized striping equipment operated so as to have the paint at temperatures up to 180°F (82°C) at the spray orifice. This maximum no tracking time shall not be exceeded when the pavement temperature varies from 35 to 120°F (2 to 49°C), and under all humidity conditions providing that the pavement is dry. The no tracking time shall be determined by passing over the paint line 60 s after paint application, in a simulated passing maneuver at a constant speed of 30 to 40 mph (48 to 64 km/h) with a passenger car. A line showing no visual deposition of the paint to the pavement surface when viewed from a distance of approximately 50 ft (15 m) from the point where the test vehicle has crossed the line shall be considered as showing no tracking and conforming to the requirement for field drying conditions. This field dry time test shall be used for production samples only.

In addition to the above, the paint shall meet the following requirements.

	Min.	Max.
Pigment, Federal Standard 141A, Method 4022, percent by weight (mass)	54	60
Titanium Dioxide, ASTM D 476, Types II, III, and IV, white only, lb/gal. (g/L) of paint	0.8 (96)	-
Medium Chrome Yellow, ASTM D 211, Type III, yellow only, lb/gal. (g/L) of paint	1.2 (144)	-
Other pigments may be used, provided the amount of pigment is such that there will be a minimum of 1.04 lb/gal. (0.125 kg/L) of pure lead chromate per gallon of paint.		
Vehicle Solids, percent of vehicle by weight (mass), Federal Standard 141A, Method 4053	35	-

Total Non-Volatiles, Federal Standard 141A, Method 4042, percent by weight (mass)	72	-
Viscosity @ 77°F (25°C), ASTM D 562, Krebs Units	80	100
C.I.E. illuminant C, 2° standard observer, ASTM E 1349, percent		
White	84	-
Yellow	50	-
Color, yellow only, x-y C.I.E. coordinates for green limit, FHWA color chart of June 1965 C.I.E. illuminant C, 2° standard observer	Match the green limit ± 8%	
Contrast ratio, ASTM D 2805, wet film 15 ± 1 mil (380 ± 25 µm) black – white chart paper, air dried at least 16 h	0.96	-
Uncombined (free) Water, Federal Standard 141A, Method 4081, percent	-	1.0

(c) White and Yellow Waterborne Traffic Paint

White and yellow waterborne traffic paints shall consist of an emulsion of pigmented binder.

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 permit 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. (100 to 150 mm) reflectorized paint lines at paint temperature up to 150°F (65°C). The paint shall be capable of being applied at speeds of 10 to 15 mph (15 to 25 km/h).

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 (5°C). 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 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 (380 µm) with glass beads at a rate of 6 lb/gal. (0.7 kg/L). 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 (60°C) at the spray guns. This maximum no tracking time shall not be exceeded when the pavement temperature varies from 50 to 120°F (10 to 50°C), and with all relative humidity conditions providing that the pavement is dry. The no tracking time shall be 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 (50 to 65 km/h) 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 (15 m) 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 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 Colour Index Number 65 and/or 74 and/or 75. The white waterborne traffic paint pigment shall contain titanium dioxide in accordance with ASTM D 476. The non-volatile portion of the vehicle shall be composed of a 100% acrylic polymer.

The cured film of waterborne traffic paint shall not contain toxic heavy metals above the limits of the regulatory levels of 40 CFR 261.24 Table 1 when tested in accordance with EPA Toxicity Characteristics Leaching Procedure Test Method 1311 in Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, EPA publication SW-846. It shall not contain other hazardous materials which would require characterization as a hazardous waste for the disposal of the dried film.

2. Specific Requirements

	Minimum	**Maximum**
Volume solids, ASTM D 2697, %	58.0	--
Total solids by mass, ASTM D 3723, %	73.0	--
Pigment by mass, ASTM D 3723, %	45.0	57.0
Vehicle solids by mass of the vehicle, %	44.0	--
Viscosity, ASTM D 562, Kreb Units	75	95
Unit mass @ 77°F (25°C), ASTM D 1475, lb/gal. (kg/L)	12.50 (1.498)	--

420	Unit mass @ 77°F (25°C), variation between manufacturer's production batches, ASTM D 1475, lb/gal. (g/L)	--	0.20 (24)
	Dry time, ASTM D 711, 15 mils (380 µm) wet film thickness, at 77°F (25°C), 50% ± 5% relative humidity, airflow of less than 50 ft^3/min (1.4 m^3/min), without glass beads	--	10 min
430	Reflectance Factor, Y, C.I.E. illuminant, C, 2° standard observer, ASTM E 1349, 15 mils (380 µm) wet film thickness, air dried a minimum of 16 h, %		
	White	84	--
	Yellow	50	57
440	Color, yellow only, x & y C.I.E. Coordinates for the strong limits of FHWA color chart PR1, 15 mils (380 µm) 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 (600 µm) sieve, ASTM D 185, %	--	0.05
450	Bleeding ratio, Federal Specifications TT-P-1952B, except asphalt saturated felt paper shall be in accordance with ASTM D 226, Type I	0.97	--
	Contrast ratio, ASTM D 2805, 10 mils (254 µm) wet film thickness on Leneta Form 2A or 2C, air dried a minimum of 16 h	0.96	--
460	Volatile organic compounds, ASTM D 3960, lb/gal. (g/L)	--	1.25 (150)
	Abrasion resistance, Federal Specifications TT-P-1952B, L	190	--
	Freeze-thaw stability, Federal Specifications TT-P-1952B, change in consistency, Kreb Units	--	10

Heat stability, Federal Specifications TT-P-1952B, change in consistency, Kreb Units	--	10
Scrub resistance, ASTM D 2486, 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 D 3168	Shall match spectrum of manufacturer's previously submitted samples	

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.

3. Formulation Approval

The manufacturer shall obtain approval of the waterborne traffic paint formulation prior to furnishing the paints. Only waterborne traffic paints from the Department's list of approved Coating Formulations shall be used. Waterborne traffic paint formulations will be placed and maintained on the Department's list of approved Coating Formulations in accordance with ITM 606.

909.06 Blank

909.07 Blank

909.08 Blank

909.09 Epoxy Penetrating Sealers

(a) Polysulfide Type

The material shall be a system composed of a mixture of equal parts by volume of components A and B. Component A shall be a solution of totally reactive epoxy resin, which may be cut back with a reactive diluent, such as cresyl glycidyl ether. Component B shall be a solution of the specified liquid polysulfide polymer and an amine curing agent compatible with the epoxy resin. The use of butyl glycidyl in either compound shall be prohibited.

Neither component shall contain a residual constituent which is unreactive with the epoxy resin. An amount of liquid polysulfide polymer sufficient to comply with the

mercaptan content, total sulfur, and total sulfur/mercaptan ratio requirements given below shall be contained within the component B.

Non-volatile, or non-reactive extenders will not be permitted in either component. Each component shall have a usable shelf life of at least six months from the date of delivery.

The epoxy resin shall be manufactured from epichlorohydrin and bisphenol A, shall contain no more than trace amounts of hydrolyzable chlorine, and may contain sufficient reactive diluent, such as cresyl glycidyl ether, to conform to the specific requirements of 909.09(c).

(b) Unmodified Type

The material shall be a system composed of a mixture of equal parts by volume of components A and B. Component A shall be a solution of a totally reactive epoxy resin, and component B shall be a solution of an amine curing agent compatible with the epoxy resin. The use of butyl glydicyl ether in either component shall be prohibited.

Neither component shall contain a residual constituent which is unreactive with the epoxy resin. Non-volatile extenders will not be permitted in either component. Each component shall have a usable shelf life of at least six months from the date of delivery.

The epoxy resin shall be manufactured from epichlorohydrin and bisphenol A, shall contain no more than trace amounts of hydrolyzable chlorine, shall contain no reactive diluents, and shall be in accordance with 909.09(c).

(c) Specific Requirements

Specific requirements for each type of sealer shall be as shown in the table.

Property	Polysulfide Type	Unmodified Type	Test Method
RESIN			
Epoxide Equivalent	180 – 195	180 – 195	ASTM D 1652
Viscosity @ 77°F (25°C), Poises	5 – 7	100 – 180	ASTM D 2196, Method A
Color (Gardner) Max.	5	5	ASTM D 1544
COMPONENT A			
Viscosity @ 77°F (25°C), cps, Max.	40	40	ASTM D 2196, Method A
Weight (mass) per Epoxy Equivalent	180 – 195	180 – 195	ASTM D 1652 Corrected to 100% Solids Basis
Color	Clear Amber	Clear Amber	Visual
Infrared Spectrum	Shall Essentially Match Std. Spectrum	Shall Essentially Match Std. Spectrum	AASHTO T 237
COMPONENT B			
Viscosity @ 77°F (25°C), cps, Max.	40	40	ASTM D 2196, Method A
Color	Clear Amber	Clear Amber	Visual
Infrared Spectrum	Shall Essentially Match Std. Spectrum	Shall Essentially Match Std. Spectrum	AASHTO T 237
Total Sulfur, % Min. Corrected to 100% Solid Basis	11.0		ASTM E 443, or other Approved Method
Mercaptan, % Min.	1.8		ITM 602
Ratio of Total Sulfur % to Mercaptan %	6.2 – 8.0		
1/1 VOLUME MIXTURE OF A AND B			
Viscosity @ 77°F (25°C), cps, Max.	40	40	ASTM D 2196, Method A
Total Solid, %, Min	50	50	ASTM D 1644 (Note 1)
Ash %, Max	0.5	0.5	ASTM D 482
Flexibility	No Breaking or Cracking of Film	No Breaking or Cracking of Film	ITM 604
Moisture Permeability, %, Max	0.8	0.8	ITM 605
Color	Clear Amber	Clear Amber	Visual (Note 2)
Set to Touch, Hrs., Max.	4 (Note 3)	4 (Note 3)	FED. Test Method Std. 141 (Note 4)

(Note 1) Method A, except sample size shall be 3.0 grams ± 0.1 gram.
(Note 2) Poured on glass plate, and cured 48 h @ 70 to 80°F (21 to 27°C).
(Note 3) Applied to tin coated steel panel, approximately 20 ga., previously warmed to 90°F ± 2°F (32°C ± 1°C).
(Note 4) Method 4061.1, applied at mixture temperature of 90°F ± 2°F (32°C ± 1°C).

The polysulfide polymer used in formulation of polysulfide sealer shall be a difunctional mercaptan made from 98 mole percent of bis, 2-chlorethyl, formal and 2 mole percent of trichloropropane, and shall be in accordance with the following requirements.

Property	Requirements	Test Method
Specific Gravity @ 20/20°C	1.24 – 1.30	ASTM D 1963
Viscosity at 25°C, Poises	7 – 12	ASTM D 2196, Method A
pH, Water Extract	6.0 – 8.0	AASHTO T 200
Moisture Content, %	0.1 Max.	Fed Test Method Std. 141A Method 4082
Pour Point, °C	-26.8 Max.	ASTM D 97
Molecular Mass Av.	1000 Max.	Empirical Formula
Flash Point, (Cleveland), °C	200 Min.	AASHTO T 48
Sulfur, %	36 – 40	ASTM D 1552
Color, Hellige	9 – 12	Fed Test Method Std. 141A Method 4242

(d) Low Temperature Epoxy Penetrating Sealer

A low temperature epoxy penetrating sealer shall consist of a system composed of a mixture of equal parts by volume of a totally reactive epoxy resin solution, and a solution of an amine curing agent. The epoxy materials shall be in accordance with 909.09(a) or 909.09(b). The material, when mixed in accordance with the manufacturer's recommendations, shall be capable of complete curing when applied to a concrete surface at a temperature of 35°F (2°C) or above, and with an ambient air temperature of 35°F (2°C) or above. The material shall be in accordance with 909.09(c), except the set-to-touch shall be determined at 20° ± 2°F (-7° ± 1°C) when applied to a tin coated steel panel at a mixture temperature of 77° ± 2°F (25° ± 1°C).

(e) Packaging and Marking

Each component shall be packaged in clean steel containers. Containers for component B shall be lined with a material inert to chemical reaction with the contents.

Each container shall be clearly marked with the product's identification, component designation (A or B), manufacturer's name, date of manufacture, formulation number, batch number, mixing directions, and such warning information as may be appropriate or required by law. A batch shall consist of a single charge of all ingredients in a mixing vessel and is not to be confused with the formulation number.

(f) Approval of Formulation

Prior to furnishing any material, the manufacturer shall obtain approval of formulation. Only epoxy penetrating sealers from the Department's list of approved Coating Formulations shall be used. Epoxy penetrating sealers will be placed and maintained on the Department's list of approved Coating Formulations in accordance with ITM 606.

909.10 Proprietary PCC Sealers

Proprietary PCC sealers shall be selected from the Department's list of approved Other Concrete Sealers. A proprietary PCC sealer may be added to the approved list by completing the requirements in accordance with ITM 806, Approved List Procedure C.

(a) Properties

The proprietary 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	20%
Siloxane Based	15%
Others	10%

(b) Test Report

The testing shall be performed by a recognized laboratory in accordance with ITM 806.

The proprietary 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

Two-component, epoxy-resin bonding systems for use in bonding freshly mixed concrete to hardened concrete shall be in accordance with ASTM C 881 for type II, grade 2, and the class consistent with the ambient temperature as follows. Class A for use below 40°F (4°C); class B for use between 40°F (4°C) and 60°F (16°C); and class C for use above 60°F (16°C). Material furnished under this specification shall be covered by a type C certification in accordance with 916.

SECTION 910 – METAL MATERIALS

910.01 Reinforcing Bars and Dowel Bars

(a) General

Unless otherwise specified, bars for concrete reinforcement shall be deformed billet steel, grade 60 (420). 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.

Reinforcing steel used in precast or precast prestressed concrete structural members, including deck panels, shall be in accordance with ASTM A 615 grade 60 (A 615M, Grade 420).

Reinforcing bars shall be furnished by selecting bars made by a manufacturer on the list of Certified Uncoated Reinforcing Bar Manufacturers and in accordance with ITM 301. When shipped to the project site, the reinforcing bars shall be accompanied by the type of certifications specified in ITM 301 and in accordance with 916.

(b) Specific Requirements

1. Billet Steel Bars

Billet steel bars shall be in accordance with ASTM A 615 (A 615M).

2. Threaded Tie Bar Assembly

The threaded tie bar assembly shall be deformed billet steel, grade 60 (420), in accordance with 910.01(b)1 and a coupling device. The tie assembly shall achieve a minimum load of 76.144 kip/in.^{2} (525 MPa). An epoxy coating with a minimum film thickness of 6 mils (150 µm) shall be applied to the coupling device.

3. Splicing Systems

Reinforcing steel splicing systems shall be selected from the list of approved Reinforcing Steel Splicing Systems. A manufacturer may request to have a splicing system added to the list by submitting three randomly selected epoxy coated bars of each bar designation to be included as an approved splicing system on the list. The samples furnished shall be assembled. The splicing system will be tested for tensile strength in accordance with ASTM A 370 and shall reach 150% of the specified yield on all three samples for each bar size submitted. Splicing systems demonstrating consistent, repeatable, and passing test results will be added to the list. Approved bar designations will be noted on the list.

4. Blank

5. Welded Steel Wire Fabric for Concrete Reinforcement

Welded smooth steel wire fabric for concrete reinforcement shall be in accordance with ASTM A 185, except as follows.

a. The wire used in manufacturing the fabric shall be as drawn, not galvanized, unless otherwise specified.

b. The fabric shall be furnished in flat sheets unless otherwise permitted or specified.

c. Weld shear tests of fabric will be performed on the test specimens obtained for testing tensile properties in accordance with the Frequency Manual. If there is weld shear failure, additional test specimens shall be obtained in accordance with ASTM A 185.

6. Welded Deformed Steel Wire Fabric for Concrete Reinforcement

Welded deformed steel wire fabric for concrete reinforcement shall be in accordance with ASTM A 497, except as follows.

a. The wire used in manufacturing the fabric shall be in accordance with ASTM A 496.

b. The fabric shall be furnished in flat sheets unless otherwise specified or permitted.

c. Weld shear tests of fabric will be performed on the test specimens obtained for testing tensile properties in accordance with the Frequency Manual. If there is shear failure, additional test specimens shall be obtain in accordance with ASTM A 497.

7. Uncoated 7 Wire Strand for Prestressed Concrete

Uncoated 7 wire strand for prestressed concrete shall be in accordance with ASTM A 416. The strand shall have the minimum tensile strength of and initial tension shown on the plans.

Low relaxation strand with a nominal diameter of 1/2 in. (12.70 mm) and a cross sectional area of 0.167 in^2 (108 mm^2) shall have a breaking strength of 45,000 lb (20 400 kg).

Uncoated 7 wire strand shall be covered by the type of certification specified in the Frequency Manual and in accordance with 916.

8. Steel Spiral Reinforcement

Steel spiral reinforcement shall be either:

a. deformed billet steel, ASTM A 615, grade 60 (A 615M, grade 420); or

b. cold drawn steel wire, ASTM A 82.

9. Epoxy Coated Reinforcing Bars

Epoxy coated reinforcing bars shall be furnished by selecting bars coated from an applicator's plant on the list of Certified Reinforcing Bar Epoxy Coaters and in accordance with ITM 301. The epoxy coating material shall be selected from the list of approved Epoxy Coating for Steel.

Epoxy coated reinforcing bars shall be in accordance with ASTM A 775 (A 775M), 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. 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. (6 mm). The coating thickness shall be 8 to 13 mils (200 to 325 µm) after cure. The thickness measurements shall be made in accordance with ASTM G 12. The average shall be based on 12 individual readings. No specific correction for the base preparation process shall be applied to the thickness measurements.

d. epoxy coated reinforcing bars which will be jobsite sampled shall be accompanied by the types of certifications in the Frequency Manual and in accordance with 916. Epoxy coated reinforcing bars furnished by coaters on the list of approved Certified Reinforcing Bar 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 coating material shall be in accordance with the Annex to ASTM D 3963 (D 3963M).

Epoxy coated support devices for epoxy coated reinforcing bars shall be in accordance with ASTM A 775 (A 775M), 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 (150 to 500 µm) after cure. The thickness measurements shall be made in accordance with ASTM G 12.

10. Dowel Bars

Dowel bars shall be plain billet steel in accordance with ASTM A 615, grade 40 (A 615M, grade 280), except the bend test and elongation requirements will not apply. The dowel bar area and weight (mass) for the nominal bar diameter shall be as follows.

Nominal Bar Diameter, in. (mm)	Cross Sectional Area, in^2 (mm^2)	Weight (Mass) lb/ft (kg/m)
1 (25)	0.79 (510)	2.670 (3.973)
1 1/4 (32)	1.23 (794)	4.172 (6.209)
1 5/16 (33)	1.35 (871)	4.600 (6.846)
1 1/2 (38)	1.77 (1142)	6.008 (8.941)

Dowel bars shall be coated with an epoxy coating material selected from the list of approved Epoxy Coating for Steel. The coating thickness after cure shall be a minimum of 7 mils (175µm). 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 list of approved Certified Reinforcing Bar 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 steel may be inspected, sampled, and tested after delivery to the project.

910.02 Structural Steel

(a) Structural Steel

Unless otherwise specified, structural steel shall be in accordance with A 709, grade 36 (A 709M, grade 250).

(b) High Strength Structural Steel

This steel, when specified, shall be in accordance with ASTM A 709, grade 100 (A 709M, grade 690); ASTM A 709, grade 50 (A 709M, grade 345); or ASTM A 709, grade 50W (A 709M, grade 345W).

The corrosion resistance of ASTM A 709, grade 50W (A 709M, grade 345W) 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 A 709, grade 50W (A 709M, grade 345W) steel shall be friction type high-strength steel bolts in accordance with ASTM A 325 (A 325M) type III. Certification and a sample shall be submitted to the Engineer prior to start of erection.

All plates and bars produced from ASTM A 572 (A 572M) steel over 3/4 in. (19 mm) in thickness shall be “killed fine grain practice”.

(c) Charpy V-Notch Toughness Tests

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 A 673 (A 673M). 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. (mm)	Foot-Pounds Joule (J) @ 40°F (4°C)
A 709 grade 36 (A 709M grade 250)		15 (20.3)
A 709 grade 50* (A 709M grade 345)*	Up to 4 in. (100 mm) mechanically fastened Up to 2 in. (50 mm) welded	15 (20.3) 15 (20.3)
A 709 grade 50W* (A 709M grade 345W)*	Up to 4 in. (100 mm) mechanically fastened Up to 2 in. (50 mm) welded Over 2 in. to 4 in. (50 to 100 mm) welded	15 (20.3) 15 (20.3) 20 (27.1)

* If the yield point of the material exceeds 65,000 psi (450 MPa), the temperature for the CVN value for acceptability shall be reduced by 15°F (-10°C) for each increment of 10,000 psi (69 MPa) above 65,000 psi (450 MPa).

This test requirement shall apply to all structural steel members and/or components except diaphragms, cross frames, stiffeners, lateral bracing, railroad ballast retainers and components, shoe assemblies, expansion joints, and compression members of trusses.

(d) 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(c).

(e) High Strength Bolts, Nuts, and Washers

1. General Use

High strength bolts shall be in accordance with ASTM A 325 (A 325M). Type 3 bolts will be required if the structural steel is to remain unpainted. High strength nuts shall be of the grade and finish specified in ASTM A 325 (A 325M) and in accordance with ASTM A 563 (A563M) or ASTM A 194 (A 194M). High strength washers shall be of the type specified in ASTM A 325 (A 325M) and in accordance with ASTM F 436. The bolts, washers, and nuts shall be coated after fabrication in accordance with ASTM A 153, class C or AASHTO M 298, 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(e)1 and the following additional requirements.

a. Bolts

The maximum tensile strength shall be 150,000 psi (1034 MPa) for bolts 1 in. (25 mm) or less in diameter. The maximum tensile strength shall be 120,000 psi (827 MPa) for bolts greater than 1 in. (25 mm) in diameter. The maximum hardness shall be 33 Rc.

b. Nuts

The nuts shall be in accordance with ASTM A 563 (A 563M), grade DH; or ASTM A 194 (A 194M), grade 2H.

c. Tests

(1) Rotational Capacity

High strength fasteners shall be subjected to the rotational capacity test in accordance with AASHTO M 169, Section 8.5. The fastener shall complete two times the required number of turns from snug tight conditions in accordance with AASHTO Standard Specifications for Highway Bridges, Division II, 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 Standard Specifications for Highway Bridges, Division II. The measured torque required to produce the required fastener tension shall not exceed the value obtained by the following equation.

$$\text{Torque} = 0.25\ PD$$

Where:

Torque = Measured Torque, (foot-pounds) (newton meters)
P = Measured Bolt Tension, (pounds) (newtons)
D = Nominal Diameter (feet) (meters)

(2) Proof Loads

Proof load tests for bolts shall be conducted in accordance with ASTM F 606, Section 3.2.3. Proof load test for nuts shall be conducted in accordance with ASTM F 606, Section 4.2.

(3) Wedge Tension Test

The wedge tests of full size bolts shall be conducted in accordance with ASTM F 606, 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, excluding shoes and bearing assemblies. 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.

(f) Bolts other than High Strength Bolts

1. General

Bolts shall be unfinished, turned, or ribbed bolts conforming to the requirements for Grade A bolts of specification for low carbon steel externally and internally threaded fasteners, ASTM A 307. 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.

Bolts, washers, and nuts utilized in the U channel steel post splice as shown on the plans shall be in accordance with ASTM A 449, SAE J429-G7.9, or ASTM A 325 (A 325M) and shall be galvanized.

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.

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. (2 mm) 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 permit 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.

910.03 Permanent Metal Forms

Metal bridge deck forms and supports shall be fabricated from steel in accordance with ASTM A 653 (A 653M) for grades A through E having a coating class of G165.

Material furnished under this specification shall be covered by the type of certification specified in the Frequency Manual and in accordance with 916. The certification shall list the yield tensile stresses, the ultimate tensile stresses, the ultimate tensile elongations, the base metal thicknesses, the weights (masses) of the galvanized coating, and shall certify that the material complies with the specified material requirements. The properties and parameters shall be listed for each gage (thickness) of material used in the panels and the hardware necessary to erect them. The materials will be sampled at the work site and shall include a representative portion of a panel of each gage (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

Steel forgings shall be in accordance with ASTM A 668 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 A 108 for cold finished carbon steel bars and shafting. Grade designation 1016-1030, inclusive, shall be furnished unless otherwise specified.

(c) Alloy Steel Forgings

Alloy steel forgings shall be in accordance with ASTM A 668 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.

Elongation is not required for shafting.

910.05 Castings

The casting design shall be proof loaded to 40,000 (178 kN) in accordance with Federal Specification FF-F-621. 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 date, casting number, and the type of material, such as gray iron, ductile iron, etc. It shall state that inspection and testing has been preformed, 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 A 743 (A 743M). Grade CA 15 shall be furnished unless otherwise specified.

(b) Iron Castings

Iron casting shall be gray iron castings in accordance with ASTM A 48, 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 ± 1/8 in. (± 3 mm) in general dimensions as shown on the plans will be permitted with the exception that the tolerance in the dimensions of grates or covers and the openings into

which they fit shall be limited to ± 1/16 in. (2 mm). All castings shall weigh at least 95% of the specified weight (mass) of that type cast to the exact 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. (3 mm). 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

These castings shall be in accordance with ASTM A 536. 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 A 47 (A 47M). 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

These castings shall be in accordance with ASTM A 27 (A 27M). 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.

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. (25 mm) in any 1 ft (0.3 m) nor shall any single hole exceed 1 in. (25 mm) in any dimension or have an area greater then 1/2 in.^{2} (323 mm^2). 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 Alloy

(a) Bronze Castings

Bronze castings shall be in accordance with ASTM B 22, alloys 911 or 913. Material furnished under this specification shall be covered by a type A certification in accordance with 916.

(b) Copper Alloy Plates

Copper alloy plates shall be in accordance with ASTM B 100. Material furnished under this specification shall be covered by a type A certification in accordance with 916.

910.07 Steel Drain Pipe

Steel drain pipe may be welded or seamless, black or galvanized, and shall be in accordance with ASTM A 53 except as follows:

Chemical	Furnace Butt Welded	Seamless or Electric Resistance Welded
Carbon, % Max.	0.20	0.20
Manganese, % Max.	1.00	1.06
Phosphorous, % Max.	0.08	0.05
Sulphur, % Max.	0.05	0.05
Copper, %	0.75-1.25	0.75-1.25
Nickel, %	1.60-2.20	1.60-2.20
Tensile Strength, min. psi (MPa)	55,000 (379)	65,000 (448)
Yield Point, Min., psi (MPa)	40,000 (276)	46,000 (317)

The minimum elongation for furnace butt welded pipe shall be 30% in 2 in. (50 mm) for seamless pipe, in accordance with ASTM A 53, grade A, and for electric resistance welded pipe, in accordance with ASTM A 53, grade B. Material furnished under this specification shall be covered by a type C certification in accordance with 916.

910.08 Blank

910.09 Guardrail

Guardrail of the same type shall be interchangeable regardless of the source. Guardrail shall be supplied by a Certified Guardrail Supplier selected from the Department's list of Approved Certified Guardrail Suppliers.

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. (2.67 mm), 12 gage, or class B, base metal nominal thickness or 0.135 in. (3.43 mm), 10 gage. They shall be type 2, zinc coated with 3.60 oz/sq ft (1.1 kg/m^2) minimum single spot and 4.00 oz/sq ft (1.22 kg/m^2) minimum triple spot. Tests for adherence of the coating may be made including the test specified in ASTM A 123, when deemed necessary.

Where beam rail is set on a curve of 150 ft (45.7 m) 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 (3 m) from a radius of 150 to 50 ft (45.7 to

15.2 m) inclusive and in increments of 5 ft (1.5 mm) from a radius of 50 ft (15.2 m) to and including 20 ft (6.1 m).

The steel channels specified on the plans shall be standard 5 in. (127 mm) channels weighing 6.7 lb/ft (10.0 kg/m). The material shall be in accordance with ASTM A 36 (A 36M). The channel shall be galvanized in accordance with ASTM A 123 after fabrication. The weight (mass) of zinc coating per area of actual surface shall average not less than 2.0 oz/ft^2 (0.61 kg/m^2) for any individual piece of channel.

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 wood 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 A 36 (A 36M). The posts shall be galvanized in accordance with ASTM A 123 after fabrication. However, the weight (mass) of zinc coating per square foot (square meter) of actual surface shall not average less than 2.0 oz (610 g) for an individual post.

The weight (mass) of the W6 x 15 post, after fabrication and coating, shall not be less than 14.60 nor more than 16.00 lb/ft (21.73 nor more than 23.81 kg/m).

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) Wood Guardrail Posts

The wood guardrail posts shall be in accordance with 911.02(d). Dimensions and construction details shall be as shown on the plans.

910.11 Guardrail Accessories, Fittings, and Hardware

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, and washers 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

1. Post brackets, bars, plates and shapes for bridge railing brackets, and plate washers shall be in accordance with ASTM A 36 (A 36M). 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 A 153. The weight (mass) 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).

3. Bolts and nuts of the sizes specified on the plans shall be in accordance with ASTM A 307. 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. (44 mm) for 5/8 in. (16 mm) bolts and 2 in. (50 mm) for 3/4 in. (19 mm) bolts with a thickness of 0.134 in. (3.4 mm) ±0.026 in. (0.66 mm) measured at the hole. The bolts, washers, and nuts shall be coated after fabrication in accordance with ASTM A 153, or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements for class C of ASTM A 153.

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-P21035. 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 A 153, class C. The weight (mass) of coating per square foot (square meter) of actual surface shall average no less than 1.25 oz (381 g) for the specimen tested and shall be no less than 1.00 oz (305 g) for any individual specimen.

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).

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 D 500 grade B and zinc coated in accordance with AASHTO M 111. The post sleeve shall be in accordance with ASTM A 53 grade B and zinc coated in accordance with AASHTO M 111. The stud shall be in accordance with ASTM F 568 class 8.8, and zinc coated in accordance with AASHTO M 111. The threads shall be in accordance with ANSI B1.13M and shall be

M24 x 3 class 6g pitch. The swaged fitting shall be in accordance with ASTM A 576 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. (6 mm) plated spring-steel pin shall be drilled through the head of the swaged fitting.

High strength bolts shall be in accordance with ASTM A 325 (A 325M) or ASTM A 449. High strength nuts shall be in accordance with ASTM A 563 (A 563M), Grade B or better. Galvanizing shall be in accordance with ASTM A 153 or mechanically galvanized and conform to the coating thickness, adherence, and quality requirements for class C of ASTM A 153. Foundation plates and bearing plates shall be in accordance with ASTM A 36 (A 36M), and shall be galvanized after fabrication in accordance with ASTM A 123, except the weight (mass) of zinc coating per square foot (square meter) of actual surface shall average no less than 2.0 oz (610 g) and shall be no less than 1.8 oz (549 g) for any individual specimen. Welding shall be in accordance with AWS D1.1.

Terminal posts shall be fabricated from tubing meeting ASTM A 500, Grade B, or ASTM A 501 and from plates meeting ASTM A 36 (A 36M). Welding shall be in accordance with AWS D1.1. They shall be galvanized after fabrication in accordance with ASTM A 123, except the weight (mass) of zinc coating per square yard (square meter) of actual surface shall average no less than 2.0 oz (610 g). The average for any component part, including paddle plate, tubing, or base plate, shall be no less than 1.8 oz (549 g).

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 A 153.

The wire rope used in the cable assemblies shall be in accordance with AASHTO M 30 and shall be 3/4 in. (19 mm) 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 (190 kN). The swaged fitting, stud, and nut shall develop the breaking strength of the wire rope. The fitting shall be galvanized in accordance with ASTM A 123 before swaging. After galvanizing, the head and nut may be tapped 0.023 in. (0.6 mm) over the ANSI B1.1, class 2B tolerance.

(b) For Steel Tube Guardrail

1. Channels and bars for connections, splice bars, and diaphragms shall be in accordance with ASTM A 36 (A 36M).

2. Cap screws shall be stainless steel in accordance with ASTM A 276, type 304 or 430.

3. Rail end caps shall be malleable iron castings in accordance with ASTM A 47 (A 47M), grade 35018, or steel castings in accordance with ASTM A 27 (A 27M), grade 70-36.

4. Cut washers and lock washers shall be standard round steel washers. The diameter of cut washers shall be 1 1/2 in. (37.5 mm) and 1/8 in. (3.2 mm) thick measured at the hole. Washers shall be coated after fabrication in accordance with requirement 3 of 909.11(a).

5. All materials other than cap screws and washers shall be galvanized after fabrication in accordance with ASTM A 123.

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.

910.12 Certification of Guardrail Suppliers

Suppliers desiring to be on certification status will be approved upon request and added to the Department's list of approved Certified Guardrail Suppliers. The written request shall be submitted to the Materials and Tests Division. An approval number will be assigned to each supplier to be used for identification acceptable of material.

The supplier shall perform testing or shall obtain documentation to ensure the quality of the material incorporated into the work.

The supplier shall prepare each month a type D certification in accordance with 916.02(e). Such certification shall contain the contract number; supplier's name; supplier's approval number; month of installation; rail manufacturer; bolt manufacturer; quantities of rail, channel, posts, block, and paddle posts incorporated into the work; quantities of sawed timber posts and blocks for thrie-beam and W-beam guardrail incorporated into the work; and a statement that the materials furnished are in accordance with 910.09 through 910.12.

The Department will inspect the steel beam guardrail on a randomly selected contract for compliance with specifications for a minimum of one time per year per supplier.

Selected contracts with failing results will be adjudicated as a failed material in accordance with normal Department practice.

If the supplier shows negligence or the inability to ensure the delivery of specified materials, the supplier may be removed from the approved list.

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.

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 (mass) per foot (meter) for tubular posts and braces shall be no less than 90% of the weight (mass) specified. Unless specified otherwise, the tubular steel fence post shall be group 1.

1. Group 1

Tubular steel fence posts for group 1 shall be hot-dipped zinc-coated and shall be in accordance with ASTM F 1083 except tests shall be conducted on sample posts selected as being representative of the posts furnished. The weight (mass) per foot (meter) will be acceptable provided it is at least 90% of the specified weight (mass).

2. Group 2

Tubular steel fence posts for group 2 shall have a minimum 50 ksi (345 MPa) 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 (229 g/m^2) average, and 0.70 oz/sq ft (214 g/m^2) for an individual test specimen, as measured in accordance with ASTM A 428. Specimens for determining weight of coating shall be obtained in accordance with ASTM F 1083.

(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 (3.8 mm) 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 (183 g/m^2 and 92 g/m^2) 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 gage 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 gage (3.8 mm). A sufficient quantity of individual ties or bands shall be furnished to provide for attaching the fabric to each line post each 1 ft (0.3 m) or as called for on the plans.

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 A 499, grade 60, and to the chemical compositions of ASTM A 1 for 91 lb/yd (45 kg/m) or larger steel rails.

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 (2.1 m) 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 (4.9 m/s). For two posts in a 7 ft (2.1 m) 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 (414 MPa) and the minimum tensile strength shall be 90,000 psi (621 MPa).

The tensile strength shall be determined by either the standard Rockwell Hardness test, Brinnel 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 must have been made within 90 days of shipment. Posts, except those used for temporary construction signs, temporary traffic signs, and temporary panel signs, shall be certified by a type B certification in accordance with 916. The certification shall include the above three test results and the elastic section modulus value in accordance with 910.14(a)3.

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. (± 25 mm). Sign posts shall be punched with 58 holes which shall be 3/8 in. (9.5 mm) in diameter located on the center-line and spaced on 1 in. (25 mm) centers beginning 1 in. (25 mm) from the top. The remainder of the post shall be punched with 3/8 in. (9.5 mm) holes on 1 in. (25 mm) or 2 in. (50 mm) centers.

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. (6 mm) in any 5 ft

(1.5 m) of length, or exceed in inches (millimeters) 1/4 times the number of feet (meter) of length divided by five. 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 A 123.

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 A 780. 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. (25 mm) 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. (200 mm) below the top of the concrete foundation.

Steel posts shall be wired or strapped securely in bundles of not more than 2,000 lb (907 kg). 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

Posts will be tested as a simple beam with the flange in compression on non-restricting supports 24 in. (610 mm) apart. Test specimens shall be 28 in. ± 1/4 in. (711 mm ± 6.3 mm) long. A load of 1,500, 3,500, or 4,600 lb (6672, 15569, or 20462 N), depending on the type of post, shall be applied at the center of the span with a mandrel of not less than 1 in. (25 in.) in diameter. Application of the load shall be at a speed of not to exceed 0.03 in. (8 mm) per min. Deflection of the post upon application of the total load shall not exceed 0.16 in. (4 mm). The load shall then be removed. Deflection of the post one minute after removal of the load shall not exceed 0.01 in. (0.25 mm).

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 (6672 N)
B	.400	3,500 lb (15569 N)
C	.560	4,600 lb (20462 N)
Abb*	.670	**
Bbb*	1.190	**

* Back to Back
** Back to Back post shall be tested singly for deflection prior to assembly.
Note: The elastic section modulus values shall be included in the type B certification.

(b) Wide Flange Posts

Structural steel members for the support of signs shall be in accordance with AASHTO M 183 and ASTM A 709 grade 36 (A 709M grade 250). These members shall be galvanized in accordance with ASTM A 123. Base plates and stiffeners shall be in accordance with the requirements of ASTM A 709 grade 36 (A709M grade 250). Fuse plates shall be in accordance with the requirements of ASTM A 36 (A 36M) and shall be galvanized in accordance with ASTM A 123. All bolts, nuts, and washers shall be high strength and be in accordance with AASHTO M 164 and ASTM A 325.

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 A 123. Material furnished under this specification, except those used for temporary construction signs, temporary traffic signs, and temporary panel signs, shall be covered by a type C certification in accordance with 916.

(d) Structural Aluminum Posts

These posts shall be standard shapes as specified and shall be aluminum in accordance with ASTM B 221 (B 221M) alloy 6061-T6. Material furnished under this specification, except those used for temporary construction signs, temporary traffic signs, and temporary panel signs, shall be covered by a type C certification in accordance with 916.

(e) Square Steel Posts

Square steel sign post, except those used for temporary construction signs, temporary traffic signs, and temporary panel signs, shall be covered by the type of certification specified in the Frequency Manual and in accordance with 916.

1. Steel

Square steel posts shall be roll formed and in accordance with one of the following:

a. ASTM A 570, hot rolled carbon sheet steel in either 0.105 in. (2.66 mm) or 0.075 in. (1.90 mm) with a minimum yield strength of 60,000 psi (414 MPa). The ultimate tensile strength shall not

exceed 79,800 psi (550 MPa) or have an elongation measured over 2 in. (50 mm) greater than 20%.

b. ASTM A 1008 or 1011, cold rolled high strength steel, 0.075 in. (1.90 mm) with a minimum yield strength of 60,000 psi (414 MPa). This shall apply to the 2 in. x 2 in. (50 mm x 50 mm) size posts only.

c. ASTM A 653, cold rolled high strength steel, 0.75 in. (1.90 mm) with minimum yield strength of 60,000 psi (414 MPa). The ultimate tensile strength shall not exceed 79,800 psi (550 MPa) or have an elongation measured over 2 in. (50 mm) greater than 20%. This requirement shall apply to the 2 in. x 2 in. (50 mm x 50 mm) size posts only.

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 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. (6.3 mm) in any 5 ft (1.52 m) of length. Cut holes or knockout holes of 7/16 in. (11 mm) diameter shall be spaced on 1 in. (25 mm) 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:

a. Before fabrication, both sides of the rolled sheet steel shall be galvanized in accordance with ASTM A 653, coating designation G 90. (A 653M, coating designation Z 275)

b. After fabrication, a triple coating system on the outside of the posts consisting of galvanizing with zinc which is in accordance with AASHTO M 120 weighing 0.60 ± 0.15 oz/ft^2 (183 ± 46 g/m^2) followed by a chromatic conversion coating weighing 15 ± 5 micrograms, µg/in.^{2} (0.02 ± 0.006 g/m^2) and a clear organic exterior coating with a dry film thickness of 0.2 ± 0.1 mil (5 ± 2.5 µm). 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 (30 ± 15 µm). 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 B 117 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 D 1654.

(f) Portable Construction Sign Trailer

The portable construction sign trailer, not including the signs and lights, shall weigh no more than 300 lb (140 kg) and shall not be fabricated with heavier than 3 x 3 in. (75 x 75 mm) angles, 2 1/2 in. (63 mm) pipe, or 3 x 2 in. (75 mm x 50 mm) rectangular tubing. The rim size of the wheels shall not exceed 12 in. (300 mm). Axle assemblies with differential housings shall not be used.

910.15 Delineator Posts

Posts shall be in accordance with 910.14(a)1.

Physical requirements for the finished delineator posts shall be:

Width of flange face	2 to 2 3/8 in. (50 to 60 mm)
Width of back	3/4 to 7/8 in. (19 to 22 mm)
Depth from face of flange to back	7/8 to 1 1/8 in. (22 to 29 mm)
Length	7.0 ft ± 1 in. (2.1 m ± 25 mm)
Weight (Mass)	1.0 to 1.5 lb/ft (1.5 to 2.2 kg/m)

Delineator posts shall be punched with a minimum of twenty-four 1/4 in. (6 mm) holes on the centerline spaced on 1 in. (25 mm) centers beginning 1 in. (25 mm) from the top.

910.16 Copper Flashing

Copper flashing shall be soft copper and shall be in accordance with ASTM B 370, except the minimum copper content shall be 99.5%. The weight (mass) per square foot (square meter) will be determined by weighing individual samples. If the first sample is not in accordance with the tolerances for 16 oz (450 g) 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 degrees flat upon itself, without failure of the outside of the bent portion. The type of certification for copper flashing will be covered by the Frequency Manual and shall be in accordance with 916.

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. 3000 psi (20684271 Pa)	B 22, Alloy C86300
B. 2500 psi (17236894 Pa)	B 100, Alloy C51000
C. 2000 psi (13789514 Pa)	B 22, Alloy C91100
D. 1000 psi (6894757 Pa)	B 22, Alloy C90500*

* Up to 2.5% lead allowed

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.

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. (0.0125mm). Curved bearing surfaces shall be machined to a tolerance of ± 0.0005 in. (0.0125 mm) in each 1 in. (25 mm) 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. (0.25 mm)	0.000 in. (0.000 mm)
Convex Surface	0.000 in. (0.000 mm)	0.010 in. (0.25 mm)

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.

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.

Material furnished under this specification shall be covered by a type C certification in accordance with 916.

910.18 Fence, Fittings, and Gates

(a) Farm Field or Woven Wire Fence

This fence shall be in accordance with ASTM A 116. The wire shall be No. 9 gage (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.

(b) Steel Fabric Chain Link Fence

This fence shall be in accordance with ASTM A 392 for galvanized steel fabric or ASTM A 491 for aluminum coated steel fabric. The height of the fabric shall be 48 in. (1.22 m) unless otherwise specified. It shall be of No. 9 gage (3.8 mm) wire woven in 2 in. (50 mm) mesh. The fabric shall be knuckled at the top and bottom selvages when the height is less than 72 in. (1830 mm). Fabric of 72 in. (1830 mm) 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 2 or more specimens no less than 2.0 oz/sq ft (610 g/m^2) and no less than 1.8 oz/sq ft (549 g/m^2) for any individual specimen. For aluminum coated fabric, coating shall be class II, 0.40 oz/sq ft (122 g/m^2) 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 gage 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 gage (2.7 mm). Sufficient ties shall be furnished to provide for attaching to the top and bottom tension wires each 24 in. (600 mm). 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.

1. Tension Wire

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. (4.5 ± 0.1 mm), a minimum breaking load of 1,950 lb (8.67 kN), and a coating of either zinc or aluminum. The minimum weight (mass) of coating shall be 0.80 oz/sq ft (244 g/m^2) for galvanized wire and 0.40 oz/sq ft (122 g/m^2) for aluminum coated steel wire. The weight (mass) of aluminum coating shall be determined in accordance with ASTM A 428.

2. Stretcher Bars, Truss Rods, and Turnbuckles

Stretcher bars shall be 3/16 by 3/4 in. (4.8 by 19.0 mm) 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 A 153 after fabrication. The turnbuckles shall be made from drop forged malleable iron. They shall have a minimum take up of 4 in. (100 mm). The fittings may be pressed or rolled steel, forged steel, cast steel, or malleable iron.

3. Braces

Braces shall be made of steel pipe with bolted steel couplings or connections. Steel pipe shall be in accordance with ASTM F 1083. 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

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 A 121. It shall be composed of No 12 1/2 gage (2.5 mm) galvanized or aluminum coated steel wire with four round 14 gage (2.0 mm) barbs at approximately 5 in. (125 mm) 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 (mass) of coating shall be determined in accordance with ASTM A 428. The use of aluminum barbs, in accordance with ASTM B 211 (B 211M), alloy 5052-H38, nominal diameter No. 14 gage (2.03 mm), will be permitted.

The use of barbed wire with No. 15 1/2 gage (1.70 mm), high tensile strength line wires, and No. 16 1/2 gage (1.47 mm) barbs will be permitted. The barbs shall be round with four points and spaced at approximately 5 in. (125 mm) intervals. The barbed wire shall be in accordance with ASTM A 121. The galvanized coating shall be in accordance with class 3 in Table 2.

(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	B 211 (B 211M)	Alclad 5056 or 6061-T94	
Barbed Wire - Line	B 211 (B 211M)	5062-0, H38, or 6061-T89	2-strand dia. 0.110 in. (2.8 mm) 4-pt barb. dia. 0.080 in. (2.0 mm) 5 in. (127.0 mm) space
Barbs	B 211 (B 211M)	5052-H38	
Tension Wire	B 211 (B 211M)	Alclad 5056 or 6061-T94	Dia. 0.192 in. (4.9 mm); Note 1
Hog Ring Fasteners	B 211 (B 211M)	6061-T94	Dia. 0.110 in. (2.8 mm)
Wire Ties	B 211 (B 211M)	1100-H18	Dia. 0.148 in. (3.8 mm)
Flat band ties	B 211 (B 211M)	3003-H14	1.2 in. (12.7 mm) wide; 0.06 in. (1.5 mm) thick
Stretcher Bars	B 211 (B 211M)	6063-T6	3/4 in. (19.0 mm) by 1/4 in. (6.4 mm); square edges
Truss and Brace Rods	B 211 (B 211M) or B 221 (B 221M)	6061-T6	Dia. 3/8 in. (9.5 mm)
Turn Buckles	B 26 (B 26M) (cast parts), B 211 (B 211M) (wrought)	356.0-T6 6061-T6	
Bands	B 221 (B 221M)	6063-T6	1/8 in. (3.2 mm) by 1 in. (25 mm) beveled edge
Bolts	B 211 (B 211M) or B 221 (B 221M)	2024-T4	ASA B 18.2 hexagon threads class 2, 2A, or 2B
Nuts	B 211 (B 211M) or B 221 (B 221M)	6061-T6	
Expansion Sleeves	B 210 (B 210M)	3003-H18	1.695 in. (43.1 mm) ID by 0.078 in. (1.98 mm); wall drawn type. 6 in. (152 mm) long; self centering
Post Tops, Rails And Brace Ends	B 26 (B 26M) or B 108	356.0T6	Fabricated in permanent molds or sand castings
Top and Brace Rails	B 241 (B 241M) and B429	6063-T6	1 1/4 in. (31.8 mm) pipe; Note 2
Barbed Wire Extension Arms	B 26 (B 26M) or B 108	356.0T6	Fabricated as for post tops; sheet castings
Line Posts	B 241 (B 241M) and B 429	6063-T6	2 in. (50 mm) pipe; Note 2
Corner Posts	B 241 (B 241M) and B 429	6063-T6	2 1/2 in. (63 mm) 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.

(d) Gates

Gate posts sizes shall be as follows:

1060

ANSI Nominal Pipe Size	Swing Gate Opening, (inclusive)	
	Single Gate	Double Gate
2 1/2 in. (64 mm)	Up to 6 ft (1.83 m)	Up to 12 ft (3.66 mm)
3 1/2 in. (89 mm)	7 to 13 ft (2.13 to 3.96 m)	13 to 26 ft (3.96 to 7.92 m)
6 in. (152 mm)	14 to 18 ft (4.27 to 5.49 m)	27 to 36 ft (8.23 to 11.28 m)
8 in. (203 mm)	19 to 32 ft (5.79 to 9.75 m)	37 to 64 ft (11.27 to 19.51 m)

1. Steel Gates

Steel gate posts shall be standard weight (mass), galvanized, steel pipe in accordance with ASTM F 1083 and furnished with all necessary fittings. Post sizes shall be as set out above. The gate frames shall be of standard weight (mass), galvanized, steel pipe in accordance with ASTM A 53; 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 A 153.

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 B 241 (B 241M) or B 429, alloy 6063-T6. Gate frames shall consist of 1 1/2 in. (38 mm) schedule 40 pipe assembled by welding and/or with fittings. Pipe shall be in accordance with ASTM B 241 (B 241M) or B 429, 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 B 209 (B 209M), alloy 6061-T6. Gate hinges may be offset type wrought aluminum, ASTM B 209 (B209M), alloy 6061-T6, or galvanized malleable iron. Fabric shall be in accordance with 910.18(c).

(e) Control Procedures for Furnishing Fence and Accessories

1. General Requirements

All fence and accessory materials shall be subject to the control procedures set out herein. The control procedure methods which may be used are as follows.

a. Suppliers qualified to furnish pretested approved stockpiled material;

b. Suppliers not qualified or not desiring to furnish pretested approved stockpiled material.

2. Suppliers of Pretested Approved Stockpiled Material

Suppliers desiring to furnish pretested approved stockpiled material shall contact the District Materials and Tests Engineer. A written request will not be required.

The requirements set out in the General Procedures for Controlling Materials Approved Prior to Delivery to the Project will apply with the following additions, modifications, or clarifications.

a. Posts, braces, or similar pieces shall be bundled before or after sampling, but prior to approval.

b. All tests will be preformed at the Materials and Tests Division.

c. Basis of acceptance will be a car seal attached to each roll of fence, barbed wire or tension wire, and each bundle of posts. Acceptance numbers will not be issued for accessories such as post caps, brackets, or tie wires.

d. If a complete roll or bundle is not shipped, the car seal shall be retained with the unused portion. The number shall be supplied to the Engineer for the material acceptance.

3. Suppliers Not Furnishing Pretested Approved Stockpiled Material

Suppliers not desiring to retain status or who lose status to furnish pretested stockpiled material will have their material inspected at the project site after delivery. No material may be used until it has been tested and approved.

910.19 Overhead Sign Structures

The complete structure with signs in place shall be able to withstand wind pressure in accordance with AASHTO specifications for the Design and Construction of Structural Supports for Highway Signs. The structure shall be designed to resist movement by the wind which might contribute to the fatigue of the material.

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 F 738M.

Strain poles for cable span signs shall be in accordance with 922.05(a). Each strain pole shall include three band type attachments for span wire clamps. Such attachments shall be galvanized in accordance with ASTM A 153. Cable shall be in accordance with 922.06(b). Each cable shall include three wire rope clips at each end. Anchor bolts shall be in accordance with 922.05(c)6. All sign mounting hardware except for the extruded aluminum bar shall be galvanized in accordance with ASTM A 153.

Material furnished under this specification shall be covered by a type C certification in accordance with 916.

(a) Aluminum Overhead Sign Structures, Box Truss and Bridge Attached

Extruded tubes shall be of aluminum in accordance with ASTM B 221 (B 221M), B 241 (B 241M), or B 429, alloy 6061-T6. Anchor base castings shall be of aluminum in accordance with ASTM B 26 (B 26M) or B 108, alloy 356.0-T6. All other castings shall be of aluminum in accordance with ASTM B 26 (B 26M), alloy 356.0-T6. Plates shall be of aluminum in accordance with ASTM B 209 (B 209M), alloy 6061-T6. Plates shall be free of sharp edges and irregularities.

Welding material and procedures shall be in accordance with applicable AWS provisions.

Bolts, nuts, screws, and flat washers shall be passivated type 304 stainless steel. Bolts and screws shall be in accordance with ASTM A 193 (A 193M), grade B8. Hexagon nuts and washers shall be in accordance with ASTM A 194 (A 194M), grade 8.

Anchor bolts shall be in accordance with ASTM A 307. A hexagon nut, leveling nut, and flat washer in accordance with ASTM A 307, grade A, shall be furnished with each anchor bolt. Threaded ends of anchor bolts and associated hardware shall be coated in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

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 ER4043 filler material. Welders shall qualify by passing the requirements of "Procedure and Performance Tests of Qualification Standard for Welding Procedures, Welders, and Welding Operations", latest edition, formulated by the Boiler and Pressure Vessel Committee of the American Society of Mechanical Engineers.

Welding shall be checked carefully by visual inspection. Poor welding workmanship as noted by visual inspection shall be sufficient cause for rejection.

Each complete structure shall be warranted that it is free from any misfits or structural deficiencies prior to shipment.

(b) Steel Overhead Sign Structures, Box Truss, Cantilever, Monotube, and Bridge Attached

Steel sections used for upright members, cross beams, or horizontal members shall be either tapered or constant cross section tubular members as specified herein. The tubular members may be either circular or multi-sided.

Box truss and bridge attached structures shall be fabricated from constant cross section tubular steel in accordance with ASTM A 53, type E or S, grade B. Constant cross section tubular steel with greater yield strength may be used, with written approval. However, structural dimensions must remain as shown on the plans. Structures shall be galvanized after fabrication in accordance with ASTM A 123.

Tri-cord truss, cantilever, and monotube structures shall be made of tapered tubular members in accordance with either ASTM A 595 or ASTM A 572, grade 50 (A 572M, grade 345), or of constant cross section tubular members in accordance with API High Test Line Pipe, grade X-52. Members shall have a minimum yield strength of 50,000 psi (345 MPa). Structures shall be galvanized after fabrication in accordance with ASTM A 123.

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 3 band type attachments for span wire clamps. The band shall be from material in accordance with ASTM A 572, grade 50 (A 572M, grade 345); ASTM A 606; 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. (450 mm) from the top with a 100 lb (445 N) load.

Pole Size	**Deflection**
15 in. x 30 in. (380 mm x 910 mm)	0.16 in. (4.1 mm)
14 in. x 26 in. (356 mm x 790 mm)	0.12 in. (3.0 mm)

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.

Gusset, flange, and base plates shall be in accordance with ASTM A 36 (A 36M) and shall be galvanized after fabrication in accordance with ASTM A 123. 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 A 126 and shall be galvanized with a minimum coating of 2 oz/sq ft (610 g/m^2). Bolts, except anchor bolts, and nuts shall be in accordance with ASTM A 307. Two nuts for use in plumbing upright poles shall be furnished with each anchor bolt. Anchor bolts, except for box truss structures, shall be in accordance with ASTM A 675, grade 90 (A 675M, grade 620); ASTM A 576 modified to 55,000 psi (379 MPa) minimum yield strength; or ASTM A 307, grade A modified to 55,000 psi (379 MPA) minimum yield strength. Anchor bolts for box truss structures shall be in accordance with 910.19(a). Steel bolts, nuts, washers, and threaded ends of anchor bolts shall be coated in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C. Welding shall be in accordance with 711.32.

Beam clamp details and sign support assemblies shall be galvanized in accordance with ASTM A 153. Clamps shall be fabricated of high strength, low alloy steel in accordance with ASTM A 242 (A 242M), ASTM A 606, 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

Materials for steel bridge railing components shall be in accordance with the following.

(a) Railing tubing shall be in accordance with ASTM A 500, Grade B.

(b) Posts, connection plates, splice bars, base plates, and anchor channel bars shall be in accordance with ASTM A 36 (A 36M).

(c) Steel bolts, nuts, and cap screws shall be in accordance with ASTM A 307.

(d) Railing end caps shall be steel castings in accordance with ASTM A 27, grade 70-36 (A 27M, grade 485-250).

(e) Threaded rods, nuts, and washers shall be in accordance with AASHTO M 164.

(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 A 276, type 304, 305, or 430.

(h) Anchor bolts shall be stainless steel in accordance with ASTM A 276, type 305 or 430. However, they shall have a minimum ultimate strength of 100 ksi (690 MPa). Threads may be cut or rolled.

(i) Railing tubing, posts, connection plates, splice bars, base plates, 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) Anchor bolts furnished under this specification shall be covered by a type A certification in accordance with 916. All other components furnished under this specification shall be covered by a type C certification in accordance with 916.

910.21 Steel Sheet Piling

Steel sheet piling shall be in accordance with ASTM A 328 (A 328M), ASTM A 1011 (A 1011M), or ASTM A 525 (A 525M).

SECTION 911 – WOOD MATERIALS

911.01 Untreated Lumber

(a) General

Untreated limber is a saw mill product which is not further manufactured than by sawing, resawing, passing lengthwise through a standard planning machine, cross cutting to length, and machining but is not treated with preservatives.

All lumber to be used without preservative treatment shall have the heart center completely boxed in pieces 6 in. (150 mm) and over in thickness. Pieces not large enough to box the center shall be cut outside the heart. Stringers, floor beams, and flooring shall have no less than 80% of heart on any girth. Caps, sills, and posts shall have no less than 60% of heart on each of the four sides measured across the side. Bracing, struts, rails, and such shall have no less than 80% on both sides measured across the side. If plans or purchase order are marked “Square Edge”, no wane will be permitted.

1. Boards

Yard lumber less than 2 in. (50 mm) thick and more than 1 in. (25 mm) wide is a board.

2. Dimension Lumber

Lumber from 2 in. (50 mm) to but not including 5 in. (125 mm) thick and 2 in. (50 mm) or more wide is dimension lumber.

3. Structural Lumber

Lumber that is 2 in. (50 mm) or more thick and 4 in. (100 mm) 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. Joists and planks shall be structural lumber. Dimensions and grade of lumber shall be as shown on the plans or as otherwise specified.

4. Timbers

Lumber of 5 in. (125 mm) or more in the least dimension is timber. Timbers may be classified as beams, stringers, posts, caps, sills, girders, purlins, etc. Timber for structural purposes shall be no less than 6 in. (150 mm) in width or thickness. Dimensions and grade of lumber shall be as shown on the plans or as otherwise specified.

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 permitted or shown on the plans, no minus tolerances will be permitted on the specified diameter.

6. Yard Lumber

Lumber of all sizes and patterns that is 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 Lumber

Lumber as it comes from the saw is rough lumber.

(b) Species and Grade

Only coast region douglas fir, red oak group, redwood, long or short leaf southern yellow pine, and white oak group will be permitted, 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 PS20-70. 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.

Coastal Region 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.

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 douglas fir and southern yellow pine.

Lumber for temporary bridges or other temporary structures may be of any species and grade which meets approval.

(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 sawed, or dressed lumber shall be in accordance with the following table.

Nominal Dimensions		Rough Lumber Tolerances*		Surfaced Lumber Tolerances (SIS and S2S to S4S)	
Thickness in. (mm)	Width in. (mm)	Thickness in. (mm)	Width in. (mm)	Thickness in. (mm)	Width in. (mm)
1 (25)	Under 8 (200)	1/8 (3)	1/4 (6)	1/4 (6)	3/8 (10)
	8 (200) and over	1/8 (3)	3/8 (10)	1/4 (6)	1/2 (13)
2 (50)	Under 8 (200)	1/4 (6)	1/4 (6)	3/8 (10)	3/8 (10)
	8 (200) and over	1/4 (6)	3/8 (10)	3/8 (10)	1/2 (13)
Over 2 (50) but Less than 8 (200)	Under 8 (200)	1/4 (6)	1/4 (6)	3/8 (10)	3/8 (10)
	8 (200) and over	1/4 (6)	3/8 (10)	3/8 (10)	1/2 (13)
8 (200) and over	8 (200) and over	3/8 (10)	3/8 (10)	1/2 (13)	1/2 (13)

* If full size rough lumber is specified, no minus tolerances will be permitted.

(e) Untreated Piling

Untreated piles shall be cut from white or red oak, dense southern yellow pine, fir, or cypress, preference given in the order named. Subject to approval, they may be of other species which can withstand driving without showing excessive brooming or splitting.

All piling shall have been cut from sound, solid, live trees. The shall contain no ring shakes, dote, or unsound knots. Sound knots will be permitted provided the diameter of the knot does not exceed 4 in. (100 mm) or 1/3 of the diameter of the pile where it occurs, whichever is the smaller. Any defects, or combination of defects, which impair the strength of the pile will not be permitted. The piles shall be free from twist of grain exceeding 1/2 of the circumference in any 20 ft (6.1 m) of length. The butts shall be sawed square and the tips sawed square or tapered to a point of not less than 16 in.^{2} (10 300 mm^2) with the tip so formed that the centerline of the pile passes through the tip.

Unless otherwise specified, all piles shall be peeled before driving by removing all the rough bark and at least 80% of the inner bark. No strip of the inner bark remaining on the pile shall be more than 3/4 in. (19 mm) wide and there shall be at least 1 in. (25 mm) of barkfree surface between any two such strips. Not less than 80% of the surface on any one circumference shall be clean wood. Piles shall be cut above the ground swell, and shall have a uniform taper from butt to tip. All knots shall be trimmed flush with the body of the pile.

A line drawn from the center of the tip to the center of the butt shall not fall outside the center of the pile at any point more than 1% of the length of the pile. In short bends, the distance from the center of the pile to a line stretched from the center of the pile above the bend to the center of the pile below the bend shall not exceed 4% of the length of the bend, but in no case more than 2 1/2 in. (63 mm). Piles shall be free from reverse bends.

After peeling, piles shall have diameters as indicated below unless otherwise approved or required.

	Diameter – Inches (mm)		
Length of Pile	Tip Minimum	3' (0.9 m) from Butt, Minimum	Butt Maximum
Less than 20 ft (6.1 m)	8 (200)	11 (279)	20 (508)
20 ft (6.1 m) and less than 40 ft (12.2 m)	8 (200)	12 (305)	20 (508)
40 ft (12.2 m) and less than 60 ft (18.3 m)	7 (178)	13 (330)	20 (508)
60 ft (18.3 m) and more	6 (152)	13 (330)	20 (508)

911.02 Treated Lumber

(a) General

Treated lumber shall be lumber which is preservative treated by pressure processes in accordance with the AWPA Standards. AWPA Standard C1 specifies general requirements for all wood products. Other AWPA Standards applying to specific

items are set out in 911.02(b), 911.02(c), 911.02(d), and 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), 911.02(d), and 911.02(e). The lumber may be inspected at the treating plant. Preservatives shall be in accordance with 911.02(f). Wherever ammoniacal copper quat type B preservative is utilized, stainless steel fasteners shall be used.

(b) Bridge Lumber

This shall be southern yellow pine or coast region douglas fir. There shall be no heartwood requirements and the amount of sapwood shall not be limited. Wane will not be permitted on any treated plank for flooring and may be excluded elsewhere when so specified. In other lumber, wane shall not exceed 1/8 of the width of any face and 1/4 of the length of the piece on any one corner. Both the outer and inner bark shall be removed from any area where wane is permitted. Lumber for bridges shall be treated with a preservative in accordance with applicable provisions of Standards C14 and C2 of the AWPA Standards.

(c) Piling

Wood piling, before treatment, shall be in accordance with 911.01(e) except piles shall be southern yellow pine, red oak, or coast region douglas fir. The outer and inner bark shall be removed before treatment. Unless otherwise specified, piling shall be treated with creosote in accordance with the applicable provisions of Standards C14 and C3 of the AWPA Standards.

(d) Guardrail Posts, Braces, and Battens

Wood for these items shall be cut from live, dense southern yellow pine, coast region douglas fir, red oak, or other species if so designated in the proposal or purchase order. Posts shall be rough sawed unless otherwise specified. Dimensions shall be as shown on the plans. There shall be a length tolerance of plus 2 in. (50 mm) for posts. The bottoms shall be sawed square and the tops roofed as shown on the plans. Wane shall not extend more than 2 ft (0.6 m) from the bottom end. Knots shall be closely trimmed, but hollow knots extending in close to the center of the post, loose knots, and knot clusters will not be permitted. Posts shall be practically straight and no post with a crook exceeding 1 in. (25 mm) between top and butt will be accepted.

Posts listed above shall be sound posts. No sapwood rot will be permitted. Ring shake will not be permitted and oak posts shall be free from pecks or excessive grub holes. Grub holes in the butt, 1/2 in. (13 mm) or less in diameter, are not considered defects. Posts containing ant holes will not be accepted. Any post which contains any defect which is detrimental to the post will be rejected.

Wood braces and battens shall be of the same general species and specifications as required for the posts and shall be of the dimensions shown on the plans.

Wood guardrail posts, and wood parts in connection with guardrails, shall be treated with a preservative in accordance with the applicable provisions of Standards C14 and C2 of the AWPA Standards.

(e) Sign Posts

Wood sign posts shall be cut from live catalpa; northern white cedar; native red cedar; southern red cedar; black locust; yellow locust; mulberry; red, black, and white oak group; osage orange; dense southern yellow pine; redwood; sassafras; coast region douglas fir, or other species as specified. Posts shall be surfaced four sides.

Dimensions shall be in accordance with the plans. There shall be a length tolerance of 2 in. (50 mm). Both butt and top ends shall be sawed square. All outer and inner bark shall be removed. One way sweep, not exceeding 1 in. (25 mm) between the top and butt, will be acceptable. Short crooks will not be permitted.

The posts shall be sound timber. No splits, shakes, excessive cracks, loose decayed or hollow knots will be permitted. 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 Standards C14 and C2 of the AWPA Standards. The oil carrier shall be a heavy petroleum solvent in accordance with the applicable provisions of Standard P9 of the AWPA Standards and shall be of such characteristics that the posts will be suitable for painting with an oil base paint.

(f) Sawed Timber Posts and Blocks for Thrie-Beam and W-Beam Guardrail

The requirements for posts and blocks prior to treatment shall be as shown below.

1. Species and Grades

Wood posts shall be of the species listed, and shall be in accordance with the grading requirements specified in Table A. Wood blocks shall be of the species listed, and shall be in accordance with the grading requirements specified in Table B. Wood posts and blocks shall have a nominal cross section and dimensions as shown on the plans.

TABLE A

SPECIAL AND GRADING REQUIREMENTS FOR SAWED TIMBER GUARDRAIL POSTS		
SPECIES	POSTS & TIMBERS GRADE	GRADING RULES AGENCIES[a]
HARDWOODS		
Red Oak (Northern Red, Black, Pin, Laurel, Cherry-Bark, Scarlet, Water and Willow Oaks)[b], Hard Maple (Black & Sugar) and Red Maple, White Ash, White-Heartwood Beech, Yellow Birch, Hickory (Mockernut, Pignut, Shagbark, and Shellbark Hickories)	Grade GRP	Department
SOFTWOODS		
Douglas Fir, Douglas Fir-Larch	No. 1 or better	WWPA or WCLIB
Southern Pine	No. 1 or better	SPIB
Jack Pine 8 in. x 8 in. (200 mm x 200 mm)	No. 1 or better	NHPMA

[a] NHPMA (Northern Hardwood and Pine Manufacturers Assoc.); WWPA (Western Wood Products Assoc.); WCLIB (West Coast Lumber Inspection Bureau); and SPIB (Southern Pine Inspection Bureau).
[b] Southern Red Oak will not be permitted.

Posts and blocks shall be graded in accordance with grading rules based on principles and methods specified in ASTM D 245. 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.

TABLE B

SPECIES AND GRADING REQUIREMENTS FOR SAWED TIMBER GUARDRAIL BLOCKS		
SPECIES	POSTS & TIMBERS GRADE	GRADING RULES AGENCIES[a]
HARDWOODS		
Red Oak (Northern Red, Black, Pin, Laurel, Cherry-Bark, Scarlet, Water and Willow Oaks)[b], Hard Maple (Black & Sugar) and Red Maple, White Ash, White-Heartwood Beech, Yellow Birch, Hickory (Mockernut, Pignut, Shagbark, and Shellbark Hickories)	Grade GRP	Department
SOFTWOODS		
Douglas Fir, Douglas Fir-Larch	No. 2 or better	WWPA or WCLIB
Southern Pine Species	No. 2 or better	SPIB
Jack Pine, Red Pine, and Eastern White Pine (Northern White Pine)	No. 1 or better	NHPMA

[a] NHPMA (Northern Hardwood and Pine Manufacturers Assoc.); WWPA (Western Wood Products Assoc.); WCLIB (West Coast Lumber Inspection Bureau); and SPIB (Southern Pine Inspection Bureau).
[b] Southern Red Oak will not be permitted.

2. Department Grade GRP

The requirements for posts to be in accordance with the Department's Grade GRP, Guardrail Posts, will be as follows.

a. Splits

Splits in the plane of the bolt hole shall not exceed 3 in. (75 mm). At other locations, splits shall not exceed 6 in. (150 mm).

b. Checks

Single checks shall not be greater than 3 in. (75 mm) deep. Checks opposite each other shall not total more than 3 in. (75 mm) deep, as measured with a probe that is not more than 1/16 in. (1.6 mm) in thickness or in diameter.

Single checks of 1/4 in. (6 mm) wide, or wider, measured at the widest point, shall not extend more than one third of the length of the post. Single checks, measured at the widest point, shall not exceed 3/8 in. (10 mm) in width.

c. Shakes

Shakes, measured in the least dimension, shall not exceed 2 in. (50 mm).

Splits, checks, and shakes shall not be in combinations which may cause the post to separate into several pieces.

d. Stains

Stained heartwood, not caused by decay, shall not exceed 15% of the piece.

e. Slope of Grain

Slope of the grain shall not exceed 1 in 10.

f. Wane

Wane shall be less than one quarter of each face.

g. Knots

Knots shall be sound and tight. The sum of the least dimensions of all knots in a 6 in. (150 mm) length of post, all faces, shall be less than 5 in. (125 mm). Grain distortion caused by knot clusters shall not exceed 2 1/2 in. (63 mm). Knots will be permitted on all faces, but knots shall not exceed 2 1/2 in. (63 mm) in the least dimension.

3. Department Grade GRB

The requirements for blocks to be in accordance with the Department's Grade GRB, Guardrail Blocks, will be as follows.

a. Splits

Splits in the plane of the bolt hole shall not exceed 3 in. (75 mm). At other locations, splits shall not exceed 5 in. (125 mm).

b. Checks

Checks shall be in accordance with 911.02(f)2b.

c. Shakes

Shakes, measured in the least dimension, shall not exceed 3 in. (75 mm). Shakes shall not extend beyond half the standard grading length of the piece.

Splits, checks, and shakes shall not be in combinations which may cause the post to separate into several pieces.

d. Stains

Stained heartwood, not caused by decay, shall not exceed 25% of the piece.

e. Wane

Wane shall be less than one third of each face.

f. Knots

Grain distortion caused by knot clusters shall not exceed 4 in. (100 mm). Knots will be permitted on all faces, but knots shall not exceed 4 in. (100 mm) in the least dimension.

4. General Requirements

Posts and blocks shall be in accordance with the following general requirements.

a. Decay

Posts and blocks shall be free from decay before treatment.

b. Unsound Wood

Posts containing unsound wood will be rejected. Blocks may contain small spots of unsound wood provided they are well scattered.

c. Crook or Bow

Crook or bow shall not exceed 1 in. per 10 ft (25 mm per 3 m) length.

d. Dimensional Tolerances

Posts and blocks shall be sawed square to within -1/2 in. (-13 mm) of the specified cross-sectional dimensions. A tolerance of -2 in. (-50 mm) will be permitted on the specific length of the posts. A tolerance of -1/2 in. (-13 mm) will be permitted on the specified length of the blocks.

5. Pressure Treating Posts and Blocks

Pressure treating posts and blocks shall be in accordance with the following requirements.

a. Machining

Posts and blocks shall be sawed to their final shape and holes bored prior to treatment.

b. Blank

c. 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 as specified below, in accordance with AWPA Standard M2. Tests of representative pieces shall be conducted. The minimum number of tests shall be the lesser of 5% or 50 pieces out of a charge.

d. Test for Moisture Content

The test shall be made with an electrical resistance type moisture meter with insulated needles of 1 1/2 in. (38 mm) in length. The readings shall be corrected for species and temperature readings in accordance with the meter instructions. The readings shall be taken on one surface at mid-length with needles driven to their full length. The lot will be considered acceptable when the average moisture content does not exceed 19%. Individual pieces exceeding 23% moisture content will be rejected. Such pieces shall be removed from the lot.

e. Preservative Treatment

All posts and blocks shall be treated with a preservative as specified herein.

f. Material for Preservative Treatments

The preservative used for treating posts and blocks shall be in accordance with the appropriate AWPA standards listed in Table C.

TABLE C

MATERIAL	AWPA Standard
Ammoniacal Copper Arsenate (ACA)	P5
Ammoniacal Copper Zinc Arsenate (ACZA)	P5
Chromated Copper Arsenate (CCA)	P5

g. Treatment Methods

Wood for guardrail posts and blocks shall be treated to be in accordance with AWPA Standards C1 and C2, ASTM D 1760, and the requirements specified herein.

h. Sorting and Spacing

The material in a charge shall consist of the same species or consist of species within one group shown in Table D. The material shall have similar moisture content and be of similar form and size. Blocks and posts may be treated in the same charge.

Pieces in the charge shall be separated by horizontal stickers so that preservative and steam, if used, shall contact all horizontal surfaces.

TABLE D

SPECIES GROUPINGS FOR TREATMENT IN SAME CHARGE	
GROUP	SPECIES
A	Southern Pine
B	Douglas Fir
C	Jack Pine*
D	Hardwoods

* Also Red Pine and Eastern White Pine Blocks.

i. Conditioning

Material may be conditioned by means of air seasoning, kiln drying, Boulton drying, vapor drying, steaming, or heating in preservative except as limited herein. Material which is air seasoned or kiln dried shall have an average moisture content not exceeding 19% before treatment. When steam conditioning, the maximum temperature shown in Table E shall not be reached in less than 1 h. If a vacuum is applied after steaming, it shall be a minimum of 22 in. (560 mm) of mercury. In addition, when using CCA, ACA, or ACZA, material shall be removed from the cylinder and permitted to cool to 120°F (49°C), or below, after steaming and before the preservative is applied. When treating southern pine, jack pine, and red pine with CCA, ACA, or ACZA, steaming will only be permitted to thaw frozen or ice coated material.

When conditioning by heating in preservative, the solution shall cover the material. Maximum temperatures permitted shall be those shown in Table E. Conditioning by means of heating in water-borne preservatives CCA, ACA, or ACZA will not be permitted.

TABLE E

CONDITIONING METHODS PERMITTED AND TEMPERATURE REQUIREMENTS FOR METHOD USED					
		HEATING IN			
		STEAMING		PRESERVATIVE	
SPECIES	CONDITIONING METHODS PERMITTED	Max. Temp °F (°C)	Max. Duration Hrs.	Max. Temp °F (°C)	Max. Duration Hrs.
Hard Maple	Air drying only				
Other Hardwoods(1)	No Steaming			220 (104)	No Limit
Southern Pine	Shown in 910.02(f)5i	245 (118)	17	220 (104)	No Limit
Eastern White Pine	All	240 (116)	4 1/2	210 (99)	6 (3)
Other Softwoods(2)	Shown in 910.02(f)5i	240 (116)	6	210 (99)	6 (3)

(1) Red Oak, White Ash, White-heartwood beech, Yellow Birch, Hickory, and Red Maple
(2) Jack Pine, Douglas Fir, and Red Pine
(3) If seasoned material is used, otherwise, no limits

j. Blank

k. 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.

l. Retentions

The minimum retentions in lb/cu ft (kg/m^3) for the outer 0.6 in. (15 mm) of guardrail posts and blocks shall be those listed in Table F. Retentions shall be determined by chemical assay with samples taken after treatment in accordance with the inspection after treatment requirements shown below and the AWPA Standards listed in Table F.

TABLE F

MINIMUM REQUIREMENTS FOR RETENTION OF PRESERVATIVE			
PRESERVATIVE	RETENTION lb/cu ft (kg/m^3)		AWPA STANDARD
	POSTS	BLOCKS	
CCA, ACA, or ACZA	0.60 (9.61)	0.40 (6.41)	A11

If blocks are treated along with posts, retention of the charge shall be determined by assay of borings from posts.

m. Penetration

The penetration requirements for heartwood and sapwood shall be as specified in Table G. Samples to determine penetration shall be taken after treatment in accordance with the inspection after treatment requirements shown below.

TABLE G

PENETRATION REQUIREMENTS FOR POSTS AND BLOCKS		
SPECIES	MINIMUM PENETRATION	
	HEARTWOOD	SAPWOOD
Permitted Species*	0.3 in. (8 mm)	0.6 in. (15 mm) or 90%, whichever is greater

* For Red Oak, 65% of the total annual rings shall be penetrated. If this is not possible, properly conditioned wood may be treated to refusal.

n. Inspection After Treatment

Following treatment, the charge shall be examined by the treater for cleanliness; mechanical damage to individual pieces; treatment damage such as severe checking, splitting, or honeycombing; and for untreated areas resulting from air pockets, floating material, or insufficient height of preservative. All such material shall be removed from the remaining acceptable material before shipment.

Sampling and testing for preservative retention and penetration will be done by the Department.

o. Branding

All post and blocks shall be burn branded clearly and permanently on one of the wide faces. The brand shall be within 12 in. (300 mm) 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 or group code designation shown in Table H, the preservative type, and retention, all in accordance with AWPA Standard M6.

p. 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.

TABLE H

GROUP CODING AS AN ALTERNATE TO SPECIES CODING*	
GROUP	CODE
Hardwoods	MH
Jack Pine	J
Other Softwoods	MS

* Species designated in Tables A and B

q. 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 Part 7.2 of AWPA Standard M2. These records shall be retained by the treating plant for five years from the date of material shipment.

r. 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.

6. Field Treatment of Posts and Blocks

Cuts, holes, or injuries to the surface of posts and blocks which occur after pressure treatment shall be field-treated by brushing, spraying, dipping, soaking, or coating. The Contractor shall ensure that all injuries, such as abrasions and nail and spike holes, are thoroughly saturated with the field-treating solution. Holes bored in pressure-treated materials shall be poured full of preservative. Horizontal holes may be filled by pouring the preservative into the holes with a bent funnel after temporarily plugging the other end of the hole.

The solution used for field treatment shall be a 20% solution of copper naphthenate.

7. Rejection for Degrade After Treatment

Guardrail posts or blocks developing the following degrade prior to installation will be rejected regardless of prior approvals.

a. single checks greater than 3 in. (75 mm) deep or checks opposite each other totaling more than 3 in. (75 mm) deep, measured with a probe not more than 1/16 in. (2 mm) thick;

b. single checks 1/4 in. (6 mm) wide or wider measured at the widest point, and extending more than one third of the length of the post or block;

c. single checks greater than 3/8 in. (10 mm) wide measured at the widest point;

d. splits greater than 3 in. (75 mm) long which are in the plane of the bolt hole;

e. crooks or bows exceeding 1 in. (25 mm) per 10 ft (3 m) 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 block to separate into several pieces.

(g) Recreational Applications

Lumber that will be used where human contact will occur, such as handrails and picnic tables, will be treated with ammoniacal copper quat, type B in accordance with AWPA Standards C-14 and P-5. The treater shall perform inspection and marking in accordance with AASHTO M 133. Material furnished under this specification shall be covered by a type C certification in accordance with 916.

(h) Preservatives

Preservatives shall be in accordance with AASHTO M 133 as modified by EPA regulation.

Waterborne preservatives shall be in accordance with AWPA-P5, and shall be Acid Copper Chromate, Ammoniacal Copper Arsenate, or Chromated Copper Arsenate.

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

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 (3.4 kg/m^2) and shall be in strips of not less than 40 in. (1.0 m) nor more than 120 in. (3.0 m) wide and no less than 2 ft (0.60 m) longer than the width of the pavement being cured.

(b) Waterproof Paper Blankets

These blankets shall be in accordance with AASHTO M 171.

(c) White Polyethylene Sheeting, Film

The sheeting shall be in accordance with AASHTO M 171.

(d) White Burlap Polyethylene Sheet

These sheets shall be in accordance with AASHTO M 171.

(e) Liquid Membrane Forming Compounds

These compounds shall be in accordance with AASHTO M 148, type 2, except the drying time requirement will be determined on a glass surface.

(f) Polyethylene Film

The sheeting shall be in accordance with AASHTO M 171.

912.02 Curing-Sealing Materials

Curing-sealing materials are single application curing and sealing products for portland cement concrete.

A list of approved Curing-Sealing Materials will be maintained by the Department. The list will identify pre-approved products, specify the manufacturer and product designation, and include application instructions.

In order to have a product added to the list of approved Curing-Sealing Materials, the manufacturer shall furnish to the Materials and Tests Division a type A certification in accordance with 916. Such certification shall state that the product is in accordance with the requirements of NCHRP 244 Series IV Southern Climate Weathering Test, and AASHTO M 148 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 reconsideration of the certification.

(c) Tests must 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 approved, it will be added to the list of approved and/or Prequalified 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 there has been a change in raw materials, formulation, or procedures for manufacture shall be recertified in order to remain on the list.

A curing-sealing material that performs unsatisfactorily in the field will be removed from the approved list.

912.03 Admixtures for Use in Concrete

Admixtures for use in PCC shall be selected from the Department's list of approved Admixtures for PCC. An admixture may be added to the approved list by

completing the requirements in ITM 806, Procedure D. Admixtures containing chloride added as an ingredient of manufacture are unacceptable.

(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 the purpose or purposes indicated below.

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.

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.

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.

8. High Range Water Reducing Admixture System

HRWR admixture system is a combination of admixtures that act as a type F mixture 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.

(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.

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.

   a. infrared analysis, residue by oven drying, and specific gravity;

   b. water content and time of setting;

   c. flexural strength at three, seven, and 28 days;

   d. relative durability.

912.04 Latex Modifiers

The 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 in the list of approved Admixtures for Portland Cement Concrete.

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 shall be furnished in accordance with 916.

Physical properties of the latex modifier shall be in accordance with the following:

Polymer Type..... Styrene Butadiene
Stabilizers..... Anionic and Nonionic Surfactants
Anitfoaming Agent ..... Polydimethyl Siloxane
Percent Solids, % by Mass.....46.0 Minimum

Mass Per Gallon (Liter) ..... 8.4 lb (1.0 kg) at Minimum
pH (as shipped) 9.0-11.0
Freeze/Thaw Stability ..... Five Cycles, -15° to 25°C
Shelf Life ..... Two Years, Minimum
Color ..... White

SECTION 913 – SOIL TREATMENT MATERIALS

913.01 Water

Water used in mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Water will be tested in accordance with AASHTO T 26. Water shall be in accordance with the requirements as follows.

(a) pH..... 6 to 8
(b) Chloride Ions.....less than 300 ppm
(c) Sulphate (SO_4) .....less than 500 ppm
(d) Total Solids .....less than 1500 ppm

In addition, water containing algae will be unacceptable for use in concrete. Water known to be of potable quality may be used without test. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

913.02 Calcium Chloride

Calcium chloride shall be in accordance with AASHTO M 144 and shall be:

(a) Type S, grade 1, class A

(b) Type S, grade 3, 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.

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 C 207, Type N.

(b) Lime for Soil Modification

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 C 25 having the following requirements.

a. The lime by-products shall contain a minimum of 60% total available 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. Sieve analysis shall be performed in accordance with ASTM C 110. The lime by-products gradation shall be as follows:

Sieve	% Retained (Max)
No. 4 (4.75 mm)	5
No. 30 (600 µm)	10
No. 100 (150 µm)	25

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 (50 mm) 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.

Topsoil shall have a pH value of 6.2 to 7.4. Testing for pH value shall be performed in the field in accordance with the procedure set out in the Purdue University Agricultural Experiment Station Bulletin No. 635 or in a qualified laboratory in accordance with the procedure set out in the Cornell Experiment Station Bulletin 960, using a one to one Soil-Water Suspension. Agricultural limestone may be added to topsoil in order to raise the pH to meet specification requirements. 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. 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 and Legume Seed

Grass and legume 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.

Seed of warm season grasses, forbs, or aquatic species shall be delivered to the project site individually packaged by species. Warm season 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.

Seeds shall contain none of the noxious weeds listed herein nor any that are listed in the Acts of the General Assembly of the State. Noxious weeds are Canada Thistle, Field Bindweed, Johnson Grass, Perennial Peppergrass, Perennial Sowthistle, Quack Grass, Russian Knapweed, and Wild Garlic.

Clover shall be free from dodder with no tolerance allowed. Lespedza will be allowed no more than 90 dodder/lb (200 dodder/kg) and 45 giant foxtail per lb (20 giant foxtail per kg).

Requirements noted above are minimum and trade allowances will not be permitted.

Seed shall be purchased from sources of supply that have been sampled, tested, and reported by the State Seed Commissioner, Purdue University, West Lafayette, Indiana, and found to be satisfactory. Seed of warm season grasses shall be tested by the State Seed Commissioner or 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. Test results shall be submitted to the State Seed Commissioner, and a copy to the Materials and Tests Division. This report is required before seed is sown. Such test report shall be no more than nine months old at the time seed is used and the use of the seed shall be subject to approval.

Seed which has been tested by the State Seed Commissioner may be used without further testing provided each bag of seed bears a tag showing the seed meets the requirements of the Standard Specifications.

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 permitted.

W x P x G = M or less

$$P = \frac{\text{Minimum Specified Purity}}{\text{Actual Purity}}$$

$$G = \frac{\text{Minimum Specified Germination}}{\text{Actual Germination}}$$

W = Actual percent of weed seeds
P = Purity Factor
G = Germination Factor
M = Maximum percent of weed seeds permitted

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.

Amount to be used = Amount specified x P x G

VARIETY		Percentages of Weed Seed Content (Not more than)
Alfalfa	Medicago sativa	0.5
Alsike Clover	Trifolium hybridum	0.5
Alta Fescue or Ky. 31 Fescue	Festuca elatior (var. arundinacea)	0.75
Birdsfoot Trefoil	Lotus corniculatus	0.5
Chewings Fescue	Festuca rubra (var. fallax)	0.5
English Perennial Rye	Lolium perfenne	0.5
Kentucky Bluegrass	Poa prateusis	0.5
Korean Lespedeza	Lespedeza stipulacea	0.75
Sericea Lespedeza	Lespedeza sericea	0.75
Ladino Clover	Trifolium repens (var. latum)	0.5
Lemons Alkali Grass	Puccinellia airoides (Lemons)	0.5
Orchard Grass	Dactylis glomerata	0.5
Red Clover	Trifolium pratense	0.5
Red Fescue	Festuca rubra	0.5
Red Top	Agrostis alba	0.75
Rough Stalked Meadowgrass	Poa trivialis	0.5
Rye, Agricultural	Secale cereale	0.5
Rye, Annual	Lolium multiforum	0.5
Sheeps Fescue	Festuca orina	0.5
Smooth Brome Grass	Bromus inermis	0.95
Sweet Clover-white (Scarified)	Melilotus alba	0.5
Sweet Clover-yellow (Scarified)	Melilotus officinalis	0.5
Timothy	Phleum pratense	0.5

White Clover .....Trifolium repens.....0.75

VARIETY		Percentages of Purity (Not more than)
Alfalfa	Medicago sativa	99
Alsike Clover	Trifolium hybridum	97
Alta Fescue or Ky. 31 Fescue	Festuca elatior (var. arundinacea)	98
Birdsfoot Trefoil	Lotus corniculatus	98
Chewings Fescue	Festuca rubra (var. fallax)	97
English Perennial Rye	Lolium perfenne	95
Kentucky Bluegrass	Poa prateusis	85
Korean Lespedeza	Lespedeza stipulacea	98
Sericea Lespedeza	Lespedeza sericea	98
Ladino Clover	Trifolium repens (var. latum)	98
Lemons Alkali Grass	Puccinellia airoides (Lemons)	85
Orchard Grass	Dactylis glomerata	85
Red Clover	Trifolium pratense	98
Red Fescue	Festuca rubra	95
Red Top	Agrostis alba	90
Rough Stalked Meadowgrass	Poa trivialis	85
Rye, Agricultural	Secale cereale	99
Rye, Annual	Lolium multiforum	95
Sheeps Fescue	Festuca orina	97
Smooth Brome Grass	Bromus inermis	85
Sweet Clover-white (Scarified)	Melilotus alba	98
Sweet Clover-yellow (Scarified)	Melilotus officinalis	98
Timothy	Phleum pratense	90
White Clover	Trifolium repens	97

VARIETY		Percentages Actual Germination (Not more than)
Alfalfa	Medicago sativa	85*
Alsike Clover	Trifolium hybridum	85*
Alta Fescue or Ky. 31 Fescue	Festuca elatior (var. arundinacea)	85
Birdsfoot Trefoil	Lotus corniculatus	80*
Chewings Fescue	Festuca rubra (var. fallax)	75
English Perennial Rye	Lolium perfenne	90
Kentucky Bluegrass	Poa prateusis	80
Korean Lespedeza	Lespedeza stipulacea	80*
Sericea Lespedeza	Lespedeza sericea	80*

Ladino Clover	Trifolium repens (var. latum)	85*
Lemons Alkali Grass	Puccinellia airoides (Lemons)	80
Orchard Grass	Dactylis glomerata	80
Red Clover	Trifolium pratense	90*
Red Fescue	Festuca rubra	85
Red Top	Agrostis alba	80
Rough Stalked Meadowgrass	Poa trivialis	75
Rye, Agricultural	Secale cereale	80
Rye, Annual	Lolium multiforum	90
Sheeps Fescue	Festuca orina	75
Smooth Brome Grass	Bromus inermis	80
Sweet Clover-white (Scarified)	Melilotus alba	85*
Sweet Clover-yellow (Scarified)	Melilotus officinalis	85*
Timothy	Phleum pratense	85
White Clover	Trifolium repens	90*

* including not more than 25% hard seeds

914.05 Mulch

(a) Mulch for Seeding

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. (100 mm to 150 mm). 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.

2. Wood Cellulose Fiber

Wood cellulose fiber mulch shall be made from wood chip particles manufactured articularly 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 permitted, 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%. One hundred grams of oven dried material saturated in water, drained, and weighed shall hold a minimum of 1000 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. (150 mm) 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 in. by 1 in. (75 mm by 25 mm) leno weave, twisted kraft paper yarn netting having a high wet strength, or a biodegradable extruded plastic mesh netting having an approximate minimum opening of 5/8 in. by 5/8 in. (16 mm by 16 mm) to an approximate maximum opening of 2 in. by 1 in. (50 mm by 25 mm). The netting shall be entwined with the excelsior mat for maximum strength and ease of handling. The minimum roll width shall be 4 ft (1.2 m). The mass of the material shall be not less than 0.7 lb/sq yd (0.4 kg/m^2), 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 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 (0.069 kg/m^2). Roll sizes shall have a minimum width of 5 ft (1.5 m).

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 permitted as component in the straw mat. The straw shall be evenly distributed throughout the mat to form a thickness of 1/2 in. ± 1/8 in. (13 mm ± 3 mm). 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 (0.4 kg/m^2). The minimum roll width shall be 6 ft (1.8 m).

(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. (12.5 mm) screen and 100% shall pass the 3 in. (75 mm) screen. Wood chips shall be from green, hardened, deciduous trees. Broken corncobs shall be no longer than 4 in. (100 mm).

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. (50 to 75 mm). Edges of sod shall be cut cleanly, either by hand or machine, to a uniform minimum thickness of 3/4 in. (19 mm) 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. (406 mm) and no less than 2 ft (6.1 m) 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 well as with Federal regulations governing interstate movement of nursery stock. A valid copy of the certification of nursery inspection shall accompany each shipment.

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 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.

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 approved list of sources that is maintained by the Department. This list will specify the sources that are currently on an immediate use basis. If the source is not on the list, then the same procedure shall be followed as stated above for plants to obtain approval.

(a) Quality of Plant Material

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

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. (25 mm) 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

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

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

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

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

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 (2°C). 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.

(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.

Trees shall have straight trunks, be well branched, and have symmetrical tops. There shall be no cuts of limbs over 3/4 in. (19 mm) 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. (300 mm) 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

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.

Nursery stock may by 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, groundcovers, etc., 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.

(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

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

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. (50 mm by 50 mm) 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.

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

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. (25 to 75 mm) and shall be approved before being used.

(e) Pipe

Pipe for underdrains shall be in accordance with 907 or 908. The size and type shall be as specified.

(f) Staples

Staples shall be made from No. 11 gage (3.0 mm) or heavier wire, 1 or 2 in. (25 or 50 mm) wide at the throat and 6 in. (150 mm) from top to bottom after bending. The staples shall be packaged in cartons.

(g) Plastic Net

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. (19 mm by 19 mm). The plastic net shall have a minimum tensile strength of 20 lb (89 N) over a 3 in. (75 mm) width in the machine direction and 15 lb (67 N) over a 3 in. (75 mm) width in the transverse direction. The plastic net shall have a nominal mass of 2.8 ± 0.4 lb per 1000 sq ft (15.6 ± 2.2 g per m^2). 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 (1.8 m).

Material furnished under this specification shall be covered by a type C certification in accordance with 916.

SECTION 915 – BRIDGE PILES AND BEARINGS

915.01 Steel Shell Encased Concrete Piles and Epoxy Coated Steel Shell Encased Reinforced Concrete Piles

(a) General Requirements

Steel shell encased concrete piles and epoxy coated steel shell encased reinforced concrete 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 shell encasement shall be uncoated unless an epoxy coating, in accordance with 915.01(d) is specified.

Steel pile shells shall be of the diameter and minimum wall thickness shown on the plans. All sections shall be one integral piece, substantially cylindrical, except as otherwise required for end sections of the outside diameter specified. All steel pile shells shall be of sufficient strength to withstand driving to the required penetration and bearing.

The tips of shells shall be equipped with conical driving points or flat closure plates. Conical driving points shall be of sufficient dimensions to ensure adequate joint and driving strength. The end of the shell shall have full bearing on the face of the point or against a shoulder inside the point. Unless otherwise permitted, the point shall be conical with a 60 to 90 degrees angle between faces. The point shall be substantially of the same diameter as the end of the shell and butt welded to the end of the lowest section.

If flat closure plates are used, they shall be non-reinforced and of a minimum thickness of 3/4 in. (19 mm) for shells 12 3/4 in. (324 mm) outside diameter and smaller, and 1 in. (25 mm) thick for shells 14 in. (356 mm) outside diameter. For shells larger than 14 in. (356 mm) outside diameter, the plates shall be designed to meet the particular cases. Flat plates shall have a diameter approximately 1/2 in. (13 mm) greater than the diameter of the shell and be fillet welded to the shell, using two passes or beads.

If necessary to facilitate handling, shells may be furnished in sections to be welded in the field to form the final integral lengths required.

The manufacturer shall provide a mill certification showing heat numbers and test results for the specified tests. Each 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 pile shells are driven.

(b) Fluted Steel Pile Shells

Fluted steel pile shells shall have a minimum tensile strength of 50,000 psi (345 MPa) when tested in accordance with ASTM A 370. Test specimens for determination of tensile strength shall be taken longitudinally adjacent to the crest of the flute. The diameter of fluted steel shells shall be measured from crest to crest of flutes.

A sufficient taper will be allowed to permit no less than 6 in. (150 mm) telescoping at the joints. The lowest section shall taper approximately 1 in. (25 mm) in 4 ft (1.2 m) from an 8 in. (203 mm) tip to the specified diameter of the upper end. Flutted steel pile shells with a taper of 1 in. (25 mm) in 7 ft (2.1 m) on the lowest section of long piles may be used provided a minimum of approximately 5 ft (1.5 m) of the top of the pile below cutoff elevation is the full diameter as shown on the plans.

(c) Rounded Steel Pipe Shells

Rounded steel pipe shells, except for end finish, shall be in accordance with ASTM A 252, grade 2 or 3. Welded pipe may be welded with straight or spiral seams.

(d) Epoxy Coating for Piles

Only powdered epoxy resin from the Department's list of approved Coating Materials shall be used for the epoxy coating of steel pile shells 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.

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 Department's list of approved Epoxy Coatings for steel shall supply the information as follows.

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.

b. Fingerprint

The fingerprint shall include the method of test, such as infrared spectroscopy or thermal analysis, and a generic description of the product.

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 which shall substantiate full compliance with the following test requirements.

(1) Tensile Strength and Elongation

The tensile strength and elongation of the coating material shall be tested in accordance with ASTM D 2370 with a rate of elongation of 10% to 20% min. The minimum tensile strength shall be 8,000 psi (56 MPa). The minimum elongation shall be 5%.

(2) Impact Resistance

The impact resistance of the coating shall be tested in accordance with ASTM G 14 using a 5/8 in. (16 mm) diameter tip, and a 12 mil (0.03 mm) minimum coating thickness of a 1/8 in. (3.2 mm) thick panel at 73°F (23°C). Three tests shall be performed. The minimum acceptable value shall be 80 Lbf in. (9.0 N·m) of impact with no visible breaks in the coating.

(3) Abrasion Resistance

The abrasion resistance of the coating shall be tested by means of a Tabor Abraser or its equivalent, using CS-10 wheels and a 2.2 lb (1000 g) load. The minimum allowable mass loss shall not exceed 100 mg per 1000 cycles.

(4) Salt Fog

The weathering resistance of the coating shall be tested by means of a salt spray cabinet following ASTM B 117 for 1000 h. The coating shall not blister or exhibit corrosion, discoloration, or loss of adhesion away from the scribed area.

2. Application

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

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 (50 µm) minimum. Any raised slivers, scabs, laminations or bristles of steel remaining on the newly cleaned surface shall be removed by abrasive sanders. All traces of grit and dust from the blasting shall be removed.

b. Coating Application

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 any 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 G 12 for measurement of film thickness of pipeline coatings on steel. The minimum coating thickness for fusion bonded epoxy shall be 8.0 mils (200 µm) for individual measurements and 12 mils (300 µm) for the average.

(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

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 shall be used in accordance with the manufacturer's instructions to check the coatings for holidays. A 67 1/2 volt Tinker and Rasor Model M-1 detector or its equivalent shall be used.

3. Certification

Material furnished under this specification shall be covered by a type C certification in accordance with 916. In addition, a certificate of compliance prepared by the applicator shall be furnished 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 comply 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

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 A 572, grade 50. Steel H piling shall be handled in the same manner and with the same care 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 Wood Piles

Wood piles shall be in accordance with 911.01(e) or 911.02(c) as specified.

915.04 Elastomeric Bearings

(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 grade of the material shall be as shown on the plans.

(b) Materials

The elastomer portion of the elastomeric compound shall be 100% virgin natural polyisoprene known as natural rubber, or 100% virgin chloroprene 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. Compounds of nominal hardness between the values shown may be used and the test requirements interpolated. When test specimens are cut from the finished product, a ± 15% variation in tensile strength and ultimate elongation will be allowed.

TABLE A

ASTM Standard	Physical Properties	50 Duro	60 Duro	70 Duro
D 2240 D 412	Hardness Tensile Strength, min. psi (kPa) Ultimate Elongation, Min. %	50 ± 5 2500 (17 240) 450	60 ± 5 2500 (17 240) 400	70 ± 5 2500 (17 240) 300
	Heat Resistance			
D 573 70 hr @ 158°F (70°C)	Change in durometer hardness, max. Points Change in tensile strength, max. % Change in ultimate elongation, max. %	+10 -25 -25	+10 -25 -25	+10 -25 -25
	Compression Set			
D 395 Method B	22 h @158°F (70°C), max. %	25	25	25
	Ozone			
D 1149	25 ppm ozone in air by volume, 20% strain 100°F ± 2°F (38°C ± 1°C), 48 h, mounting procedure D 518, Procedure A	No Cracks	No Cracks	No Cracks
	Adhesion			
D 429, B	Bond made during vulcanization, lb/in. (kg/m)	40 (714)	40 (714)	40 (714)
	**Low Temperature Test			
	Bearing or sample preparation 96 h @ -20°F ± 2°F (-29°C ± 1°C), axial load 500 psi (3450 kPa) and strain of 20% "T"* Test Recorded shear resistance after 1 h (Min.) at 25% shear strain psi (kPa) shall not exceed	30 (207)	40 (276)	50 (345)

* Effective rubber thickness

** Unless otherwise specified, the Low Temperature Test will be waived.

TABLE B

ASTM Standard	Physical Properties	50 Duro	60 Duro	70 Duro
D 2240 D 412	Hardness Tensile Strength, min. psi (kPa) Ultimate Elongation, Min. %	50 ± 5 2500 (17 240) 400	60 ± 5 2500 (17 240) 350	70 ± 5 2500 (17 240) 350
	Heat Resistance			
D 573 70 hr @ 212°F (100°C)	Change in durometer hardness, max. Points Change in tensile strength, max. % Change in ultimate elongation, max. %	+15 -15 -40	+15 -15 -40	+15 -15 -40
	Compression Set			
D 395 Method B	22 h @ 212°F (100°C), max. %	35	35	35
	Ozone			
D 1149	100 ppm ozone in air by volume, 20% strain 100°F ± 2°F (38°C ± 1°C), 100 h, mounting procedure D 518, Procedure A	No Cracks	No Cracks	No Cracks
	Adhesion			
D 429, B	Bond made during vulcanization, lb/in. (kg/m)	40 (714)	40 (714)	40 (714)
	**Low Temperature Test			
	Bearing or sample preparation 96 h @ -20°F ± 2°F (-29°C ± 1°C), axial load 500 psi (3450 kPa) and strain of 20% "T"* Test Recorded shear resistance after 1 h (Min.) at 25% shear strain psi (kPa) shall not exceed	50 (345)	75 (517)	100 (690)

* Effective rubber thickness
** Unless otherwise specified, the Low Temperature Test will be waived.

Unless otherwise specified, laminates shall be rolled mild steel sheets in accordance with ASTM A 36 or ASTM A 1011, grade 36.

(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. Edges of the non-elastic laminations shall be covered by a minimum of 1/8 in. (3 mm) of elastomer except at laminate restraining devices and around holes that shall be entirely closed on the finished structure. Air bubbles within the elastomeric material shall be cause for rejection.

Each bearing pad shall be marked permanently to show the manufacturer and the month and year of fabrication.

(d) Appearance and Dimensions

The class for finish and appearance, and flash tolerance, shall be RMA-F3-T.063 for molded bearings and RMA-F2 for extruded bearings in accordance with the requirements of the Rubber Handbook published by the Rubber Manufacturer's Association, Inc.

The permissible variation from the dimensions and configuration required by the plans for both plain and laminated bearings shall be as follows.

Overall Vertical Dimensions
Average Total Thickness 1 1/4 in. (32 mm)
or less .....-0, + 1/8 in. (0, +3.2. mm)
Average Total Thickness Over 1 1/4 in.
(32 mm).....-0, +1/4 in. (0, +6.4 mm)
Overall Horizontal Dimensions .....-1/8 in., +1/4 in. (-3.2 mm, +6.4 mm)
Thickness of Individual Layers Elastomer
(Laminated Bearings Only).....-1/16 in., +1/16 in. (-1.6 mm, +1.6 mm)
Variations from a Plane Parallel to the Theoretical Surface
Top ..... 1/8 in. (3.2 mm)
Sides ..... 1/4 in. (6.4 mm)
Individual Non-Elastic Laminates
(as determined by measurements at the
edges of the bearing)..... 1/8 in. (3.2 mm)
Position of Exposed Connection Members..... 1/8 in. (3.2 mm)
Edge Cover of Embedded Laminates or
Connection Members .....-0, +1/8 in. (0, +3.2 mm)
Size of Holes, Slots, or Inserts.....-0, +1/8 in. (0, + 3.2 mm)
Position of Holes, Slots, or Inserts.....-0, +1/8 in. (0, +3.2 mm)
Thickness of Non-Elastic
Laminates .....-1/32 in., +1/16 in. (-0.8 mm, + 1.6 mm)

(e) Quality Assurance

The mechanical properties of the finished bearing shall be determined by laboratory test by the manufacturer. The following values shall be used for control of laboratory testing of full size bearings.

1. Compressive strain of any layer of an elastomeric bearing shall not exceed 7% at 800 psi (5.5 MPa) 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 30 psi (207 kPa) for 50 durometer, 40 psi (276 kPa) for 60 durometer, or 50 psi (345 kPa) for 70 durometer, Table A compounds; nor 50 psi (345 kPa) for 50 durometer, 75 psi (517 kPa) for 60 durometer, or 110 psi (758 kPa) for 70 durometer, Table B compounds at 25% strain of the total effective rubber thickness after an extended four day ambient temperature of -20°F (-29°C). Unless otherwise specified, the shear resistance test will be waived.

(f) Certification

Material furnished under this specification shall be covered by a type B certification in accordance with 916. In addition, one bearing pad from each type to be furnished for the structure will be required for laboratory testing. However, when shapes A and B of any type are required, only shape A need be furnished for testing. The material may be sampled prior to shipment to the project, provided suitable arrangements can be made through the Materials and Tests Division. Materials not previously sampled and approved for use shall be sampled after delivery to the project. Samples shall be furnished at least 30 days before date of use.

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.

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.

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.

(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

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.

(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

Types of certifications other than type A, B, C, and D are specified for selected materials. The requirements for a certification are described in the material's specification.

(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 American Requirement

All steel products used in the contract shall be certified to be in accordance with 106.01(c).

916.03 Sample Forms

(a) For Buy American Requirement

BUY AMERICAN CERTIFICATION

In accordance with Indiana Department of Transportation Specification 106.01(c), I hereby certify that all steel products incorporated in Contract No. _____ were produced and manufactured in the United States of America or territories subject to its jurisdiction.

_____ _____
Date CONTRACTOR

_____
SIGNATURE

(b) Sample Type A Certification Form

INDIANA DEPARTMENT OF TRANSPORTATION

TYPE A CERTIFICATION OF COMPLIANCE

CONTRACTOR NUMBER _____

PROJECT NUMBER _____

CONTRACTOR'S NAME _____

MANUFACTURER'S NAME _____

B/L or INVOICE NUMBER _____

MATERIAL DESTINATION _____

This is to certify that for the contract described above, the materials supplied are as follows:

**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:

TEST METHOD	LIMITS OF TEST VALUE	ACTUAL TEST RESULTS
_____	_____	_____
_____	_____	_____
_____	_____	_____

_____ _____
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.

(c) Sample Type B Certification Form

INDIANA DEPARTMENT OF TRANSPORTATION

TYPE B CERTIFICATE OF COMPLIANCE

CONTRACT NUMBER _____

PROJECT NUMBER _____

CONTRACTOR'S NAME _____

MANUFACTURER'S NAME _____

B/L or INVOICE NUMBER _____

MATERIAL DESTINATION _____

This is to certify that for the contract described above, the materials supplied are as follows:

**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.

TEST METHOD	LIMITS OF TEST VALUE
_____	_____
_____	_____

_____ _____
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.

(d) Sample Type C Certification Form

CONTRACT NUMBER _____

PROJECT NUMBER _____

CONTRACTOR'S NAME _____

MANUFACTURER'S NAME _____

B/L or INVOICE NUMBER _____

MATERIAL DESTINATION _____

This is to certify that for the contract described above, the materials supplied are as follows:

**Material Name Quantity

_____ _____

_____ _____

***Conform to: _____

_____ _____
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.

(e) Sample Type D Certification Form

CONTRACT NUMBER _____

PROJECT NUMBER _____

MANUFACTURER'S NAME _____

MATERIAL DESTINATION _____

This is to certify that for the contract described above, the materials supplied are as follows:

**Material Name Quantity

_____ _____

_____ _____

***Is in accordance with: _____

_____ _____
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.

(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

_____
Date

_____
work address of Engineer for
Indiana Department of Transportation

ATT: _____
Name, Project Engineer/Supervisor

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.

Very truly yours,

_____
Signature of Contractor official

_____
Title of Contractor official

cc: District Bridge Inspection Engineer
Environment, Planning and Engineering Division Chief
Project File

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.

(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.

Specific details of this program are contained in ITM 211. Sampling and testing details are found in the Inspection and Sampling Procedures for Fine and Coarse Aggregates manual. A Certified Aggregate Producer shall operate in accordance with the requirements of both publications.

917.02 Quality Control Plan

An aggregate source will not be approved as a Certified Aggregate Producer 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 Materials and Tests Division 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.

An aggregate source may not be considered for entry into the certification program until the preliminary source investigation has been completed in accordance with Indiana Test Method 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 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

The aggregate source will become an approved Certified Aggregate Producer 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

The Materials and Tests Division 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%;

(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;

(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.

Notice of removal from Certified status will be in written form, will be issued by the Materials and Tests Division, 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 – SOIL FABRICS

918.01 Fabric for Waterproofing

Fabric for waterproofing shall be treated cotton in accordance with AASHTO M 117, woven glass in accordance with ASTM D 1668,or glass fiber mat in accordance with ASTM D 2178. Material furnished under this specification shall be covered by a type C certification in accordance with 916.

918.02 Geotextile for Use Under Riprap

The material used shall consist of a non-woven geotextile consisting of strong, rot resistant, chemically stable long-chain synthetic polymer material dimensionally stable with distinct and measurable openings. The plastic yarn or fibers used in the geotextile, shall consist of any long-chain synthetic polymer composed of at least 85% by weight of polyolefins, polyesters, or polyamides, and shall contain stabilizers and inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The geotextile shall be calendared or otherwise finished so that the yarns or fibers will retain their relative position with respect to each other. Silt film geotextiles will not be permitted unless approved.

The geotextile shall meet the following physical requirements.

GEOTEXTILE MATERIAL PROPERTIES

TEST	METHOD	REQUIREMENTS*
Tensile Strength	Grab Tensile Strength, ASTM D 4632	200 lb (890 N)
Elongation	Grab Tensile Strength, ASTM D 4632	15%
Seam Strength	Grab Tensile Strength, ASTM D 4632	180 lb (800 N)
Bursting Strength	Mullen Burst, ASTM D 3786	320 psi (2.21 MPa)
Puncture Strength	ASTM D 4833	80 lb (356 N)
Trapezoid Tear	ASTM C 4533	50 lb (225 N)
Ultraviolet Degradation at 150 h	ASTM D 4355	70% strength retained
Apparent Opening Size (AOS)	ASTM D 4751	AOS shall be No. 50 (300 µm) standard sieve or filter
Permeability**	ASTM D 4491 (Permittivity)	0.01 cm/sec or >

* Use value in weaker principal direction. All numerical values represent minimum average roll value and test results from any sampled roll in a lot shall meet or exceed the minimum values in the table. Lots shall be sampled according to ASTM D 4354.

** The nominal coefficient of permeability shall be determined by multiplying permittivity value by nominal thickness. The nominal thickness is measured under a normal load of 280 psi (1.93 MPa).

The geotextiles to be used will be selected from the list of approved Geotextiles for Use Under Riprap.

A manufacturer, requesting that a geotextile be added to the approved list, shall provide a certification documenting compliance with the above requirements and a sample to the Materials and Tests Division. The certification shall be prepared by the

manufacturer which addresses all the required information as shown on a sample certification form in ITM 804. No relabeled materials will be considered for approval. A specified material on the approved list will not be listed under more than one name.

When it is determined the material is acceptable, it will be added to the list of approved Geotextiles for Use Under Riprap and it may be used upon publication of the list.

918.03 Geotextile for Use With Underdrains

This material shall consist of a non-woven needle punched or heat bonded geotextile consisting of strong, rot resistant, chemically stable long-chain synthetic polymer materials, which are dimensionally stable relative to each other including selvedges. The plastic yarn or fibers used in the geotextile shall consist of at least 85% by weight of polyolefins, polyesters, or polyamides. The plastic yarn or fibers shall have stabilizers and inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure.

The geotextile shall be in accordance with the physical requirements as follows.

TEST	METHOD	REQUIREMENTS[2]
Grab Strength	ASTM D 4632	80 lb (355.8 N)
Seam Strength[1]	ASTM D 4632	70 lb (311.4 N)
Puncture Strength	ASTM D 4833	25 lb (111.2 N)
Burst Strength	ASTM D 3786	130 psi (896 kPa)
Trapezoid Tear	ASTM D 4533	25 lb (111.2 kg)
Apparent Opening Size (AOS)	ASTM D 4751	Sieve No. 50 or smaller opening
Permeability	ASTM D 4491	0.1 mm/sec
Ultraviolet Degradation at 150 h	ASTM D 4355	70% strength retained

1 Values will apply to both filed and manufactured seams.
2 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 table. Lots shall be sampled in accordance with ASTM D 4354.

The geotextiles to be used shall be selected from the list of approved Geotextiles for Use With Underdrains.

Requests for adding geotextiles to the approved list shall be supported by a certification documenting compliance with the above requirements and a sample. The certification shall be prepared by the manufacturer in accordance with the applicable requirements of 916. No relabeled materials will be considered for approval. A specified material on the approved list will not be listed under more than one name. When it is determined the material is acceptable, it will be added to the list of approved Geotextiles for Use with Underdrains and it may be used upon publication of the list.

A manufacturer, requesting that a geotextile be added to the approved list, shall provide a certification documenting compliance with the above requirements and a sample to the Materials and Tests Division. The certification shall be prepared by the manufacturer in accordance with 916. No relabeled materials will be considered for approval. A specified material on the approved list will not be listed under more than one name. When it is determined the material is acceptable, it will be added to the list of

approved Geotextiles for Use with Underdrains and it may be used upon publication of the list.

918.04 Geotextile for Silt Fence

The silt fence fabric shall consist of a woven or non-woven geotextile consisting of strong, rot resistant, chemically stable long-chain synthetic polymer materials, which are dimensionally stable relative to each other including selvedges. The plastic yarn or fibers used in the geotextile shall consist of at least 85% by weight of polyolefins, polyesters, or polyamides. The plastic yarn or fibers shall have stabilizers and inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure.

The geotextile shall be in accordance with the guidelines of AASHTO-AGC-ARTBA, Task Force 25 and AASHTO M 288.

The geotextile shall be in accordance with the physical requirements as follows.

TEST	METHOD	REQUIREMENTS[1]	
		Wire Fence Supported	Self Supported
Grab Strength	ASTM D 4632	90 lb (41 kg)	90 lb (41 kg)
Elongation at 45 lb (20 kg)	ASTM D 4632		50% Max.
Apparent Opening Size[2]	ASTM D 4751	No. 20 (0.84 mm)	No. 20 (0.84 mm)
Permittivity[2]	ASTM D 4491	0.01 sec^{-1}	0.01 sec^{-1}
Ultraviolet Degradation at 500 h	ASTM D 4355	70% strength retained	70% strength retained

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 D 4354.
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.

Material furnished under this specification shall be covered by the type of certification specified in the Frequency Manual and in accordance with 916.

918.05 Geogrid

Geogrid shall be on a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding material. 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 degradation encountered in the soil being placed on.

Geogrid shall be in accordance with the property requirements as specified in the Geosynthetic Research Institute Standard Test Methods GG1, GG3, GG4, and ASTM D 5262.

During periods of shipment and storage, the geogrid shall be protected from temperatures greater than 140°F (60°C), 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 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 for the entire width shall be replaced.

Only geogrids selected from the Department's list of approved Geogrids shall be used. Geogrids will be placed and maintained on the Department's list in accordance with ITM 806, procedure P. No relabeled materials will be considered for approval. A specified material shown on the approved list will not be listed under more than one name.

The geogrid shall be in accordance with the property requirements for the type specified as follows.

(a) Type I

PROPERTY	TEST METHOD	UNIT	VALUE, Min.
Aperture	Calibered	in. (mm)	0.5 x 0.5 (13 x 13)
Open Area	COE, CWO2215	percent	> 50.0, ≤ 80.0
Tensile Modulus, machine direction cross machine direction	 GRI, GG1[1,3,4] GRI, GG1[1,3,4]	 lb/ft (N/m) lb/ft (N/m)	 10,000 (146 000) 10,000 (146 000)
Ultimate Strength, machine direction cross machine direction	 GRI, GG1[2,3,4] GRI, GG1[2,3,4]	 lb/ft (N/m) lb/ft (N/m)	 800 (11 670) 800 (11 670)

1. Secant modulus at 5% elongation measured by Geosynthetic Research Institute Test Method GG1, Geogrid Tensile Strength. No offset allowance shall be made in calculating secant modulus.
2. Ultimate strength measured by Geosynthetic Research Institute Test Method GG1, Geogrid Tensile Strength.
3. Results for machine direction, MD, and cross machine direction, CMD, are required.
4. Minimum average roll values shall be in accordance with ASTM D 4759.

(b) Type II

PROPERTY	TEST METHOD	UNIT	VALUE, Min.
Open Area	COE, CWO2215	percent	> 50.0, ≤ 80.0
Tensile Modulus, machine direction	GRI, GG1[1,4]	lb/ft (N/m)	49,300 (720 000)
Creep Limited Strength, machine direction at 5% strain	GRI, GG3[2,3]-87 or ASTM D 5262	lb/ft (N/m)	1090 (16 000)

1. Secant modulus at 2% elongation measured by Geosynthetic Research Institute Test Method GG1, Geogrid Tensile Strength. No offset allowance shall be made in calculating secant modulus.
2. Long term load capacity measured by through the junction tensile creep testing to 10,000 hours in accordance with Geosynthetic Research Institute Test Method GG3, Creep Behavior and Long Term.
3. The Long Term allowable design strength, LTADS, is determined in accordance with GR1-GG4, Determination of the Long Term Design Strength of Stiff Geogrids.
4. Minimum average roll values shall be in accordance with ASTM D 4759.

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 permitted subject to the following conditions.

(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 permitted on the entire sign.

Overlap splices on sheet signs will be permitted only because of insufficient sheeting width on signs whose smaller dimension exceeds 48 in. (1220 mm). 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. (6 mm). Butt splices shall not be used. Roll splices are permitted 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.

Repaired areas on panel signs shall not be larger than 3 in. by 3 in. (75 mm by 75 mm). Repaired areas 1 in. by 1 in. (25 mm by 25 mm) 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. (25 mm by 25 mm) 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.

(a) Backing Material

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 B 209 (B 209M), alloy 5052H38, or alloy 6061-T6.

The minimum thickness of the sheet shall be as shown for the appropriate sign width.

Width, in. (mm)	Thickness, in. (mm)
Up to 30 (750)	0.080 (2.00)
31 to 60 (775 to 1500)	0.100 (2.50)
61 (1525) and Over	0.125 (3.20)

Backing material for temporary ground mounted signs shall be aluminum, steel, fiberglass, reinforced plastic, or plywood, unless otherwise approved.

2. Panel Signs

Extruded aluminum panels shall be in accordance with ASTM B 221 (B 221M), alloy 6063-T6, and be 12 in. (300 mm) in width. Extruded aluminum panels shall be flat and straight within tolerances established by the aluminum industry. The weight (mass) for panels shall be 2.48 lb/ft (3.70 kg/m).

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 B 211 (B 211M), alloy 2024-T4. Panel bolts shall be 3/8 in. by 3/4 in. (10 mm by 19 mm) standard hex head. Lock-nuts shall be standard hex head.

3. Demountable Letters, Numbers, and Symbols

Backing material for letters, numbers, and symbols shall be 0.040 in. (1.0 mm) thick aluminum sheets in accordance with ASTM B 209 (B 209M), alloy 3003-H14. Borders shall be 0.032 in. (0.8 mm) thick aluminum sheet in accordance with ASTM B 209 (B 209M), alloy 6061-T6.

(b) Sheeting Material

Only sheeting materials from the Department's list of approved Sign Sheeting Materials shall be used. Sheeting materials will be placed and maintained on the Department's approved list in accordance with ITM 806, procedure G.

1. Reflective Sheeting

Reflective sheeting used for signs, channelizing and delineation devices shall be in accordance with AASHTO M 268. Type V reflective sheeting may be used on delineators. Reboundable reflective sheeting shall be used on plastic drums, flexible delineator posts, and other flexible channelizers.

The color chromaticity specifications limits, and the minimum reflective intensity values for fluorescent yellow, fluorescent yellow green, and fluorescent orange reflective sheeting materials shall be in accordance with the following tables.

COLOR SPECIFICATIONS LIMITS AND REFERENCE STANDARDS FOR FLUORESCNET REFLECTIVE SHEETING MATERIAL

	Chromaticity Coordinates							
	1		2		3		4	
	x	y	x	y	x	y	x	y
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Yellow/Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540

DAYTIME LUMINANCE FACTORS FOR FLUORESCENT REFLECTIVE SHEETING MATERIAL

	Luminance Factor Limits (Y)		
	Min	Max	YF
Fluorescent Orange	25	None	15
Fluorescent Yellow	45	None	20
Fluorescent Yellow/Green	60	None	20

MINIMUM REFLECTIVE INTENSITY VALUES FOR FLUORESCENT REFLECTIVE SHEETING MATERIAL

Observation Angle	Entrance Angle	Fluorescent Orange	Fluorescent Yellow	Fluorescent Yellow/Green
0.2	-4.0	200	240	325
0.2	30.0	85	150	200
0.5	-4.0	80	165	175
0.5	30.0	32	75	70

The reflective sheeting shall include an adhesive backing Class 1 or Class 2 in accordance with AASHTO M 268.

2. Non-reflective Sheeting

Non-reflective sheeting shall be in accordance with AASHTO M 268 except that the sheeting shall not incorporate optical elements. The color shall be black in accordance with Federal Standard 595a, Color No. 17038.

3. Transparent Sheeting

Transparent sheeting shall be a material recommended by the background sheeting manufacturer.

(c) Letters, Numbers, Symbols, and Accessories

Letters, numbers, symbols, and accessories shall be demountable.

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.

Completed demountable units shall be dipped coated with a high gloss clear finish coat as specified by the sheeting manufacturer. The finished units shall be clean cut, sharp, and have essentially a plane surface.

(d) Fasteners

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 A 276, or type 304 carbon steel in accordance with ASTM A 307, grade A. Carbon steel hardware shall be galvanized in accordance with ASTM A 153. Lock washers and hex nuts shall be used in lieu of the lock-nuts when carbon steel hardware is furnished.

The bolts shall be 5/16 in. by 3 in. (8 mm by 75 mm) hex head, full threaded. The steel flat washers shall be size no. 1/4, 0.738 in. (19 mm) outside diameter, 0.317 in. (8.1 mm) inside diameter, and 0.051 to 0.08 in. (1.2 to 2.0 mm) thick and in accordance with Military Specifications MS 15795-811. Nylon flat washers shall be 7/8 in. (22 mm) outside diameter, 0.317 in. (8.1 mm) inside diameter, and shall be 0.032 in. (0.81 mm) thick.

2. Panel Signs and Temporary Panel Signs

The aluminum post clips shall be in accordance with ASTM B 26 (B 26M) or ASTM B 108 (B 108M), 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 B 211 (B 211M), alloy 2024-T4. Lock-nuts shall be in accordance with ASTM B 211 (B 211M), alloy 2017-T4. Flat washers shall be in accordance with ASTM B 209 (B 209M), alloy Alclad 2024-T4.

3. Aluminum Rivets

Aluminum rivets shall be determined by character size and shape but shall not be more than 8 in. (200 mm) on center. All rivets shall be color matched to the legend or supplemental panel being installed.

(e) Basis for Use

Materials furnished under this specification, except those used for temporary construction signs, temporary traffic signs, and temporary panel signs, shall be covered by a type C certification in accordance with 916.

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.

Warranties for all major equipment shall be in accordance with 807.03.

(a) Lighting Standards and Mast Arms, under 80 ft (24.4 m)

1. General Requirements

Conventional lighting standards shall be aluminum or steel and shall be in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

For conventional light standards, design wind velocity shall be 80 mph (1.30 km/hr). The maximum horizontal deflection of the pole under maximum loading conditions shall not exceed a deflection angle of one degree and 10 min from the vertical axis of the pole for any 1.0 ft (0.3 m) section of the pole along the entire length of the pole. The maximum stress shall be 80% of the AASHTO Standard Specifications for Group I-DL loads. 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 1.2.5c of Group I loads.

Conventional light standards shall be designed to support a 53 lb (24 kg) luminaire with an effective area of 2.4 ft^2 (0.22 m^2). When larger luminaires are specified, the light standards shall be designed to support the larger luminaires and this shall be shown on the light standard shop drawings.

Conventional poles shall have a 4 in. by 8 in. (100 mm by 200 mm) reinforced handhole centered 18 in. (460 mm) above the base of the pole 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 by a service drop clamp attached to the cable. A wiring hole with a 1 in (25 mm) inside diameter grommet shall be provided where the arm is attached. Pole bases shall be designed for mounting on anchor bolts equally spaced on an 11 1/2 in. (292 mm) or 14 1/2 in. (368 mm) diameter anchor bolt circle. Anchor bolt covers shall be furnished.

Hardware shall be type 304 or 305 stainless steel in accordance with ASTM A 276, except where otherwise specified.

For conventional poles, a 1/2 in. (13 mm) by 13 UNC threaded grounding nut or other approved method shall be provided near the bottom of and shall be accessible through the handhole for attaching the ground wire. The ground wire shall be No. 6 AWG soft-drawn, solid copper in accordance with ASTM B 3.

Mast arms less than 8 ft (2.4 m) in length shall either be single member or truss type, except that mast arms on bridge deck light standards 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. (13 mm) bolts. Mast arms 8 ft (2.4 m) 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 members shall be welded to a pole plate and bolted or clamped to the pole. A minimum of four 1/2 in. (13 mm) bolts at the upper member and a minimum of two 3/8 in. (10 mm) 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. (13 mm) 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. (50 mm) 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 (m)	MAXIMUM RISE ft (m)
9 (27) or less	4 (1.2)
10 to 14 (3 to 4.3)	5 (1.5)
15 to 19 (4.5 to 5.8)	5.5 (1.7)
20 to 25 (6.1 to 7.6)	6 (1.8)
26 to 30 (7.9 to 9.1)	8 (2.4)

Light standards 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 proper shaft length shall be determined by field measurement prior to placing an order for the poles.

A variation in the nominal mounting height of ± 1 ft (0.3 m) is permitted so that the "Effective Mounting Height", foundation to luminaire, of the light standards may be supplied for 40 ft (12.2 m) nominal mounting height.

Elevation of Foundation Top with Respect to the Near Road Edge ft (m)	Effective Mounting Height, Foundation to Luminaire ft (m)
+7.00 to +5.01 (2.13 to 1.53)	34 (10.4)
+5.00 to +3.01 (1.52 to 0.92)	36 (11.0)
+3.00 to +1.01 (0.91 to 0.031)	38 (11.6)
+1.00 to -1.00 (+0.30 to -0.30)	40 (12.2)
-1.01 to -3.0 (-0.31 to -0.91)	42 (12.8)
-3.01 to -5.00 (-0.92 to -1.52)	44 (13.4)
-5.01 to -7.00 (-1.53 to -2.13)	46 (14.0)

The effective mounting heights for other nominal mounting heights deviate from the table by the difference in the nominal heights.

2. Aluminum Lighting Standards

a. Round Seamless

The pole and mast arm shall be in accordance with ASTM B 241 (B 241M), alloy 6063-T4, 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 and/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. (5.6 mm). 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 (0.9 m) 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. (5.6 mm). Attaching plates or clamps for aluminum mast arms shall be in accordance with ASTM B 241 (B 241M), 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 B 26 (B 26M) for sand castings or ASTM B 108 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.

b. Single Longitudinal Welded

The material for these lighting standards shall be round, tapered structural marine aluminum sheet in accordance with ASTM B 209 (B 209M), 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. (5.6 mm). 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 B 26 (B 26M), alloy 356.0-T6. The base casting for the formed and welded shaft shall be designed to be inserted a minimum of 12 in. (300 mm) 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.

3. Stainless Steel Lighting Standards

Stainless steel lighting standards shall be fabricated from stainless steel in accordance with ASTM A 666, type 201, that has a minimum yield point of 68,000 psi (469 MPa). Welds other than spot welds shall be performed with conventional welding equipment and with stainless steel welding rods. Welds shall be free of cracks and pores. The wall thickness and diameter of the pole shall be sufficient to withstand designed loads. Exposed surfaces of the standard shall be smooth and free from marks or imperfections. During shipment, the poles and mast arms shall be protected with a non-staining protective material to preserve the finish.

4. Galvanized Steel Lighting Standards

The pole and base plate shall be fabricated from steel in accordance with ASTM A 572 (A 572M) A 595, or A 1011 with a minimum yield strength of 50,000 psi (345 MPa). Single member mast arms and the upper members of truss type mast arms shall be fabricated from steel in accordance with ASTM A 572 (A 572M) or A 595 with a

minimum yield strength of 50,000 psi (345 MPa). The lower member of truss type arms may be fabricated from standard steel pipe in accordance with ASTM A 53 with a minimum yield strength of 36,000 psi (250 MPa). After fabrication, the pole and mast arm shall be thoroughly cleaned and galvanized in accordance with ASTM A 123.

Steel standards shall be tapered 0.14 in./ft (11.67 mm/m) and shall be round, octagonal, or dodecagonal. The design load shall be used to determine the pole diameter and wall thickness. The pole shall have one longitudinal electrically welded joint. A steel base plate shall be welded to each pole and provided with 4 slotted holes for the anchor bolts.

All welds on steel standards 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.

5. Wood Pole Lighting Standards

Wood poles for highway lighting standards shall be in accordance with 922.05(b).

6. Frangible Breakaway Bases

All light standards, except high mast towers and those protected by bridge end bents or retaining walls, 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 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals as modified in 920.01(a)1.

A certification from the manufacturer shall be furnished with the shop drawings stating the breakaway devices conform to the breakaway criteria of the AASHTO Standard 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. (381 mm). The bolt holes in the transformer base may be slotted. The pole shall be bolted to the transformer base with four 1 in (25 mm) diameter galvanized steel bolts.

An approved handhole in the transformer base may be substituted for the 4 in. by 8 in. (100 mm by 200 mm) 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 (15 m) and with steel poles that weigh 600 lb (272 kg) 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.

7. Anchor Bolts

Anchor bolts shall be 1 in. (25 mm) with 8NC rolled threads in accordance with ASTM A 307. The minimum length of threads shall be 6 in. (150 mm). Mean diameter of rod stock shall be 0.918 in. ± 0.011 in. (23.32 mm ± 0.28 mm) and out-of-round tolerance shall be ± 0.012 in. (0.3 mm). The top 10 in. (254 mm) of the bolt shall be galvanized in accordance with ASTM A 153. Anchor bolts shall be in accordance with 910.19(b). The bolts shall be a minimum of 36 in. (914 mm) in length for poles 8 in. (200 mm) outside diameter or less and 48 in. (1.22 m) in length for poles 9 in. (230 mm) or 10 in. (254 mm) outside diameter. In addition to the minimum length, the bolt shall have a 4 in. (100 mm) right angle bend at the unthreaded end. The anchor bolts in bridge structures shall be as shown on the plans.

(b) High Mast Standards of 80 ft (24.5 m) 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 90 mph (155 km/h), gust of 117 mph (188 km/h), using applicable design criteria in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. Minimum design criteria for each fixture shall be an effective projected area of 2.8 ft^2 (0.26 m^2) and a weight of 85 lb (38.6 kg). 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 manufacturer's warranties for material and workmanship. External lowering devices shall be designed to attach to the pole as shown on the plans. The pole shall include the mounting accommodations as shown on the plans.

1. High Mast Poles

The poles shall be made of steel in accordance with ASTM A 560, grade C. The steel shall have a minimum yield strength of 59,500 psi (410 MPa).

All steel used in the base plate and shaft shall meet an impact property of 15 ft·lbs (20.3 J) at 40°F (4.5°C) in the longitudinal direction using the Charpy V-Notch test. This shall be an average of 3 tests per mill heat with no test below 10 ft·lbs (13.6 J). 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.

The tapered pole shall be multi-sided or circular in shape. The pole shaft sections shall be welded together or slipfitted. The minimum diameter of the pole top shall be 7.5 in. (190 mm) and shall provide at least 1 in. (25 mm) radial clearance from all interior devices.

The exterior of the pole shall be thoroughly shotblasted or otherwise cleaned to a near white finish to remove all oily and foreign matter. The interior of the pole shall be cleaned of all mill scale and foreign matter by a pickling process or shotblasting.

Hardware shall be stainless steel in accordance with ASTM A 276, type 304 or 305, except where otherwise specified.

For the slipfit design, the pole shall be made up of not more than four sections for poles up to and including 120 ft (36.6 m) in length. For the poles between 120 ft (36.6 m) and 150 ft (45.7 m), five sections will be permitted. For poles over 150 ft (45.7 m) and up to 200 ft (61 m), six sections will be permitted. The inside edge of the lower section of the slip joint shall be beveled to prevent the transition joint assembly from catching on the edge. Slip joints shall have a minimum overlap of 1 1/2 times the diameter of the bottom of the upper section. The sections shall be pre-fitted and matchmarked at the factory.

2. Welding

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 (0.6 m) 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.

3. Handholes

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. Samples of the gaskets shall be furnished for approval. 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 in^2 (2580 mm^2). Nylon or non-corrosive screens, or other approved methods of bugproofing 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

The ring shall be fabricated from ASTM A 666 Type 201 or 304 stainless steel and shall have a removable raceway cover. The ring shall be designed as an enclosed wire raceway to provide for the symmetrical mounting of luminaires having an effective projected area of 2.8 ft^2 (0.26 m^2) and a weight of 85 lb (38.5 kg) or actual projected area and weight, if greater. All structural connections shall be made with bolts and nuts.

The luminaire ring shall be supported by three 3/16 in. (5 mm) stainless steel aircraft cables of seven strands with 19 wires each strand with a minimum breaking strength of 3900 lb (17 350 N). The cables shall be secured to the ring, and to cable terminating devices within the poles by means of stainless steel hardware.

Positive positioning devices shall be incorporated into the ring assembly. These devices shall be designed to prevent any horizontal movement in the ring assembly. The ring assembly shall have a minimum of six non-abrasive rollers mounted on the ring interior.

5. Head Frame Assembly

The head frame shall be made of ASTM A 666 Type 201 or 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 3.5 in. (90 mm) and the power cable sheave or individual rollers in a roller assembly shall have a minimum pitch diameter of 18.5 in. (470 mm) and shall be grooved to fit the power cable.

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.

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. (8 mm) diameter galvanized steel aircraft cable of 7 strands with 19 wires each strand with a minimum breaking strength of 9800 lb (43 600 N).

The winch shall have a drum with a minimum diameter of 4 in. (100 mm) and drum flanges with a minimum diameter of 8 in. (200 mm). 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.

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 (8.15 J) 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 (7.6 m) from the pole. The control voltage for any hand-held control equipment shall not exceed 120 volts. The hand-held control equipment shall be shock proof.

The external drive system shall be capable of operating all high mast pole installations. Shop drawings shall be furnished in accordance with 920.01(g) 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. (300 mm) in diameter and the weight shall be distributed so that it presents a balance load.

8. Cable Terminator

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.

9. Lightening Rod Assembly and Grounding System

The lightening rod, air terminal, shall shield the head frame assembly cover and the outer edge of the luminaires within a 45 degree electrostatic shielded cone. The grounding system shall include bonding plates, grounding clamps, four 5/8 in. (16 mm) diameter by 12 ft (3.7 m) copperweld grounding rods, a grounding conductor with a minimum size of 28 strands of 14 gauge bare copper wire in rope lay configuration, 9/16 in. (14 mm) diameter with a weight of copper of 375 lb (136 kg) per 1000 ft (306 m), air terminal, lightening rod and other incidental connectors. All hardware shall be stainless steel, brass, copper, copper alloy, or equally corrosion-resistant metal.

Bonding plates, with a minimum contact surface area of 8 in.^{2} (5160 mm^2), 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. (100 mm) of contact with the copper wire. At the point of termination the grounding conductor shall extend beyond the bonding plate a minimum of 3 in. (75 mm).

Each ground rod clamp shall have a minimum of 1 1/2 in. (38 mm) 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.

Bends of conductors shall form an angle of 90 degrees or more. Unsupported conductors shall have a radius of bend 8 in. (200 mm) 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 A 615 (A 615M) modified to a minimum yield strength of 75,000 psi (517 MPa). The top 12 in. (300 mm) of each anchor bolt, nut, and washer shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

(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 D 3485 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 size of the conduit for different cable conductor sizes shall be as follows.

Cable Conductor Size	Conduit Size
3-1/C No. 4	1 1/4 in. (32 mm)
3-1/C No. 2	1 1/2 in. (38 mm)
3-1/C No. 1/0	2 in. (50 mm)
3-1/C No. 3/0	2 in. (50 mm)

2. Conductors in Cable-Duct

The cable shall consist of three 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 AWG size specified. Conductor sizes No. 8 AWG and larger shall be stranded in accordance with ASTM B 8, class B.

Each conductor shall be insulated with crosslinked polyethylene manufactured in accordance with Insulated Power Cable Engineer Association publication S66-524. Each conductor shall have the following 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 three 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.

Identification coding of the conductors shall be accomplished by complete color coding or by ribbing of the insulation. 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, and one red. Ribbing shall consist of one non-ribbed conductor, one single ribbed conductor, and one double ribbed conductor. The same method of conductor identification coding shall be used throughout the project.

3. Lighting Standard Circuit Wiring

This wiring shall consist of two 1/C No. 10 AWG, 600 volt, THWH or MTW insulation, stranded copper wire.

4. Sign and Underpass Wiring

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 THHN 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; THHN 90°C; THWN 75°C; and AWM 105°C. It shall be installed in 3/4 in. (19 mm) conduit between the breaker box and luminaires.

5. Aerial Cable

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 Poles

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 B 3, ASMT B 173, and IPCEA S-19-83. Conductor insulation shall be in accordance with ASMT D 169 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

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

1. General Requirements

Lamps supplied for luminaires shall be electrically compatible with the luminaires. Luminaires shall include the lamp ballast. The ballast shall be integrally built in and of the constant wattage regulator type of sufficient size to operate the designated lamp at the required voltage. The ballast shall provide satisfactory lamp performance to 20°F (-7°C) with an input voltage variation of ± 10% of the rated operating voltage specified.

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 can not 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. (6 mm).

2. Roadway Lighting Luminaires

Roadway lighting luminaires shall have a precision-cast aluminum housing and refractor holder with weatherproof finish. They shall have a strong, easily operated, positive latch on the street side of the refractor holder and a hinge with a safety catch that prevents accidental unhinging on the house side of the refractor holder. They shall include a slipfitter capable of adapting to a 2 in. (50 mm) mounting bracket; an easily detachable highly specular aluminum reflector; and an easily adjustable socket in both horizontal and vertical directions capable of producing lighting patterns to meet all the requirements of the American Standard Practice for Roadway Lighting as sponsored by the Illumination Engineering Society and as shown on the plans. They shall have a high impact, heat-resistant, glass, prismatic refractor; and 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.

3. Sign Luminaires

Luminaires shall be 250W mercury vapor unless otherwise specified. Sign luminaires shall have the same requirements as roadway luminaires plus 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. (1.3 mm) 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.

Aluminum and steel structural members for luminaire supports shall include aluminum conduit, conduit clamps, fittings, and stainless steel screws.

4. Underpass Luminaires

Underpass luminaires shall have the same requirements as roadway luminaires except they shall have vandal shields and the ballast shall meet the same requirements except it may be mounted separately near the luminaire as shown on the plans.

5. High Mast Luminaires

The luminaires shall be in accordance with the American Standard Practice for Roadway Lighting by the Illumination Engineering Society and shall produce lighting patterns as shown on the plans. The lamp in the high mast luminaire shall be supported at both ends with mechanical spring grips or other means to hold the lamp secure against vibration. The socket shall be mogul sized and porcelain enclosed. The luminaire housing shall be an enclosed aluminum unit with a reflector and borsillicate glass refractor. It 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 optical assembly.

(e) Circuit Breakers and Enclosure

All circuit breaker enclosures shall be NEMA 4/5.

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 (1.5 mm) 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.

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 Poles

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.

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 (-40°C) to 185°F (85°C);

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.

(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, 3 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 shall be a cast aluminum weatherproof case, with a hinged cover, having provisions for padlocking and a hanger for pole or wall mounting.

(g) Shop Drawings

Six sets of shop drawings shall be submitted for lighting standard assemblies, luminaires, service points, circuit breaker enclosures, external drive assemblies, and multiple relay switches. A copy of the transmittal shall be given to the Engineer. These items shall not be ordered or installed until shop drawings have been approved.

These drawings will be reviewed for design features only. The Contractor shall be responsible for dimensions, accuracy, and fit of work. The drawings for conventional light standards shall show the shaft outside diameter, height, wall thickness, the arm length rise, size, handhole details, grinding details, materials used, and complete anchor bolt details including bolt circle-projection and hardware. When a breakaway base is required, details shall be shown. Service point shop drawings shall show the arrangement and brand name of each component.

When requested, sufficient design data shall be furnished with the drawings to verify the conventional light standards meet wind load, deflection, vibration, and breakaway requirements. All of the above shall be based upon the lighting standards as shown on the plans. After approval, the Engineer shall be advised of where changes to the Installation Summary Sheets must be made because of existing roadside conditions. Where necessary, additional light standard drawings shall be submitted for approval.

Unless calculations are on file with the Department, the following design calculations and data shall be submitted for approval prior to the fabrication of any parts of the high mast pole.

1. general dimensions of all component parts;

2. 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 (6.1 m);

3. computation of stresses in base plate, connection attachment, and anchor bolts;

4. maximum deflection at the top of the structure under the specified loading; and

5. the dimensions and wiring diagrams of the external drive system connection to the pole in accordance with 920.01(b)7.

(h) Materials Certification

Unless otherwise specified, materials furnished under this specification require a type C certification in accordance with 916.

SECTION 921 – PAVEMENT MARKING MATERIALS

921.01 Traffic Paint

Traffic paint shall be in accordance with 909.05.

921.02 Durable Marking Material

Durable marking material shall be thermoplastic, preformed plastic, or 100% solids epoxy.

(a) Thermoplastic

This material shall be in accordance with AASHTO M 249.

(b) Preformed Plastic

This material shall consist of a homogeneous preformed plastic film with a minimum thickness of 60 mils (1.5 mm) and a width as specified. The preformed plastic material shall have a precoated adhesive and an easily removable backing which shall protect the adhesive in storage and facilitate rapid application. 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 plastic 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.

The color of the white plastic film shall be determined by a standard color difference meter, such as the Gardner Color Difference Meter manufactured by Gardner Laboratories, Inc. Bethesda, Maryland. The plastic film shall not show deviations from a magnesium oxide standard greater than the following.

SCALES	DEFINITION	MAGNESIUM OXIDE	SAMPLE
Rd	Reflectance	100	70 Minimum
a	Redness-Greenness	0	-5 to +5
b	Yellowness-Blueness	0	-10 to +10

The color of the yellow plastic film shall visually match color No. 33538 of Federal Standard 595a. The pigment shall include medium chrome yellow.

1. Material Requirements

The material shall be composed of plasticizers, pigments, and glass beads. The pigment shall contain 20% minimum titanium dioxide for white plastic material. During manufacture, glass beads shall be mixed into the compound at a minimum of 15% and a maximum of 20% by weight. A layer of glass beads shall be bonded to the top surface.

a. Tensile Strength

The specimens for this test shall be type I prepared in accordance with ASTM D 638 (D 638M). A sample 6 in. by 1 in. (150 mm by 25 mm) shall be tested at a temperature between 70°F (21°C) and 80°F (27°C) using a jaw speed of 0.25 in. (6.4 mm) per minute. 1 in. (25 mm) squares of carborundum extra coarse emery cloth or equivalent may be applied to each end of the test sample to prevent the plastic adhesive from adhering to the test equipment. The break resistance shall be based on an average of at least three samples. The elongation of the film at rupture shall be 15% minimum and 50% maximum. The minimum tensile strength shall be 40 psi (275.8 MPa).

b. Adhesive Stability Test

A 3 in. by 6 in. (75 mm by 150 mm) sample of plastic material shall be applied to a 3 in. by 6 in. (75 mm by 150 mm) piece of carborundum extra coarse emery cloth or equivalent, so that a 3 in. by 3 in. (75 mm by 75 mm) overlap occurs. The specimen shall withstand a static load of 4 lb (17.8 N) for a period of 30 min, in accordance with ASTM D 816, method B. The slippage between the plastic sample and the emery cloth shall not exceed 1 in. (25 mm). The test shall be conducted at a temperature between 70°F (21°C) and 80°F (27°C).

c. Adhesive Shear Strength

Specimens shall be tested in accordance with the method described in ASTM D 638 (D 638M) as modified to test the adhesive shear strength. Plastic samples cut to dimensions of 1 in. by 6 in. (25 mm by 150 mm) shall have applied to the adhesive face a 1 in. by 3 in. (25 mm by 75 mm) piece of carborundum extra coarse emery cloth, or its equivalent, so that there is a 1 in.^{2} (645 mm^2) overlap at one end of the plastic specimens. A pressure of 50 psi (344.7 kPa) shall be applied over this area for a period of 30 s. The load shall be applied by gripping each end of the test piece in a suitable tensile test machine such as a Dillon or Scott Tester. The average of the load required to break the adhesive bond shall be 10 lb (4.5 kg) minimum. The speed of testing shall be conducted at a temperature between 70°F (21°C) and 80°F (27°C) and at a speed of 2 in. (50 mm) per minute.

d. Bend Test

At a temperature of 80°F (27°C) the property of the plastic material shall be such that a piece 3 in. by 6 in. (75 mm by 150 mm) with the side covered by backing paper

placed against a 1 in. (25 mm) mandrel may be bent over the mandrel until the end faces are parallel and 1 in (25 mm) apart. Visual inspection shall show no apparent fracture lines in the uppermost surface.

2. 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.

3. Basis For Use

A type C certification in accordance with 916 shall be furnished for the preformed plastic material except materials used for temporary pavement markings.

(c) 100% Solids Epoxy

This material shall be a two component material. Component A shall consist of pigment and epoxy resins formulated as set out by the manufacturer. The mixing ratio for the two components of the material shall be as recommended by the material manufacturer. This ratio shall not vary more than ± 2 1/2% during the mixing operation or the application procedures of these materials.

Component A shall have the following properties.

Property	Minimum % by Weight
Pigment	
White, TiO_2, conforming to ASTM D 476, Type II	22
Yellow, Medium chrome yellow conforming to ASTM D 211, Type III	25
Epoxy Resins	
White	77
Yellow	70

The pigment composition shall consist of either titanium dioxide or medium chrome yellow. The epoxide value shall be tested in accordance with ASTM D 1652 and shall be 300 to 375 for both white and yellow component A, pigment free basis.

Component B shall be a curing agent and shall have the amine number tested in accordance with ASTM D 2071. The amine number shall be 300 to 450.

The system, component A plus component B, shall contain no volatile solvents.

1. Material Requirements

a. Glass Beads

The glass beads shall be in accordance with 921.02(e).

b. Abrasion Resistance

The material shall be abraded with 1000 cycles using a 1000 gram load on CS-17 wheels in accordance with ASTM D 4060. The average loss in weight shall not exceed 82 milligrams. The tests shall be run on cured samples which have been applied at a film

thickness of 15 mils ± 1 1/2 mils (375 µm ± 38 µm) to code S-16 stainless steel plates. The films shall be allowed to cure at a temperature between 70°F (21°C) and 80°F (27°C) for 72 h prior to performing the indicated test. The test panel shall be unbeaded.

c. Hardness

The epoxy materials shall be tested in accordance with ASTM D 2240 and have a Shore D hardness of between 75 to 100. Films shall be cast on a suitable substrate at 15 mils ± 1 1/2 mils (375 µm ± 38 µm) in thickness and allowed to cure at a temperature between 70°F (21°C) and 80°F (27°C) for 72 h prior to performing the indicated test.

d. Tensile Strength

The material shall be tested in accordance with ASTM D 638 (D 638M). The tensile strength shall not be less than 6000 psi (41.4 MPa). The type IV specimens shall be cast in a suitable mold not more than 1/4 in. (6.4 mm) thick. The samples shall be allowed to cure at a temperature between 70°F (21°C) and 80°F (27°C) for 72 h prior to performing the indicated tests. The rate of pull shall be 1/4 in. (6.4 mm) per minute.

e. Compressive Strength

The material shall be tested in accordance with ASTM D 695 (D 695M), except as modified herein. The cured epoxy material shall have a minimum compressive strength of 12,000 psi (82.7 MPa). The cast sample shall be conditioned at a temperature between 70°F (21°C) and 80°F (27°C) for 72 h before performing the indicated tests. The maximum rate of compression of these samples shall be 1/4 in. (6.4 mm) per minute. The sample size shall be 1/2 in. (13 mm) high by 1/2 in. (13 mm) in diameter.

f. Weather Resistance

The mixed epoxy compound, both white and yellow, shall be applied to 3 in. by 6 in. (75 mm by 150 mm) aluminum panels at a thickness of 15 mils ± 1 mil (375 µm ± 25 µm) with no glass beads and cured at a temperature between 70°F (21°C) and 80°F (27°C) for 72 h. The cured samples shall be exposed in an Environment Testing Chamber as described in ASTM G 154. The test shall be conducted for 80 h at 122°F (50°C) in alternating cycles of 4 h condensation and 4 h ultraviolet light.

SPECIMEN	REQUIREMENTS
White Material	ASTM E 1347, directional reflectance a minimum 80% after exposure.
Yellow Material	Initially conform to V+ to C+ limits when visually compared with the highway yellow color tolerance chart, PR#1 of June 1965. The color of exposed material shall be within V+, C+, and H+ limits when visually compared.

g. Laboratory Drying Time

The epoxy pavement marking material shall be mixed in the proper ratio and applied at 15 mils ± 1 1/2 mil (375 µm ± 38 µm) wet film thickness at 75°F ± 2°F (24°C ± 1°C) with the proper application of glass beads. It shall exhibit a maximum no tracking time of 10 min when tested in accordance with ASTM D 711.

h. Viscosity

Formulations of each component shall be such that the viscosity of both components shall coincide within 10% at a recommended spray temperature. Component

B shall be formulated so as to have a steady and constant viscosity at temperatures recommended for spray application.

2. Materials Preparation

Before mixing, the individual components shall be heated to the following temperatures.

Component	Temperature °F (°C)
A	90 to 100 (32 to 38)
B	70 to 100 (21 to 38)

Each component shall be stirred thoroughly prior to mixing. After mixing, the application temperature for the combined materials at the gun tip shall be between 90°F (32°C) and 100°F (38°C).

3. Packaging and Storage

The epoxy material shall be shipped to the job site in white epoxy lined drums which are plainly marked with the manufacturer's name and address, component identification A or B, the color of the material, date of manufacture, and batch number. Storage shall be at temperatures between 35°F (2°C) and 100°F (38°C).

The reflective glass beads shall be shipped in 50 lb (22.7 kg) moisture resistant bags. Each bag shall be marked in accordance with 921.02(e).

4. Basis For Use

Pavement marking material, except glass beads and material used for temporary pavement markings, furnished under this specification shall be covered by a type A certification in accordance with 916. A type A certification shall be furnished for each batch supplied. The material manufacturer shall perform all tests included elsewhere herein on each batch and shall provide these test results as part of the Type A certification.

(d) Raised Pavement Marker

The raised pavement marker shall be either snowplowable, which is inset into the pavement, or temporary, which is affixed with adhesive to the pavement surface.

1. Snowplowable Raised Pavement Marker

Snowplowable raised pavement marker shall consist of a durable base to which is attached a replaceable prismatic retro-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.

a. Prismatic Reflector

The dimensions of the reflector face shall be nominal width of 4 in. (100 mm) and a minimum vertical height of 0.460 in. (12 mm) with a slope of 30 degrees from the horizontal to the face. Minimum reflecting surface area shall be 1.62 in^2 (1045 mm^2). The reflectors shall consist of an acrylic plastic shell filled with tightly adherent potting compound. The shell shall contain one of two prismatic faces. The reflector shall be in the shape of a shallow frustrum of a pyramid. The bottom of the reflector shall be

equipped with a pressure sensitive adhesive for attachment. The shell shall be molded of methyl methacrylate conforming to Federal Specification L-P-380c, Type 1, Class 3. The filler shall be potting compound selected for strength, resilience and adhesion adequate to pass the necessary physical requirements. The adhesive shall be pressure sensitive, 100% solids, 0.040 in. (1.0 mm) thick with closed cell release paper on the bottom. Pressure sensitive adhesive shall meet the requirements of adhesive tensile strength test.

Prismatic reflectors shall not be installed on bases until the adhesive in the pavement slots has properly hardened. All rust or foreign matter shall be removed from the surface of the base and the base shall be coated with a primer in accordance with the manufacturer's recommendations. The release paper shall be peeled from the butyl adhesive bottom of the reflector. The reflector shall be inserted into the recessed attachment area and a downward pressure of 150 lb (667 N) shall be applied for 3 s.

(1) Optical Performance

In order to perform the optical performance test, the following definitions shall apply. Horizontal incident angle shall mean the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the reflector. Reflective intensity shall mean candlepower of the return light at the chosen divergence angle for each 10.76 footcandle (lux) of illumination at the reflector on a plane perpendicular to the incident light.

A steel wool abrasion test shall be performed by forming a 1 in. (25 mm) diameter flat pad using No. 3 coarse steel wool. The steel wool pad shall be placed on the reflector lens, a load of 50 lb (22.7 kg) shall be applied, and the entire lens surface shall be rubbed 100 times.

After abrading the lens surface, the reflective intensity of each white reflecting surface at 0.2 degree divergence angle shall meet the following requirements when the incident light is parallel to the base of the reflector.

HORIZONTAL INCIDENT ANGLE	MINIMUM REFLECTIVE INTENSITY
0°	3.0 Candlepower/footcandle (0.279 cd/lx)
20°	1.2 Candlepower/footcandle (0.1115 cd/lx)

The reflective intensity for yellow reflectors shall be 60% of the value for white. The reflective intensity for red reflectors shall be 25% of the value for white.

A sample consisting of 100 markers shall be submitted and 23 will be tested. The reflectors to be tested shall be located with the center of the reflecting face at a distance of 5 ft (1.5 m) from a uniformly bright light source having an effective diameter of 0.28 in. (7 mm). The photocell width shall be an annular ring 0.37 in. (9 mm) inside diameter and 0.47 in. (12 mm) outside diameter and shall be shielded to eliminate stray light. The distance from light source center to the photocell center shall be 0.21 in. (5 mm). If a test distance of other than 5 ft (1.5 m) is used, the source and receiver shall

be modified in the same proportion as the test distance. Failure of more than 4% of the samples reflecting faces shall be the cause for rejection.

(2) Seal Test

A sample of 50 units shall be submerged in water at room temperature and subjected to a vacuum of 5 in. (125 mm) mercury for 5 min. After restoring atmospheric pressure, the units shall be left submerged for an additional 5 min. The unit shall be examined for water intake and failure of more than one unit shall be cause for rejection.

(3) Heat Resistance Test

Three reflectors shall be tested for 4 h in a circulating air oven at 175°F ± 5°F (80°C ± 3°C). The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test the samples shall be removed from the oven and permitted to cool in air to room temperature. After exposure to heat, the samples shall show no significant change in shape and general appearance when compared with corresponding unexposed control standards. Failure of one or more units shall be cause for rejection.

(4) Strength Test

A random sample of three reflectors shall be selected for test purposes. The reflector base shall be positioned at the center of a flat steel plate which has a minimum thickness of 0.5 in. (13 mm) and a minimum outside diameter of 4.5 in. (114 mm). A load shall be applied to the top of the reflector through a 1 in. (25 mm) diameter by 1 in. (25 mm) high metal plug centered on the top of the reflector. The rate of loading shall be 0.2 in. (5 mm) per minute. The reflector will be rejected if there is either breakage or significant deformation of the reflector at any load of less than 2000 lb (8896 N).

(5) Impact Test

The red lens shall not be subjected to impact test. A random sample of 20 lenses shall be selected from each lot of reflectors.

The reflectors shall be placed in a convection oven at 130°F (55°C) for 1 h. The reflectors shall be removed from the oven and the reflective face shall be immediately impacted by allowing a 0.42 lb (0.2 kg) dart fitted with a 0.25 in. (6 mm) radius spherical head to drop 18 in. (460 mm) perpendicularly onto the center of the reflective surface. Cracks in the impact area shall be concentric in appearance. There shall be no more than two radial cracks longer than 0.25 in. (6 mm). There shall be no radial cracks extending to the edge.

If 18 lenses of the test samples meet the above requirements, the lot shall be acceptable. Failure of four lenses of the sample shall be cause for rejection of the lot. If three lenses fail, a resample of 20 additional lens shall be tested for failure. Failure of more than one lens of the resample shall be cause for rejection of the lot.

(6) Temperature Cycling Test

A random sample of 20 lenses shall be selected from each lot of reflectors. The samples shall be subjected to three cycles of 140°F (60°C) for 4 h followed by 20°F (-7°C) for 4 h. There shall be no cracking nor delamination following temperature cycling.

If 18 lenses of the test sample meet the above requirements, the lot shall be acceptable. Failure of four lenses of the sample shall be cause for rejection of the lot. If three lenses fail, a resample of 20 additional lenses shall be tested for failure. Failure of more than one lens of the resample shall be cause for rejection of the lot.

(7) Adhesive Tensile Strength Test

A standard 4 in. by 2 in. by 0.46 in. (100 mm by 50 mm by 12 mm) reflector with pressure sensitive adhesive on the bottom shall be adhered to a flat 0.12 in. (3.0 mm) carbon steel test plate. The plate shall be primed in accordance with 921.02(d)1a, and the reflector shall be applied with a minimum application pressure of 60 psi (41 kPa). Both the top of the reflector and bottom of the flat plate shall have fastened to it an appropriate coupling device to ensure compatibility with the tensile testing device. The test sample shall then be tested in the tensile mode at 2 in. (50 mm) per minute pull rate. Minimum load to produce failure shall be 125 lb (566 N) at 70°F (21°C). Any load below 124 lb (566 N) is a failure and shall be cause for rejection of the lot.

(8) Basis For Use

The prismatic reflector shall be covered by a type B certification in accordance with 916.

2. Cast Metal Base

The base shall be a ductile iron casting made of modular iron in accordance with ASTM A 536, Grade 70-50-05 hardened to 52-54 RHC. The cast iron base shall be marked with the manufacturer's name and model number. The maximum dimensions shall be 2.00 in. (50 mm) high , 6 in. (152 mm) wide, and 10.0 in. (250 mm) long.

The exposed height of the casting after installation shall not exceed 0.50 in. (13 mm). The bottom of the casting shall have two parallel keels and a shaped web designed to fit into an accurately sawed, grooved slot in the pavement surface as shown on the plans.

a. Epoxy Adhesive

The epoxy adhesive shall be in accordance with AASHTO M 237, type IV, Table 3 with respect to composition and performance. For sampling purposes, a batch shall consist of a single charge of all components into a mixing chamber.

b. Basis For Use

A type B certification in accordance with 916 shall be furnished for the epoxy material. A type C certification in accordance with 916 shall be furnished for the cast metal base for the pavement markers.

3. Precast Cement Concrete Base

The base shall be made of cement concrete with a compressive strength of 5000 psi (34.5 MPa) when tested in accordance with ASTM C 39. The maximum dimensions shall be 2.00 in. (50 mm) high, 6 in. (150 mm) wide, and 10 in. (254 mm) long. The maximum exposed height of the base after installation shall be 0.50 in. (13 mm).

a. Adhesive for Precast Concrete Base

This adhesive shall be quick setting magnesium phosphate concrete patching material with high strength and high bonding qualities. This material shall be used between 30°F (-1°C) and 90°F (32°C) and in thicknesses varying from 1/2 in. (13 mm) to full depth.

The material may be complete dry mix requiring only the addition of either water or a liquid activator just prior to mixing and use. The material shall not contain sufficient soluble chloride nor soluble sulfates to cause corrosion of reinforcing steel or damage to portland cement concrete.

The adhesive shall have an initial setting time of 10 min in accordance with ASTM C 266. The compressive strength shall be in accordance with ASTM C 109 and as listed.

TIME	COMPRESSIVE STRENGTH
2 h	1500 psi (10.3 MPa) min.
24 h	4000 psi (27.6 MPa) min.
7 days	6000 psi (41.3 MPa) min.

The adhesive shall have a durability factor of not less than 80 after being subjected to 300 cycles of the freeze and thaw test in accordance with ASTM C 666, Procedure B.

The adhesive shall be suitable for use with hand tools and shall not require special curing procedures.

b. Packaging

The patching material adhesive shall be packaged in strong moisture resistant bags or other suitable containers capable of withstanding normal shipping and handling without damage. The container shall protect the material from deterioration for a period of one year when stored in a dry condition. Mixing instructions shall be printed on each container.

c. Basis For Use

A type C certification in accordance with 916 shall be furnished for the precast cement concrete base. A type B certification in accordance with 916 shall be furnished for the marker adhesive patching material.

(e) Glass Beads

Glass beads shall be in accordance with AASTHO M 247, type I except sampling shall be in accordance with the frequency manual. The beads shall have a moisture resistant coating.

SECTION 922 – TRAFFIC SIGNALS

922.01 Traffic Signal Controller and Cabinet

(a) Model Approval

Each model of controller and its cabinet will be tested, evaluated, and approved prior to use. Testing, evaluation, and approval will require a minimum of six months to perform. The period of evaluation will commence when the Department receives the preliminary product evaluation form accompanied by the product brochure, operational manual, maintenance manual, and documented theory of operation. The Procurement and Distribution Division will advise the manufacturer or vendor, in writing, of the date to deliver the controller and cabinet, for which model approval is requested, to the Procurement and Distribution Division. Certification in accordance with 922.01(f)6b, shall be received at the Procurement and Distribution Division a minimum of two weeks prior to the date of delivery of the controller and cabinet. Certifications in accordance with 922.01(f)6a, schematics for the controller and cabinet, operational manuals, theory of operation and parts list shall be furnished with the controller when it is submitted to the Procurement and Distribution Division for evaluation and testing. The controller and cabinet will undergo the bench test in accordance with 922.01(d). A controller or control unit that fails the bench test procedure three times will be rejected and will not be placed upon the approved products list, nor will it be considered for future evaluation without documented changes to design. A list of approved Models will be maintained by the Department. Only models from the approved list of Control Equipment in effect as of the date of letting, or as otherwise specified, shall be used in the contract. Continued failure and repeated malfunctions of an approved controller or control equipment shall be cause to remove that model from the Department's list of approved Products.

A design change to an approved model of controller will require a resubmittal 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.

(b) Controllers or Control Units Furnished and Installed by the Contractor

A controller with all components of equipment, necessary for an operating signal, wired into a cabinet will be a control unit. The Contractor shall prepare three packets for each control unit and provide these packets to the Engineer. Packet 1 shall consist of one complete set of wiring and schematic diagrams for the control unit and its appurtenances and a listing of model name/number and serial number of the removable equipment that can be readily exchanged or replaced, such as controller enclosure, controller modules, load switches, conflict monitor, detectors, and flashers. Packets 2 and 3 shall each consist of the same items as in Packet 1 plus a descriptive parts list and instruction and maintenance manuals that include the manufacturer's data sheets on each different type of I.C. chip being used, connection diagrams, voltage checks and the theory of operation. Each packet shall be labeled with the name of the intersection, the Contract Number, the Commission Number and the date of installation. Packet 1 will be forwarded to the Procurement and Distribution Division, packet 2 will be retained in the controller cabinet, and Packet 3 will be retained by the District Traffic Office.

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.

(c) Blank

(d) Bench Testing

The Department's Traffic Signal Control Bench Test Procedures, which are used for bench testing of traffic signal controllers, cabinets, and related equipment are on file and available upon request.

During bench testing a control unit will be considered as failed if one of the following conditions are encountered during the physical or operational test procedure.

a. The controller unit skips intervals, or phases, places false calls, presents false indicator lights, does not follow the prescribed sequence or exhibits changes in timing beyond the tolerances of the specifications.

b. The load switches produce incorrect signal indications.

c. The conflict monitor fails to perform in accordance with the specifications of the requisition or contract.

d. Auxiliary equipment such as pre-emptors, coordinators, or detectors do not operate in accordance with the specifications.

e. The wiring for the interface of any items set out above is defective or incorrect.

If the control unit fails the bench test procedure, the control unit shall be removed from the Procurement and Distribution Division for repairs and returned to the Traffic Support Center for retesting. The cover letter for the resubmittal of the control unit for retesting shall include an explanation of why the unit failed and what specific repairs were made.

A written test report will be provided for each control unit tested. A representative of the manufacturer or vendor may be present during the bench testing procedure.

(e) Pretimed Solid State Digital Controller

The following requirements are the minimum for the design and operation of a pretimed solid state digital, keyboard entry or keyboard entry backlit liquid crystal display menu-driven display type controller. The controller shall be capable of operating as a master or secondary control unit having four cycles, three offsets and four splits per cycle, and a minimum of four signal plans with individual control of 24 signal circuits, with an option of a total of 40 signal circuits, in each of 24 intervals. Controller, cabinet, and component parts shall be in accordance with NEMA Standards TS-1, all provisions contained herein, and the Department's traffic signal control bench test procedures. The requirements herein and the test procedures shall govern over NEMA standards.

1. General

The controller shall have a keyboard entry or keyboard entry backlit liquid crystal display menu-driven type with internal pre-emption, time base coordination, telemetry, printer, and interconnect modules. The controller unit shall contain a printer interface module, which permits a hard copy printout of all keyboard settings. The unit shall employ circuit designs, consistent with the latest techniques, using a microprocessor to implement the control logic.

The keystroke buttons shall be clearly marked as to function. The controller shall be programmable to permit initialization in any interval after a defined power interruption or reset by the conflict monitor.

All data entry display windows shall be liquid crystal design. The display shall be a high resolution type display such that the display shall be readable on a plane located 2 ft (0.6 m) in front of, and parallel to, the display window. As a minimum, the display shall be readable throughout a vertical 60 degree angle that contains a minus 15 degree angle to a plus 30 degree angle measured from the horizontal line that is perpendicular to the center of the display window. Also, the display shall be readable throughout a horizontal 60 degree angle that contains a minus 15 degree angle to a plus 30 degree angle measured from the vertical line that is perpendicular to the center of the display window. The backlit liquid crystal display shall have a diffusion type lens or membrane to reduce its surface glare. All menu driven, data entry displays shall be backlit. The display for the menu driven controller shall be a minimum of four lines with 40 characters per line. All programming buttons and indicators pertinent to the operation of a phase shall be on the front of the controller. The display windows shall be capable of displaying the cycle length, offset, split, and any other variable functions or controller settings.

Materials, conductors and component identification for all printed circuit boards shall be in accordance with NEMA Standards TS-1-14.2.3. Where practical, components shall be individually soldered directly to the printed circuit boards except for the memory elements, such as ROM, RAM, and PROM, which shall be socket mounted.

All volatile memory chips and modules shall have battery back-up to protect any operator programmed data for a period of at least 60 days without 115 volt, 60 hertz AC input to the controller unit. Battery back-up may be achieved with either a rechargeable battery maintained in a charged state through a trickle charge or a non-rechargeable battery with a minimum shelf life of 10 years. Batteries shall be capable of being disconnected for shelf storage of the controller unit. An indicator shall be provided on the front of the controller to indicate that the battery is connected and operating properly. If a non-rechargeable battery is supplied, an indicator shall also be provided to show a low battery charge. The memory module, when removed from the mainframe, shall maintain all programmed data for at least 48 h.

Any external battery within the controller unit shall be turned off or disconnected during shipment and storage.

All electrical components such as integrated circuit chips, transistors, diodes, triac, and capacitors shall be of such quality that they function properly under the environmental conditions experienced in field operation. All printed circuit boards shall be protected with a rosin coating. Fusing shall be on the front panel of the controller and shall provide protection to the controller from internal and external overload.

The motherboard in the mainframe shall be capable of accepting all plug-in modules, including additional modules to provide for 40 signal circuits, necessary for the operation of the controller. All plug-in modules shall be equipped for easy removal or installation without the use of tools. All plug-in circuit boards shall be readily accessible for maintenance. Extender boards may be used for this purpose. As a minimum, all circuit boards shall be edge labeled with the first and last number, the first and last letter, and the first and last double letter if applicable, corresponding to the pin connector position. All modules shall each be removable without removing any other module. All hinges used shall have stainless steel pins.

The controller unit shall be able to operate as a master controller or a secondary controller without requiring any changes in the unit itself. When used as a master controller, it shall not be required to program the unit's offsets to zero. The controller unit shall be capable of operating in an existing pretimed interconnected system, which may have an electromechanical interrupter utilizing 115 volts, 60 hertz, AC. Cycle, offset, and split selectability shall be either by application of 115 volts, 60 hertz AC to the fuse panel or manually from the keyboard. Use of 115 volts AC Interconnect to a 24 volts DC logic interface is acceptable. As a minimum, the controller shall be capable of accepting nine conductors for interconnect, two conductors for cycle 1-4 selection, three conductors for reset 1-3 selection, two conductors for split 1-4 selection, and one conductor each for flash and common.

With each controller unit and cabinet there shall be furnished three complete sets of wiring and schematic diagrams, two descriptive parts lists, two instruction and maintenance manuals that include the manufacturer's data sheets on each different type of integrated circuit chip being used that has not been previously submitted to and on file at the Procurement and Distribution Division, connection diagrams, voltage checks and the Theory of Operation. The instructions manual shall contain explicit programming procedures for all required features and any additional features incorporated in the controller's design. All schematics shall also include numbered test points, where applicable, with operating voltages.

Serial number and model numbers shall be permanently applied on the face or front of all removable components of the controller where it is easily readable, without removing or disconnecting the component. Serial number and model number of the main frame shall be permanently applied near the front panel.

2. Controller Requirements

The controller shall be capable of providing four cycle lengths with a minimum time setability from 10 to 255 s in increments of 1 s. Transfer from one cycle to another cycle shall occur at the end of the interval in effect at the time of request for transfer if that interval is programmed for transfer. Cycle selection of any of the four cycles, from a remote location, shall be accomplished by use of no more than three conductors.

The unit shall be capable of providing three individually programmable offsets for each cycle with a minimum time setability from 0 to 250 s in 1 s increments. The offset to be in effect shall be selected by activation of one of the three reset inputs of the controller. Energization of a reset input shall place that offset in effect independent of timing plan selection. Momentary de-energization, for a period of 3 to 5 s, of a reset input shall define the system reference or synchronization.

The controller shall have program selected capabilities of a minimum of two methods of offset seeking transfer, shortway or dwell.

Shortway offset transfer is the transfer from one offset to another by shortening or lengthening the permitted intervals of the signal plan so that no offset change may exceed 25% of the cycle length in one cycle. The new offset shall never be more than 50% away from the existing offset. The permitted intervals, whose duration may be varied, shall be specified in the signal plan. During shortway offset seeking, no interval shall time less than the minimum programmed, in the signal plan, for that interval.

Dwell offset transfer is the transfer from one offset to another by holding in a programmed interval up to a maximum programmed duration. The controller shall be capable of programming the maximum dwell time between 1 and 250 s in 1 s increments. Only one maximum dwell interval shall be timed between transitions of reset input lines. The unit shall be capable of accepting interrupter pulses.

The controller shall provide the capabilities of four splits for each programmed cycle. Each split for each cycle shall consist of a programmed number of intervals, variable up to a maximum of 24. If split transfer is programmable, transfer from one split to another shall occur in the intervals programmed to allow split transfer. If split transfer is not programmable, transfer shall occur at the zero point of the cycle. Split selection of any of the four splits, from a remote location, shall be accomplished by the use of no more than three conductors.

A minimum of 24 signal intervals shall be provided for each combination of cycle and split. The intervals shall be individually programmable minimum time setability, selectable from 0 to 12.7 s in increments of 0.1 s or from 0 to 127 s in increments of 1.0 s for each cycle and split. The controller shall be capable of copying the timing values for any cycle and split into any other cycle and split in one operation.

If the controller can indicate time settings greater than required, the greater time settings shall be active when entered into the controller.

The controller shall be capable of implementing any one of up to four different signal plan sequences. The signal plan shall be either externally selectable by placing logic ground to the input terminal or manually selectable through the keyboard. During any controller cycle, it shall be possible to operate in any of the four signal plans, if the signal plans are compatible. Signal plan transfer shall occur in the next interval programmed for signal plan transfer. Each signal plan shall have at least one interval to enable safe transfer between signal plans. The controller unit shall operate in accordance with the programmed values for the selected cycle, offset and split, regardless of the

signal plan in effect. Signal plan PROM programming shall effect the On-Off-Flash condition of the signal circuits, and minimum and backup timing of each interval.

The unit shall provide the capabilities for a minimum of two detector inputs which can be programmed for Lock, Non-Lock, or Recall modes. The detector inputs shall provide a means to enter vehicle or pedestrian demand. When activated, these inputs may add intervals up to a total of 24 intervals to the cycle.

The unit shall provide the capabilities for a minimum of two preempt inputs. These inputs, either of which is activated, shall cause initialization of the selected preemption sequence which shall remain in effect until the input is removed.

The controller unit shall have an internal time clock with capabilities of programming for time-of-day, day-of-week, and week-of-year. The time clock shall allow selection of cycles, splits, and offsets through the time clock, the hardwire interconnect, the communication module, manual selection through keyboard entry, or a combination of these functions.

The controller shall have internal communication and telemetry with at least FSK 1200 Baud rate capable of transmitting on Bell 3002 four wire conductor with 600 ohm line impedance.

The controller unit shall provide capabilities for the following inputs: Stop Timing, External Start, Start-up Flash, Interval Advance, Manual Control Enable, Remote Flash, and System or Computer Control.

Stop timing shall cause all timings to be discontinued. When stop timing is removed, timing shall resume from the point of interruption.

External start shall cause the controller to assume its programmed initialization conditions and commence normal operations upon removal of the input.

Interval advance shall cause the controller to advance to the next interval in sequence, provided the manual control enable input is not energized. The actual advance shall occur on the trailing edge of the actuation. The duration of any interval shall be capable of being shortened without regard to the programmed minimum for the interval with the interval advance input active.

Manual control enable shall cause the controller to operate in the manual mode of operation. The transfer from automatic to manual mode operation and back to automatic operation shall occur immediately upon activation or de-activation of manual control enable.

When operating in the manual mode, the same color sequence, as provided in automatic control, shall be displayed. Duration of all programmed variable intervals shall be controlled by operation of the interval advance input. Duration of programmed non-variable intervals shall not be less than the minimum time specified in the signal plan for such intervals. Operation of the interval advance input shall not advance the controller out of these intervals.

Synchronization with the system shall be maintained during manual mode operation. When transferring back to automatic operation, the controller shall resume timing of the interval at the point in the selected timing plan that corresponds to the beginning of the interval being displayed when the transfer occurs.

Remote flash shall cause the controller to transfer to flashing operation when an AC+ signal is applied to the unit's fuse panel by an external source. The police panel switch shall cause the controller to go to immediate flash. Synchronization with the system master shall be maintained during flashing operation, if applicable. Upon de-activation of remote flash, transfer to cyclic operation shall be immediate and the unit shall display the interval that was programmed for exit from flash.

System or computer control, when activated, shall control the duration of the programmed variable intervals, except when pedestrian or vehicle calls are not placed on the detector inputs.

3. Spare Modules

All spare modules shall be in accordance with the appropriate sections of this specification.

4. Controller Enclosure

The enclosure shall be of adequate physical strength to protect the components during normal physical handling. Fusing, keypad, liquid crystal display, and input-output connectors required for the operation and standard field adjustments shall be mounted on the front panels.

The main frame shall be completely equipped and wired as a complete pretimed controller so that no additional hardware or wiring is required. The front panel of the controller shall be positively fastened to the frame. Special tools shall not be required to remove or replace modules or plug-connected printed circuit boards.

5. Power Requirements

The controller shall operate in accordance with NEMA Standard TS-1-2.

6. Certification of Traffic Control Units

Certification of traffic control units shall be in accordance with 922.01(f)6.

7. Warranty

The warranty for traffic control units shall be in accordance with 922.01(f)7.

(f) Traffic Actuated Solid State Digital Controller

The following requirements are the minimum for the design and operation of an 8 phase fully-actuated solid state, digital, menu-driven with backlit liquid crystal display controller. Controller, cabinet, and component parts shall meet NEMA Standards TS-1, all provisions contained herein, and the Department traffic signal control bench test procedures. The requirements herein and the test procedures shall govern over NEMA standards.

1. General

The controller shall be keyboard entry, menu-driven with liquid crystal type display. The controller shall have internal preemption, time base coordination, telemetry, printer and interconnect modules. The microprocessor shall utilize non-volatile memory devices. If "0" Powered Ram is utilized, the shelf life, with load, shall be a minimum of 10 years. Time base coordination shall use battery backed RAM to maintain the system clock and power outage. Any external battery within the controller unit shall be turned off or disconnected during storage and shipment. With each controller unit and cabinet, there shall be furnished three complete sets of wiring and schematic diagrams, two descriptive parts lists, two instruction and maintenance manuals that include the manufacturer's data sheets on each different type of integrated circuit chips used that has not been previously submitted to and on file at the Procurement and Distribution Division, connection diagrams, voltage checks, and the Theory of Operation. The instruction manual shall contain explicit programming procedures for all required NEMA features and any additional features of which are incorporated into the controller design. All schematics shall also include numbered test points, where applicable, with operating voltages.

Serial number and model numbers shall be permanently applied on the face or front of all removable components of the controller where it is easily readable, without removing or disconnecting the component. Serial number and model number of the main frame shall be permanently applied externally near the front panel.

2. Controller Requirements

The time settings shall be in accordance with NEMA Standards TS-1-14. If the controller can indicate time settings greater than required, the greater time settings shall be active when entered into the controller. A minimum of two maximum timing parameters shall be supplied on all phases of the controller and shall function when activated.

The controller shall be capable of 2 through 8 phase programming and shall be capable of accepting an interrupter pulse on any coordinated phase.

Pedestrian timing shall be provided on all phases of a controller.

The backlit liquid crystal display window shall consist of a minimum of four lines with 40 characters per line. The display shall be a high resolution type display such that the display shall be readable on a plane located 2 ft (0.6 m) in front of, and parallel to, the display window. As a minimum, the display shall be readable throughout a vertical 60 degree angle that contains a minus 15 degree angle to a plus 30 degree angle measured from the horizontal line that is perpendicular to the center of the display window. Also, the display shall be readable throughout a horizontal 60 degree angle that contains a minus 15 degree angle to a plus 30 degree angle measured from the vertical line that is perpendicular to the center of the display window. The backlit liquid crystal display shall have a diffusion type lens or membrane to reduce its surface glare.

The Time Base Coordinator shall operate such that the line function has the capability to provide output for a minimum of four time of day functions during the same event time.

Controllers shall be capable of servicing eight phases. The control unit, when delivered, shall be programmed to initialize in phase 2 and phase 6 green. The controller shall be keyboard programmable to permit initialization in any phase after a defined power interruption or reset by the conflict monitor. The following recall functions shall be a minimum and shall show functional status on the liquid crystal display.

(1) lock detection
(2) maximum recall
(3) minimum recall
(4) non-lock detection
(5) pedestrian recall

Keystroke buttons shall be clearly marked as to function.

All indicators shall be liquid crystal design. All programming buttons and indicators pertinent to the operation of a phase shall be on the front of the controller. The controller shall have complete phase skipping capabilities. Dual ring, eight phase controllers shall have single entry operation.

Controllers shall have keyboard programmable overlaps in accordance with NEMA Standards TS-1-14.3.7. All inputs and outputs from the controller shall be in accordance with NEMA Standards TS-1-13 and shall be accessible within the cabinet at the output terminal facility.

All electrical components such as integrated circuit chips, transistors, diodes, triac, and capacitors shall be of such quality that they function properly under the environmental conditions experienced in field operation. All printed circuit boards shall be protected with a rosin coating. As a minimum, all plug-in circuit boards shall be edge labeled with the first and last number, the first and last letter, and the first and last double letter if applicable, corresponding to the pin connector position. Input-output pin connectors and MS connectors shall be as specified in NEMA Standards TS-1. Fusing shall be on the front panel of the controller and shall provide protection to the controller from internal and external overload.

3. Spare Modules

All spare modules shall be in accordance with the appropriate sections of this specification.

4. Controller Enclosure

The enclosure shall be of adequate physical strength to protect the components during normal physical handling. Fusing, keypad, liquid crystal display and input-output connectors required for the operation and standard field adjustments shall be mounted on the front panels.

The main frame shall be completely equipped and wired as a complete 8 phase NEMA controller so that no additional hardware or wiring is required. The front panel of the controller shall be positively fastened to the frame such that no special tools shall be required to remove or replace modules or plug-connected printed circuit boards.

5. Power Requirements

The controller shall operate in accordance with NEMA Standards TS-1-2.

6. Certification of Traffic Control Units

The following certifications shall be furnished in accordance with the applicable provisions of 916.

a. Certification of a Production Run Model

A certification for a model of control unit shall be on file with the Department. A production run model shall be tested in accordance with, and comply with, all requirements of the NEMA Standards TS-1, Part 2, including shock and vibration. A certification of a production run model will be valid for a maximum period of four years from the date of testing or unless a significant change is made in the controller. 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 major change to the circuitry in the control unit.

b. Certification of Environmental Testing

A certification shall be furnished with each control unit approval indicating it has been tested and is in accordance with the following tests from NEMA Standards TS-1-2.

TS1-2.2.03- Test Procedure – Transients, Temperature, Voltage, and Humidity.
TS1-2.2.04- Cabinet ventilation tests.
TS1-2.2.07- Power interruption test.
TS1-2.2.08- Timing accuracy tests.
TS1-2.2.09- Signal conflict monitoring tests.

The cabinet requirements in 922.01(g) shall be applicable during the appropriate tests.

The certification shall specify the model and serial number of the following components: cabinet, controller main frame, phase modules, ring modules, conflict monitor, load switches, flasher, and all specified auxiliary control equipment.

A complete log of each test for every controller shall be maintained. 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 vs time chart. The maximum revolution 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 testing.

7. Warranty

A standard manufacturer's warranty shall be furnished for each traffic signal control unit which is furnished and installed. The effective date for the beginning of the warranty shall be the turn-on date shown on form IC 636A. The warranty shall be provided prior to final acceptance.

Each traffic signal control unit purchased by the Department shall have a minimum two year operational warranty or the manufacturer's standard warranty, whichever is longer. The two year warranty shall begin on the date the control unit is received at the Procurement and Distribution Division. The vendor or manufacturer shall be responsible, during the warranty period, for transportation costs to and from the Procurement and Distribution Division for items requiring warranty service.

Continued failure and repeated malfunctions of an approved model of controller shall be cause to remove that model from the Department's list of approved Models.

(g) Cabinet Requirements for Traffic Signal Controllers

1. General

The cabinet and the shelf, if needed, shall be fabricated of aluminum. The cabinet shall be 0.125 in. (3 mm) minimum thickness sheet aluminum or 0.25 in. (6 mm) minimum thickness die-cast 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 the lock shall be furnished with two No. 2 keys. 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 degrees, and 150 to 180 degrees. The door shall be hinged on the left or right side of the cabinet.

The cabinet shall have a police door within the main door. The police door shall use a standard Corbin Police panel lock. The police door shall be weathertight. Two keys shall be furnished for the police door.

In a cabinet used for a pretimed controller, the police door shall contain three separate switches for controller operation, one for automatic or manual, one for signal or flash, and one for signal on or off. A 1/4 in. (6 mm) phone jack receptacle shall be connected to the proper circuits for manual control of any signal interval. The switches shall be protected from water when the door is opened.

In a cabinet used for actuated controllers, the police door shall contain two separate switches, one switch for master power cut-off and one switch to change automatic signal control to flashing control, or vice-versa. The switches shall be protected from water when the door is opened.

The cabinet shall contain one duplex convenience outlet and a switch controlled lamp receptacle. 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 Electrical Code. These units shall be protected with a 15 amp cartridge fuse wired ahead of the multi-breakers.

The cabinet shall contain a thermostatically controlled ventilating fan and a vent with a commercially classified uniform 1 in. (25 mm) thick filter. The vent size and filter

size will be according to the provisions for the type of cabinet. The thermostat shall be manually adjustable from 70°F to 100°F (21°C to 38°C). 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 controller. The fan shall be rated at a minimum of 100 ft^3 (2.83 m^3) per minute. The thermostat shall be located within 6 in. (150 mm) of the fan.

The cabinet shall contain a surge arrestor. The surge arrestor shall be wired behind the multi-breaker, in parallel with the 35 amp circuit breaker signal buss and in series with the 10 amp circuit breaker for the solid state electronic equipment such as controller, conflict monitor and detectors. The surge arrestor shall have a maximum clamp voltage of 350 volts at a peak current of 20,000 amps for a minimum of 20 occurrences. The surge arrestor will operate between -30°F to 165°F (-34°C to 74°C). The dimensions of the unit shall not exceed 3.25 in. (80 mm) wide by 6 in. (150 mm) long by 2.5 in. (64 mm) deep.

Each inductive device, including the fan, shall have a separate power surge protection.

The terminals for AC + and - input to the cabinet shall be capable of accepting a No. 6 wire.

Test inputs A and B shall not be used for any purpose that will prevent interchangeability of controllers manufactured in accordance with these specifications.

The manual flashing switch shall be wired to let the controller operate when the signals are flashing.

The cabinet shall contain a jack mounted type 3 solid state flasher in accordance with NEMA Standards TS1-8 or approved non-repairable unit in accordance with the NEMA Standards TS1-8 electrical and physical dimensions. Repairable flashers shall consist of opto or photo isolated solid state power relays.

Remote flashing shall be provided for all signal circuits. Phases that the controller is to initialize in green, shall be wired to flash yellow. All other phases shall be wired to flash red. Flashing for signal circuits shall be as evenly balanced as possible on the circuits of the flasher controller.

The cabinet shall be wired to activate the pedestrian timing, including load switches and all other necessary components. The pedestrian load switch and the signal load switch shall be a triple signal load switch in accordance with NEMA Standards TS1-5 or approved non-repairable units in accordance with NEMA Standards TS1-5 electrical and physical dimension requirements. Repairable load switches shall consist of opto or photo isolated solid state power relays. The repairable load switch shall not use a printed circuit board to transmit the 115 volts AC line - in input or signal buss output. Each load switch shall have an indicator 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 shall be capable of being programmed for

flash, overlap, vehicular, or pedestrian phases with the use of a standard slotted or Phillips screw driver or standard nut driver. Programming of the load switches shall be accomplished on the front of the cabinet terminal facilities by installing or removing electrical conductors.

The cabinet for a pretimed secondary controller used in a hardwired interconnect system shall contain a fuse block with a 2 amp fuse for the remote selection of each of the following inputs: Reset 1, Reset 2, Reset 3, Cycle 2, Cycle 3, Split 2, Split 3, and Flash. For an actuated controller, an additional input shall be provided for system or free operation. The fuse block shall have a 150 volt, 10 amp metal oxide varistor on the controller side of the fuse, connected to ground.

The cabinet for a pretimed master controller used in a hardwired interconnect system shall contain a fuse block with a 6 amp fuse for the output selection of each of the following inputs: Reset 1, Reset 2, Reset 3, Cycle 2, Cycle 3, Split 2, Split 3, and Flash. For an actuated controller, an additional output shall be provided for system or free operation. The fuse block shall have a 150 volt, 10 amp metal oxide varistors for each of the output selections, on the controller side of the fuse, connected to ground. The fuse block shall also have a 1.0 K ohms, 30 watt resistor for each of the output selections, on the interconnect side of the fuse, connected to ground.

The cabinet shall contain a main backpanel and supplementary backpanels, as needed. The model number of the main backpanel shall be permanently applied to the front of the backpanel, where it is easily readable, without removing or disconnecting the backpanel. Each controller input and output circuit shall terminate on the main backpanel or on a supplementary backpanel.

The cabinet shall contain auxiliary control devices such as conflict monitor, vehicle detectors, or other items specified. All terminal facilities and fusing within the cabinet shall be readily accessible for field connection without removing the controller or associated equipment. All equipment and terminals shall be readily accessible for maintenance in the cabinet. 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 or other cabinet appurtenances.

2. G Cabinet

The G cabinet shall be pedestal mounted or pole mounted. The bottom of the cabinet shall be reinforced to ensure a secure pedestal mounting. The G cabinet shall have dimensions of 25 in. (635 mm) wide, 38 in. (965 mm) high, 18 in. (460 mm) deep with a tolerance of + 4 in. (100 mm) in all dimensions.

A cabinet slipfitter shall be used to attach the cabinet to the pedestal. The slipfitter shall fit a 4 1/2 in. (114 mm) 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.

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.

The cast aluminum base shall be made of aluminum in accordance with ASTM B 179, alloy ANSI 319.1 or 319.2, or in accordance with ASTM B 26 (B 26M), 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. (8630 mm) square and 15 in. (380 mm) in height ± 1 1/4 in. (32 mm). The weight shall be 22 lb ± 5% (10.0 kg ± 2.2 kg).

The base shall be designed to support a 150 lb (68 kg) axial load and 11 ft^2 (1.0 m^2) 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 (5.5 m). In addition to the dead load, the base shall be designed to withstand wind load 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 in. by 8 1/4 in. ± 1/4 in. (200 mm by 210 mm ± 6 mm) with a stainless steel hex head bolt for attaching the door.

The base shall be attached to a foundation by four anchor bolts, with an anchor bolt circle of 12 3/4 in. (324 mm). 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 with ASTM A 36 (A 36M). The diameter of the anchor bolt shall be 3/4 in. (19 mm) with a minimum length of 18 in. ± 1/2 in. (460 mm ± 13 mm), plus 2 1/2 to 3 in. (64 to 75 mm) right angle hook on the unthreaded end. The top 4 in. (100 mm) of the bolt shall be threaded with 10 NC threads. The threads, plus 3 in. (75 mm), shall be coated after fabrication in accordance with ASTM A 153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C. Each anchor bolt shall be provided with two hex head nuts in accordance with ASTM A 325 (A 325M) and three washers. Two of the washers shall have a minimum 2 in. (50 mm) and maximum 2 1/8 in. (54 mm) outside diameter and be in accordance to ANSI B 27, Type B regular series and one shall be a nominal 3/4 in. (19 mm) series W washer, in accordance with ASTM F 436 (F 436M).

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

The top of the base shall accommodate a pole having a 4 1/2 in. (114 mm) outside diameter. The threads inside the top of the base shall be 4 in. (100 mm) national standard pipe threads. The pole shall be either a steel pedestal pole or an aluminum pedestal pole.

A steel pedestal pole shall be a seamless schedule 40 carbon steel pipe in accordance with ASTM A 53, grade B. The pole shall have an outside diameter of 4 1/2 in. (114 mm). The pole shall weigh approximately 10.8 lb/ft (16 kg/m). 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. (64 mm). The pole shall be galvanized, after threading, in accordance with ASTM A 123. 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 B 241 (B 241M) for seamless aluminum alloy, schedule 40, 6061-T6. The outside diameter of the pole shall be 4 1/2 in. (114 mm). The length of the pole shall be as shown on the plans. The pole shall weigh approximately 3.7 lb/ft (5.5 kg/m). 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. (64 mm) and protected by a suitable shield. The pole shall have a spun finish.

c. Pole Cap

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 B 179, alloy ANSI 319.1 or 319.2. The cap shall fit freely on the 4 1/2 in. (114 mm) outside diameter of the pole. A set screw using a 3/4 in. (19 mm) 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.

A pole cap made from spun aluminum shall be in accordance with ASTM B 209 (B 209M), alloy 1100-0. The cap shall fit tightly when placed on the end of the pole.

3. M Cabinet

The M cabinet shall be ground mounted on a concrete foundation at locations and dimensions shown on the plans.

The M cabinet shall have dimensions of 30 in. (762 mm) wide, 48 in. (1219 mm) high, and 16 in. (406 mm) deep with a tolerance of ±2 in. (50 mm) in any or all dimensions.

Anchor bolts shall be steel in accordance with ASTM A 36 (A 36M). Diameter of the bolt shall be 1/2 in. (13 mm) or 5/8 in. (16 mm) and the minimum length shall be 15 in. (381 mm) plus a 3 in. (75 mm) right angle hook on the unthreaded end. The top 6 in. (150 mm) of the bolt shall be threaded with 13 NC threads on 1/2 in. (13 mm) bolts and 11 NC threads on 5/8 in. (16 mm) bolts. The hexagon nut, the flat washer, and the threaded end of the bolt shall be galvanized in accordance with ASTM A 153, or be

mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

If an interrupter is shelf mounted, a shelf shall be located a minimum of 12 in. (305 mm) from the top of the cabinet but shall have adequate room to easily install or remove the interrupter.

The vent shall have a uniform 1 in. (25 mm) thick filter which may be of any of the following sizes: 20 in. by 10 in. (510 by 255 mm); 16 by 10 in. (405 by 255 mm); or 16 by 8 in. (405 by 200 mm).

The cabinet shall contain solid state load switches with incandescent lamp load rating of 1200 watts with nominal 120 volts 60 hertz which meet NEMA Standards TS1-5. Cabinets for pretimed controllers shall contain a type 6 conflict monitor and cabinets for actuated controllers shall contain a type 12 conflict monitor. Conflict monitors shall be in accordance with NEMA Standards TS1-6. The conflict monitor upon sensing conflicting signal indications or unsatisfactory operating voltage shall transfer the signals to a flashing indication and the controller shall be wired to provide flash transfer if the conflict monitor is removed from service. Each channel of the conflict monitor shall have an indicator to show the channel's on or off status.

A red failure indicator shall be provided, exclusively labeled red failure, and shall be continuously illuminated when red failure has occurred. The conflict monitor shall indicate the channel where red failure occurred by means of the channel indicator.

The phase arrangement of the controller shall coincide with the channel arrangement of the load switches and conflict monitor.

The cabinet shall contain a multi-breaker with one 10 amp circuit breaker to provide overload protection to the controller, conflict monitor, and detectors and one 35 amp circuit breaker to provide overload protection to the signal and flash buss load. When both circuit breakers are in the off or tripped position, the signal output, the conflict monitor, and the controller shall be turned off. The signal shall be capable of operating in the flashing mode with the 10 amp circuit breaker OFF and the 35 amp circuit breaker ON. The controller, the conflict monitor, and the detectors shall be capable of operating with the 10 amp circuit breaker ON and the 35 amp circuit breaker OFF.

Two 1.0 microfarad 600 volts + 10% capacitors shall be installed on the output field terminal strip for left turn phases which are normally phases 1 and 3. One capacitor shall be connected from the green output terminal to AC negative terminal on each phase and the other capacitor shall be connected from the yellow output terminal to AC negative terminal on each phase.

The cabinet shall contain a type 3 solid state flasher in accordance with NEMA Standards TS1, Part 8. The flashing output circuits carrying the signal load shall consist of opto or photo isolated solid state power delays. Programmable flash shall be provided for on the cabinet terminal facilities. No special tools shall be required to program flash.

Flashing for even numbered phases shall be placed on one circuit and flashing for odd numbered phases shall be placed on the other circuit.

The cabinet shall contain all terminal blocks, solid state load switch blocks, and harnesses necessary for the operation of the controller. It shall have two adjustable shelves with the first shelf located 15 in. ± 1 in. (380 mm ± 25 mm) below the top of the cabinet and the second shelf located 7 in. (178 mm) below the first shelf. The cabinet shall contain 30 spare terminals. The spares shall be in one location and easily accessible in the cabinet. If vehicle detection is required for a controller, the spare terminals may be used for this purpose.

Terminal strips shall be consecutively numbered and shall be in accordance with the schematic diagram. Numbering for terminal strips shall be neat and legible, silk screen type painting. All harnesses shall be of sufficient length to allow for the placement of the controller and conflict monitor at any location within the upper half of the cabinet. The shelf of the cabinet connector harnesses shall be grounded. All relays and conflict monitors shall be encased in a protective covering to reduce the potential of electrical shock.

The police panel shall contain two separate switches. One switch for master power cut-off and one switch to change operation from automatic signal control to flashing control, or vice-versa. The switches shall be protected from water when the door is in the open position.

4. P-1 Cabinet

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 922.01(g)3. The P-1 cabinet shall house an 8 phase traffic actuated solid state digital controller and shall have two adjustable shelves with the first shelf located 20 in. (508 mm) below the top of the cabinet and the second located 7 in. (178 mm) below the first shelf. The cabinet shall be 44 in. (1118 mm) wide, 52 in. (1321 mm) high, and 24 in. (610 mm) deep with a tolerance of ± 3 in. (75 mm) in all dimensions. Maximum exterior dimensions shall be 34 in. (864 mm) deep, 47 in. (1194 mm) wide, and 63 in. (1600 mm) high.

The cabinet shall be in accordance with applicable provisions of 922.01(g)1 and 922.01(g)4. It shall have one type 12 conflict monitor which shall be in accordance with NEMA Standards TS-1, Part 6.

Two 1.0 microfarad 600 volt, 10% capacitors shall be installed on the output field terminal strip for the left turn phases which are normally phases 1, 3, 5, and 7. One capacitor shall be connected from the green output terminal to AC negative terminal on each phase, and the other capacitor shall be connected from the yellow output terminal to AC negative terminal on each phase.

The cabinet shall have a vent with a uniform 1 in (25 mm) thick filter which may be of any of the following sizes: 16 by 25 in. (405 by 635 mm); 15 by 20 in. (380 by 510 mm); or 16 by 20 in. (405 by 510 mm). It shall contain 40 spare terminals.

(h) Two Circuit Alternating Flasher

Two circuit alternating flasher shall be solid state.

1. 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.

The flasher shall be a type 3 solid state flasher conforming to Section 8 of the NEMA Standards Publication TS 1-1983. 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 alternating flashers shall be plug-in design. The flasher design shall not permit 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.

The flasher shall operate between 95 volts and 135 volts AC 60 Hertz. No degradation of performance shall be experienced in environmental changes from -20°F to 165°F (-29°C to 74°C) and 0 to 90% relative humidity.

2. Cabinet Requirements

The cabinet shall be weatherproof and fabricated from cast aluminum or aluminum sheeting with a minimum thickness of 0.125 in. (3.18 mm). 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.

Minimum dimensions for the cabinet shall be 12 in. (305 mm) deep, 12 in. (305 mm) wide, and 12 in. (305 mm) high. The maximum dimensions shall be 18 in. (460 mm) deep, 15 in. (380 mm) wide, and 18 in. (460 mm) 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. (100 mm) and a maximum diameter of 18 in. (460 mm). Two hub plates for 1 in. (25 mm) 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.

It shall have a screened vent in the bottom with a minimum size of 1 3/4 in.^{2} (1129 mm^2). A fan and thermostat shall be located in the top of the cabinet. The fan shall have separate power surge protection. The thermostat shall be located within 6 in. (150 mm) of the fan and shall be adjustable between 70°F and 110°F (21°C and 43°C).

The panel in the cabinet shall be capable of being removed and reinstalled with simple hand tools. A 25 amp radio interference filter and surge arrestor in accordance with 922.01(g)1 wired ahead of a 15 amp circuit breaker shall be mounted on the panel. A terminal block capable of the following electrical connections shall be mounted on the panel.

Circuit 1 -	for connection of field signals
Circuit 2 -	for connection of field signals
AC plus -	can be attached to breaker if circuit breaker can accept a No. 6 wire
AC minus lug -	capable of accepting a No. 6 wire
Neutral lug -	capable of accepting a No. 6 wire
Fan Circuit -	adequately fused separately from circuit breaker with a fuse rating less than 15 amps

922.02 Interconnection Equipment

(a) Hardwire Interconnection

1. Electro-Mechanical Dial Coordination Unit

a. General

The coordinating unit shall operate and be compatible with a 2 phase, 4 phase, and 8 phase controller in accordance with 922.01(f). It shall function in an interconnect system containing three dial electro-mechanical controllers and actuated controllers and shall contain three background cycles that are programmable in length of time and percentage split.

The dial coordinating unit shall generate a continuous background cycle. With an absence of vehicle actuation, recall operation, or pedestrian actuations, the traffic signal controller shall continue to rest in the coordinated phase. During periods of heavy vehicular demands, the coordinating unit shall not permit transfer of right-of-way to non-coordinated phase or pedestrian until the background cycle is in the predetermined position. When there is insufficient vehicular demand to extend the phase to the force-off limit the unit shall allow an early return to the coordinated phase.

The interface between the coordinating unit and the actuated controller shall provide a yield/force-off type of coordination. The coordinated phase or phases shall yield and the remaining phases shall be forced off. The coordination unit shall operate in a coordinated system with the number of controller phases specified. The interface between the coordinator and the controller shall provide for Max I timing during coordinated operation. During non-coordinated, free run, operation, Max II timings shall be in effect.

The coordinating unit shall operate on 115 volt AC, 60 Hertz. It shall be shelf mounted and enclosed in a case with maximum dimensions of 19 in. (483 mm) wide, 7 1/2 in. (191 mm) high, and 8 in. (200 mm) deep. Three sets of wiring and schematic diagrams, three descriptive parts lists, and two instruction and maintenance manuals shall be furnished with each coordinating unit.

b. Additional Requirements for Master Locations

A master control unit shall include a dial coordinating unit interrupter and a dial coordinating unit master both compatible and able to function in an interconnected system containing 3 dial electro-mechanical controllers and actuated controllers.

The master control unit shall be capable of the following output selections: Reset 1, Reset 2, Reset 3, Dial 2, Dial 3, Flash, and coordinating free. The dial coordinating unit master and the dial coordinating unit interrupter shall have the following 5 cycle length gears for each dial.

Dial 1	60-80-90-100-110 sec
Dial 2 & 3	70-75-85-95-110 sec

A master control unit shall contain a fuse block with a 6 amp fuse for the output selection of each of the following: Reset 1, Reset 2, Reset 3, Dial 2, Dial 3, Flash, Split 2, and Split 3. The fuse block shall have 10 amp metal oxide varistors for each of the output selections on the controller side of the fuse, connected to ground. The fuse block shall have 1000 ohm, 30 watt resistors for each of the output selections on the interconnect side of the fuse, connected to ground.

c. Additional Requirements for Secondary Locations

A secondary control unit shall contain a secondary dial coordinating unit compatible and able to function in an interconnect system containing three dial electro-mechanical and actuated controllers. The location shall be capable of the following input selections form a remote location: Reset 1, Reset 2, Reset 3, Dial 2, Dial 3, Flash, and coordinating free. Two switches within the secondary control unit shall be provided to manually select the following operations and labeled to show which operation is in effect. One switch shall select Dial 1, Dial 2, Dial 3, Time Clock, or System. The other switch shall select Coordination or Free Run. Secondary dial coordinating unit shall have the same 5 cycle length gears for each of the three dials as required by the master and interrupter dial coordinating units.

922.03 Blank

922.04 Signal Head Components

(a) Vehicle Signal Face

Vehicle signal faces shall be as shown on the plans. The components shall be in accordance with the latest standard of the Institute of Transportation Engineers for Adjustable Face Vehicular Traffic Control Signal Heads.

1. General

The signal faces shall be sectional in construction, requiring one section for each lens and furnished in the nominal size of 12 in. (305 mm). Each section of a face shall have a rectangular silhouette when viewed from the front or the rear.

2. Housing, Door, and Visor

The top and bottom of each housing shall have an integral locking ring with 72 serrations to permit rotation of the signal housing in 5 degree increments. Hub openings in the top and bottom of the signal housing shall accommodate standard 1 1/2 in. (38 mm) bracket arms. The thickness of the hub at the top and bottom of the housing shall be a maximum of 1 in. (25 mm) and a minimum of 3/8 in. (10 mm). The 12 in. (305 mm) 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.

3. Lens

The lens shall be made of plastic and shall be in accordance with ASTM D 788, grade 8; or ASTM D 3935. The index of refraction shall be between 1.48 and 1.59. The lens shall be uniformly colored throughout the body of the material, true to size and form, and free from any streaks, wrinkles, chips, or bubbles. The values of luminous transmission for the signal lens and the limits of chromaticity for the lens colors shall be in accordance with the latest standard of the Institute of Transportation Engineers for Adjustable Face Vehicular Traffic Control Signal Heads. The lens hole with the lens gasket in place shall be of sufficient size to accommodate a 12 in. (305 mm) diameter lens.

4. Reflector Assembly

The reflector shall be made of Specular Alzak Aluminum. The reflector assembly shall be designed so that it is pivoted and can be swung out of the housing and easily removed without the use of tools. A neoprene gasket shall be provided between and completely around the reflector and the reflector frame and shall be reusable. The reflector frame shall be aluminum or plastic.

5. Lamp Receptacle and Wiring

The lamp receptacle shall be fixed focus type, positioning the lamp filament at the correct focal point with respect to the reflector. The assembly shall be designed so the lamp socket can be rotated through 360 degrees into positions of adjustment for proper positioning of the lamp filament after relamping. The lamp socket shall be equipped with color coded wire either red, yellow, or green depending upon the lens color of the section. The socket wires shall be a minimum of 26 in. (660 mm) long, fixture wire No. 18 AWG or larger, 600 volts, with insulation designed to withstand 221°F (105°C). The conductor size, insulation type letter designation, and temperature rating shall be marked on the insulation or a material certification of compliance shall accompany each signal head combination. The wiring leads shall be terminated with screw spade lug type or female type connectors for ease of connection to the terminal block. The socket shall be equipped with a gasket to insure a dust tight fit between the socket and reflector.

6. Section Coupling

Any method to connect two or more sections together may be used, if the following requirements are met.

a. Two or more sections, when joined together, shall maintain structural integrity when loaded to Institute of Transportation Engineers Standards.

b. The opening between joined sections shall accommodate two 1/2 in. (13 mm) cables.

c. The maximum length of bolts used to connect sections together shall be 4 in. (100 mm).

Nuts, bolts, or lock washers shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and be in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

7. Terminal Block

The yellow section of the 3 section signal head shall be equipped with a 5 position terminal block for termination of field wiring. Each section shall have provisions for addition of an 8 position terminal block or two 5 position terminal blocks or one 5 position and one 3 position terminal block. The terminal block shall have a minimum spacing between screw connections of 1/2 in. (13 mm). The height of the insulating ridge between screw connections shall be a minimum of 19/32 in. (15 mm) from the base of the terminal blocks.

8. Material Requirements

a. Polycarbonate Signal Head

The housing, door, and visor of the section shall be made of ultraviolet and heat stabilized polycarbonate. The color shall be permanently molded into the components except the inside surface of the visor shall be painted non-reflecting flat black. The color shall be yellow in accordance with 909.02(d)4.

b. Die-Cast Aluminum Signal Head

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 B 85. All surfaces of the housing, doors, and visor shall receive a prime coat of zinc chromate paint in accordance with 909.02(a) or shall be anodized with a chromate aluminum oxide coating process. The finish shall be highway yellow enamel, two coats, oven baked and in accordance with 909.02(b) except the inside surface of the visor shall be painted non-reflecting flat black.

9. Certification

A material certification in accordance with the applicable provisions of 916 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.

(b) 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. (460 to 485 mm), including the visor and the hinges. The signal shall contain two figures with two different colored messages. The left figure shall transmit an upraised hand symbol message, and the right figure shall transmit

a walking person symbol message. The pedestrian signal shall be in accordance with the standard of the Institute of Transportation Engineers for Pedestrian Traffic Control Signal Indications.

1. Housing, Door, and Visor

The housing shall be equipped with mounting device hardware, such as clamshell, and round openings at top and bottom for mounting with brackets made of iron pipe standard, to fit the 1 1/2 in. (38 mm) pipe. The openings shall have a common vertical centerline through the housing to permit 360 degrees rotation after it is mounted. The openings shall have a serrated ring which permits locking of the housing in 5 degree increments throughout the entire 360 degrees of rotation. The brackets or the clamshell shall serve as the electrical conduit for the pedestrian signal. The housing shall be made of die cast, corrosion resistant, copper free, non-ferrous metal which shall be in accordance with ASTM B 85.

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 exterior of the housing shall be Federal yellow in color. The polycarbonate components shall be black in color impregnated throughout. The metal components shall be painted with enamel in accordance with 909.02(b).

Each signal shall be provided with a visor. The visor shall consist of a minimum of 20 horizontal and 20 diagonal equally spaced louvers. Every other formed louver shall be reversed to provide diamond shaped cells each having a minimum area of 1 in^2 (650 mm^2). The louvers shall be made of impregnated black polycarbonate plastic processed with a flat finish on both sides, to eliminate sun phantom. The door and visor assembly shall be attached to the housing by means of stainless steel screws and nuts.

2. Optical Unit

The optical unit shall consist of the redirecting lens, the lamp, a reflector, a filter, and other optical elements necessary for proper operation. The optical unit shall be designed to minimize the return of the outside light rays entering the unit, such as sun phantom. The optical unit shall be designed and assembled so that no light escapes from one message unit to the other.

The values of luminous transmission for pedestrian signal lenses and the limits of chromaticity for pedestrian signal colors shall be in accordance with the standard of the Institute of Transportation Engineers for Pedestrian Traffic Control Signal Indications.

3. Lens

The lens shall be made of plastic. The lens shall be in accordance with ASTM D 788, grade 8; or ASTM D 3935. However, the index of refraction shall be between 1.48 and 1.53. As required by the type of pedestrian signal, the lens shall be uniformly clear or colored throughout the body of the material, true to size and form and free from any streaks, wrinkles, chips, or bubbles.

4. Message

When illuminated, the upraised hand symbol shall be in Portland Orange on the left surface of the signal indications. The walking person symbol shall appear in white on the right surface of the signal indication when illuminated. The upraised hand and walking person symbols shall each be a minimum of 11 in. (280 mm) in height. The width of the upraised hand symbol shall be a minimum of 7 in. (178 mm). The width of the walking person symbol shall be a minimum of 6 in. (150 mm). Message configuration, color, and size shall be in accordance with the standard of the Institute of Traffic Engineers for Pedestrian Traffic Control Indications.

5. Reflector Assembly

The reflector shall be a double parabolic type, made of textured polycarbonate plastic sheet coated with aluminum, or made of specular Alzak Aluminum with bead or flange on the outer edge to stiffen the reflector and ensure the true shape. The reflecting surface shall be free of flaws, scratches, defacements, or mechanical distortion.

The 2 sections of the reflector shall be divided by a full depth divider which properly mates with the message lens to effectively prevent light spillage from one section to the other.

6. Light Distribution

The illuminated signal shall be uniformly illuminated over the entire message surface without shadows when viewed from usual angles encountered in service. The upraised hand and walking person symbols shall not appear to be illuminated portions of the lens. When not illuminated, the upraised hand and walking person symbols shall not appear to be illuminated by external light sources when viewed from the far end of the crosswalk. The pedestrian indication shall be visible to the pedestrian at all times at all distances from 10 ft (3 m) to the full width of the street to be crossed.

7. Electrical

The signal shall be equipped with a lamp and a socket for each of the 2 sections of the double parabolic reflector. The lamp receptacle shall be of heat resisting material. The lamp receptacle shall be provided with a grip to prevent the receptacle from working loose due to vibration. Each lamp shall be traffic signal lamp type A 21. The metal portion of the lamp receptacle shall be compatible with brass or copper.

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.

(c) Disconnect Hanger Junction Box

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 galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153. The housing shall be made of a die-cast, corrosion resistant, copper free, non-ferrous metal which shall be in accordance with ASTM B 85. 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.

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 or hex head bolts and nuts with lock washers, shall be 0.062 in. (1.6 mm). The span hanger bolt where the eye-bolt or the balance adjuster is attached shall be 5/8 in. (16 mm) diameter.

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 permit rotation of the disconnect hanger clevis, hub plate, or signal head in five degree increments. There shall be no thread in contact with a wearing surface. Locking rings shall have a minimum thickness of 3/16 in. (4.8 mm) and a maximum thickness of 1/4 in. (6.4 mm) from the base of the ring to the serration peaks. The inside diameter shall be 2 in. (50 mm) and the outside diameter shall be 2 7/8 in. (73 mm).

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 (2.0 mm) wires.

The disconnect hanger shall have two side entrance holes on opposite sides capable of receiving a 1 1/2 in. (38 mm) plastic or rubber insert to reduce water infiltration. It shall be capable of supporting signal faces in the ambient temperature range of -30°F to 120°F (-35°C to 49°C) without failure.

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. (13 mm) in diameter.

A type C certification in accordance with 916 shall be provided.

(d) Signal Bulbs

The minimum design requirements for 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 and as follows.

1. Bulbs shall be 67 watt, 116 watt, or 150 watt for different kinds of indications, as specified below.

INDICATION	WATTAGE
9 in. (230 mm) pedestrian	67
12 in. (305 mm) and 18 in. (455 mm) pedestrian	116
8 in. (200 mm) red, yellow, and green	67
12 in. (305 mm) red	150
12 in. (305 mm) yellow and green	116
12 in. (305 mm) yellow and green arrows	150
optically programmed heads	150

2. All bulbs shall have medium size, brass bases.

3. Bulbs shall be designed for use in a horizontal position or a base down position.

4. The light center length shall be 2 7/16 in. (62 mm) for 67 watt bulbs and 3 in (75 mm) for 116 watt and 150 watt bulbs.

5. The filament shall be C9 design with a minimum of seven supports. The two voltage supply leads may be counted as two of the seven supports.

6. The maximum, overall bulb length for 67 watt and 116 watt bulbs shall be 4 3/8 in. (111 mm) and for 150 watt bulbs shall be 4 3/4 in. (120 mm).

7. All bulbs shall be clear and shall be 130 volt.

8. The 150 watt bulb shall be P25 or A21 size and shape.

9. The 67 watt and 116 watt bulbs shall be A21 size and shape.

10. All bulbs shall have 6000 h minimum burning life.

(e) Free Swinging Signal Support Assemblies

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. (1.6 mm). No bushings or shims will be allowed in this assembly.

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.

The span hanger, balance adjuster, weatherhead, and all related hardware shall be made of non-corrosive metal or shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153. The weatherhead shall have a minimum of 2 1/2 in. (64 mm) 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 slipin 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. (6.4 mm) diameter and shall have sufficient threads to be able to secure the hanger to a 1/4 in. (6.4 mm) or a 1/2 in. (13 mm) messenger cable. The multiple pipe arm assembly shall consist of a span hanger assembly, a balance adjuster, a signal weatherhead, a 2, 3, or 4 way pipe arm, 1 1/2 in. (38 mm) pipe, a lower arm assembly, and all related hardware necessary for a complete assembly.

The 2, 3, or 4 way pipe arms shall have a minimum of 2 in. (50 mm) of exposed thread. Each arm of the pipe arm shall be furnished with two 72 serration locking rings. One locking ring shall have a 3 in. (75 mm) outside diameter and one locking ring shall have a 2 3/8 in. (60 mm) outside diameter.

ASSEMBLY	MAXIMUM ALLOWABLE WEIGHT
2 Way	19 lb (8.6 kg)
3 Way	25 lb (11.3 kg)
4 Way	28 lb (12.7 kg)

(f) Mid-Mast Arm Mount Signal Bracket

The bracket shall permit the following four adjustments.

1. rotational adjustment about bracket axis;
2. vertical adjustment;
3. rotational adjustment about mast arm; and
4. rotational adjustment right and left from vertical plane

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 mast arm.

Upper and lower arms shall be cast from aluminum in accordance with ASTM B 26 (B 26M), alloy 713.0-T5 or 356.0-T6. The vertical support tube shall be extruded from aluminum in accordance with ASTM B 241 (B 241M), alloy 6063-T6 or 6061-T6, and the strapping to attach the bracket to the arm shall be stainless steel. All steel or malleable iron parts shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153.

(g) Pedestal Mounted Control Cabinets or Pedestrian Signal Heads

The pedestal base used for mounting pedestrian signal heads or control cabinets shall be in accordance with 922.01(g)2a. The length of the pedestal pole shall be as shown on the plans.

922.05 Signal Support

(a) Steel Strain Pole

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 reinforced handhole within 18 in. (460 mm) of the base. The minimum size shall be 5 in. (130 mm) by 8 in. (200 mm) with a cover and latching device. 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 A 595 or A 572 with a minimum yield strength of 50,000 psi (345 MPa). The pole shall be galvanized after fabrication in accordance with ASTM A 123.

All hardware, handhole cover and latching device, band type steel pole bands, steel bolts, nuts, and washers shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153. All nuts and bolts, except anchor bolts, shall be in accordance with ASTM A 307. If a cast pole top or cap is used it shall be in accordance with ASTM A 126 and shall be galvanized with a minimum coating of 2 oz/ft^2 (0.610 kg/m^2).

The pole bands shall fit the pole as planned. The wire rope shall not be in contact with any 90 degrees edges or with any threads on the band. The pole band material shall be in accordance with ASTM A 572, grade 50 (A 572M, grade 345); ASTM A 606; or ASTM A 36 (A 36M) with a minimum yield of 50,000 psi (345 MPa). The minimum width of the bands shall be 3 in. (75 mm) 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.

All welding shall be in accordance with 711.32. Welds shall generate the full strength of the shaft. Only longitudinal continuous welding shall be permitted on the pole

shaft. Contacting joint surfaces shall be thoroughly cleaned before fabrication then completely sealed by means of welding. Shop drawings shall be submitted in accordance with 922.05(c)9.

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.

The steel strain pole shall be capable of supporting an 8000 lb (35.6 kN) load applied horizontally 18 in. (460 mm) below the top of the pole with a maximum allowable deflection of 0.16 in. (4.1 mm) per 100 lb (445 N) of load. The pole shall be tapered 0.14 in. per foot (12 mm per meter) 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 A 36 (A 36M), A 572 (A 572M), or A 588 (A 588M). The base plate shall have four holes of adequate size to accommodate 2 1/4 in. (57 mm) anchor bolts. The bolt circle shall have a 22 in. (560 mm) diameter and bolt square of 15 1/2 in. (394 mm).

Four high strength steel anchor bolts, 2 1/4 in. (57 mm) diameter and 96 in. (2400 mm) long, including the hook, shall be furnished with each pole. Each bolt shall have two hex nuts and two washers in accordance with ASTM A 307, grade A. The anchor bolt material shall be in accordance with ASTM A 576 or ASTM A 675 (A 675M) with a minimum yield strength of 55,000 psi (379 MPa) or ASTM A 36 (A 36M), special quality, modified to 55,000 psi (379 MPa) or approved equal. The threaded end of the anchor bolt shall have 12 in. (305 mm) of 4 1/2 NC threads and shall be galvanized the length of the threads, plus 3 in. (75 mm). The threaded end shall be coated after fabrication in accordance with ASTM A 153 or be mechanically galvanized and be in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C. The unthreaded end of the anchor bolt shall have a standard L bend for a distance of 9 in. (230 mm) 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 in.^{2} (2900 mm^2) and 1 1/4 in. (32 mm) thick may be welded to the embedded end of the anchor bolt.

(b) Wood Strain Pole

Wood 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.

All poles shall be full length pressure treated by the full cell process in accordance with current specifications as set forth in the AWPA Standards C1 and C4, using preservative as outlined in standard P5 and set forth in 911.02(h).

Treatment, handling, and storage methods shall be in accordance with the current AWPA Standards.

(c) Signal Cantilever Structures

1. General

A signal cantilever structure shall be designed in accordance with the latest AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, except where modified herein.

Where the manufacturer has wind tunnel test data, he may use drag coefficients based on actual tests. Otherwise, the manufacturer shall use the drag coefficients in Table 1.2.5c.

2. Signal Support

The traffic signal pole and mast arm shall be designed to support the loads in accordance with the plans in an 80 mph (129 km/h) wind with gusts to 104 mph (167 km/h). Loading shall assume diecast aluminum heads.

The traffic signal pole and mast arm shall be designed to provide a 17 ft (5.3 m) minimum clearance at all signals. Clearance shall be the vertical distance from the lowest point of the signal combination to a horizontal plane 3 in. (75 mm) below the base of the mast arm pole or from the lowest point of the signal combination to the pavement surface below the signal combination, whichever governs. Adjustment of the clearance at the installation site shall be by raising or lowering the mast arm along the upper length of the pole. After the pole is anchored to the foundation, the pole design shall permit the mast arm to be rotated 90 degrees in either direction and secured. The cable inlet shall not be obstructed when a field rotation or vertical adjustment of the mast arm is made.

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 a 11/16 in. (18 mm) diameter bolt hole to receive the signal face assembly.

3. Combination Signal-Luminaire Support

All requirements for a signal support shall apply to a combination signal-luminaire support.

The minimum design load of the luminaire shall be 53 lb (24 kg) with a projected surface area subject to wind loading of 2.4 ft^2 (0.223 m^2). If heavier or larger luminaires are used, their actual values shall be used. The required luminaire mounting height shall be in accordance with the plans. Mounting height shall be defined as the vertical distance from the lowest point of the luminaire to the horizontal plane which passes through the base of the pole.

The maximum percentage of allowable stress shall be 80% of the AASHTO Standard Specifications for Group 1 loads. Vibration dampers shall be furnished as recommended by the manufacturer.

4. Pole Requirements

a. General

The pole shall be a round or multi-sided tapered tube, except the upper 4 to 6 ft (1.2 to 1.8 m) of a signal support pole may be non-tapered. The signal support pole shall have a reinforced handhole 4 in. (100 mm) by 6 in. (150 mm) minimum complete with

cover and latching device located 18 in. (460 mm) above the base. A 1/2 in. (13 mm) 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 set screws. The combination signal-luminaire pole shall have a reinforced handhole 4 in. (100 mm) by 8 in. (200 mm) minimum complete with cover and latching device, located 18 in. (460 mm) above the base. The combination signal-luminaire 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. A wiring hole with a 1 in. (25 mm) to 1 1/2 in. (38 mm) inside diameter grommet shall be provided where the luminaire mast arm attaches to the pole.

b. Deflection

The maximum allowable horizontal deflection of the pole under maximum loading conditions shall not exceed a deflection angle of one degree 10 min from the vertical axis of the pole for any 1 ft (305 mm) section of the pole along the entire length of the pole.

c. Materials

The signal pole and the combination signal-luminaire pole shall be steel or aluminum. Steel poles shall be in accordance with ASTM A 595 or A 572 with a minimum yield strength of 50, 000 psi (345 MPa) and shall be galvanized in accordance with ASTM A 123. Aluminum poles shall be in accordance with ASTM B 221 (B 221M) alloy 6063-T6 or 6005-T5, or ASTM B 241 (B 241M), alloy 6063-T6.

d. Hardware

All hardware for steel poles except bolts for the mast arm clamps and anchor bolts shall be in accordance with ASTM A 307 and shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C. A cast pole cap shall be in accordance with ASTM A 126 and shall be galvanized with a minimum coating of 2 oz/ft^2 (0.610 kg/m^2).

All hardware for aluminum poles shall be stainless steel in accordance with ASTM A 276, type 304 or type 305.

e. Anchor Base

A one piece anchor base shall be secured to the lower end of the pole and shall develop the full strength of the pole. The base shall be provided with four holes of adequate size to accommodate 1 1/4 in. (32 mm) anchor bolts equally spaced on a bolt circle of 15 in. (380 mm) diameter and shall have four tapped holes for attaching the bolt covers. 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. The steel for the anchor base shall be in accordance with ASTM A 36 (A 36M), A 572 (A 572M), or A 588 (A 588M). Aluminum for the anchor base shall be in accordance with ASTM B 26, alloy 356.0-T6 or 356.0-T7 or ASTM B 209, alloy 6061-T6.

5. Arm Requirements

a. Signal Cantilever Arm

A signal cantilever arm shall be attached to the pole by circular clamps. One-half of the clamp shall be welded to the cantilever arm. The single member arm or the upper tapered member of the truss style arm shall have a cable inlet adjacent to the clamp complete with grommet. The cable inlet shall be a 1 3/4 in. (44 mm) diameter hole with a 1 1/2 in. (38 mm) inside diameter rubber grommet. The 20, 25, and 30 ft (6.1, 7.6, and 9.2 m) cantilever arms shall have one intermediate cable inlet with grommet located 12 ft (3.7 m) from the free end of the arm. The 35 and 40 ft (10.7 and 12.2 m) cantilever arm shall have two intermediate cable inlets with grommets located 12 ft (3.7 m) and 24 ft (7.3 m) respectively from the free end of the arm. The intermediate cable inlet shall be a 1 in. (25 mm) diameter hole with a 3/4 in. (19 mm) inside diameter rubber grommet.

The maximum rise of the single member arm shall be 1/2 in. (13 mm) per 1 ft (305 mm) of arm after loading. The maximum rise of the truss style arm shall be as set out in the table. The rise 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 (m)	Total Rise ft - in. (m)	Tolerance in. (mm)
12 - 20 (3.7 - 6.1)	4 - 0 (1.2)	±1 (± 25)
25 (7.6)	4 - 3 (1.3)	±1 (± 25)
30 - 40 (9.2 - 12.2)	4 - 7 (1.4)	±1 (± 25)

The end signals on the truss style arms shall be suspended and the intermediate signals shall be rigidly attached. All signals on the single member arms shall be rigidly attached as shown on the plans. The cantilever arms shall be used as an enclosed raceway for wiring and shall be free of burrs and rough edges.

Both parts of the clamp for the single member arms shall be stamped with the arm length prior to galvanizing.

b. Luminaire Mast Arm for Combination Support

The luminaire mast arm shall be in accordance with 920.01(a)1.

c. Materials

The signal mast arm shall be of the same material as the pole. The luminaire mast arm shall be of the same material as the pole except that a truss type arm shall be in accordance with 920.01(a). Bolts for the mast arm clamp shall be stainless steel in accordance with ASTM A 276, type 304 or 305.

6. Anchor Bolts

Four steel anchor bolts, each fitted with two hex nuts and two flat washers, shall be furnished with each pole. The anchor bolt shall be 1 1/4 in. (32 mm) diameter with a minimum of 10 in. (254 mm) of 7 NC threads on the upper end. The threads, nuts, and washers shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153. The anchor bolt shall be 48 in (1220 mm) long with a 4 in. (100 mm) right angle bend on the lower end or a square steel washer, 6 in. by 6 in. by 1/2 in. (150 mm by 150 mm by 13 mm), with a hex nut welded onto the lower end. The steel for the bolt shall

be in accordance with ASTM A 576, or ASTM A 675 (A 675M), with a minimum yield strength of 55,000 psi (379 MPa), or ASTM A 36 (A 36M), special quality, modified to 55,000 psi (379 MPa) or approved equal.

7. Finish

All steel material shall be fully galvanized. Galvanizing shall take place after all welding is accomplished. Aluminum poles shall be provided with a satin finish accomplished by mechanical rotary grinding and aluminum mast arms shall be provided with a satin etched finish.

8. Certification

Unless otherwise specified, all materials covered herein shall be covered by a type C certification in accordance with 916.

9. Shop Drawings

Five sets of shop drawings and a set of design calculations shall be submitted to the Design Division for approval. A copy of the transmittal letter shall be sent to the Engineer. The approved drawings will be distributed by the Design Division.

(d) Downguys, Anchors, Rods, and Guards

Pole anchors shall be 8 way expanding with a minimum area of 135 in.^{2} (87 100 mm^2) when expanded or a 10 in. (250 mm) diameter screw anchor. They shall have a minimum holding strength of 10,000 lb (44.5 kN). They shall be painted and in accordance with ASTM A 1011 (A 1011M). Anchor rods for expanded anchors shall be 3/4 in. (19 mm) diameter steel and for screw anchors shall be 1 1/4 in. (32 mm) diameter steel, 8 ft (2.4 m) long, in accordance with ASTM A 659 (A 659M), and be galvanized in accordance with ASTM A 153.

Guy guards shall be made of 18 gauge galvanized steel, polyethylene, polyvinylchloride, or melamine phenolic, and shall be 7 ft (2.1 m) 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 A 659 (A 659M). The non-metallic 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.

922.06 Traffic Cable

(a) Messenger Cable

Messenger cable shall be zinc-coated steel wire strand, contain seven wires, and have a nominal diameter of 3/8 in. (10 mm). The cable shall be in accordance with ASTM A 475, Siemens-Martin Grade.

(b) Span, Catenary, and Downguy Cable

Span, catenary, and downguy cable shall be aircraft cable for non-aircraft use, and shall be 3/8 in. (10 mm) nominal diameter, made of stainless steel wire, and consist of seven, 19 wire steel strands. The 3/8 in. (10 mm) cable shall have a minimum breaking

strength of 12,000 lb (53.4 kN). It shall be in accordance with Military Specifications MIL-W-1511.

(c) Tether and Support Cable

Tether and support cable shall be aircraft cable, for non-aircraft use, and shall be 1/8 in. (3 mm) nominal diameter, made of stainless steel wire, and consist of seven, 7 wire flexible steel strands. The 1/8 in. (3 mm) cable shall have a minimum breaking strength of 1700 lb (7560 N). It shall be in accordance with Military Specifications MIL-W-1511.

(d) Cable Hardware

1. Messenger Hangers

Messenger hangers shall be either a three bolt clamp or a 3/8 in. (10 mm) by 1 3/4 in. (44 mm) steel hanger with a 90 degree bend extending from the pole 3 3/4 in. (95 mm). The hanger shall have a curved groove and clamp capable of receiving a 5/16 in. to 1/2 in. (8 mm to 13 mm) cable.

The messenger shall be clamped by two 1/2 in. (13 mm) high carbon steel bolts. The angle hanger shall be mounted with a 5/8 in. (16 mm) through bolt and a 1/2 in. (13 mm) lag screw. The three bolt clamp shall be mounted with a 5/8 in. (16 mm) through bolt. The angle hanger shall be in accordance with ASTM A 575. The bolts shall be in accordance with NEMA PH 23.

2. Cable Ring

Cable rings shall be galvanized steel in accordance with IMSA 51-1.

3. Clamps

Clamps shall be made of 3/8 in. (10 mm) steel and in accordance with ASTM A 575.

Two bolt clamps shall be a minimum of 3 3/4 in. (95 mm) long and 1 1/4 in. (32 mm) wide with two 1/2 in. (13 mm) bolts which shall clamp cable of 1/8 to 1/2 in. (3 to 13 mm) diameter.

Three bolt clamps shall be a minimum of 6 in. (150 mm) long and 1 5/8 in. (42 mm) wide with three 5/8 in. (16 mm) bolts which shall clamp cable of 5/16 to 1/2 in. (8 to 13 mm) 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.

4. Servi-Sleeves

Servi-sleeves shall be 1 1/4 in. to 2 1/4 in. (32 mm to 57 mm) in length and shall hold the size of the cable specified. The sleeves shall be in accordance with ASTM A 659 (A 659M).

5. Straight Eye-Bolts

Straight eye-bolts shall be 3/4 in. (19 mm) diameter drop forged steel, a minimum of 14 in. (356 mm) long, and have 6 in. (150 mm) of thread. The steel washers shall be 2 1/4 in. (57 mm) by 2 1/4 in. (57 mm) by 3/16 in. (5 mm) in size with 13/16 in. (21 mm) hole in the center. All parts shall be in accordance with ASTM A 575 and shall be galvanized in accordance with ASTM A 123.

6. Hub-Eyes

Hub-eyes shall be made of drop forged steel and in accordance with ASTM A 575. They shall receive a 3/4 in. (19 mm) mounting bolt and have a full rounded thimble eye for protection of the guy cable.

(e) Signal Cable

1. Hook-up Wire

Signal hook-up wire shall be stranded one conductor wire, type THW 7 strand No. 14 AWG, with a thermoplastic sheath 3/64 in. (1.19 mm) thick and a 600 volt rating. Insulation shall be color coded, as required, and labeled with gauge, voltage rating, and insulation type.

2. 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.

3. Integral Messenger Interconnect Cable

Integral aerial interconnect cable shall be figure “8” self-supporting type cable consisting of a messenger cable and 7 conductors No. 14 AWG signal cable in accordance with IMSA 20-3.

4. 6 Pair/19 Telemetry Cable

6 pair telemetry cable shall contain six twisted pairs of 19 gauge conductors and shall be in accordance with IMSA Specification 40-2 for underground application and IMSA Specification 40-4, integral messenger, for aerial application.

5. Fiber Optic Interconnect Cable

Fiber optic cable shall contain four stranded multimode, graded index, optic fibers with a minimum of one non-metallic central strength member. The cable shall be loose tube, all dielectric construction, suitable for outdoor use in conduit or on aerial supports. Each individual fiber shall be 62.5/125µm diameter, core/clad, and each fiber shall be individually encased in its own gel-filled color coded buffer. 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 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 Bellcore Technical Reference TR-TSY-000020.

The exterior of the polyethylene outer cable jacket shall be stenciled so that every fifth meter on each reel is marked with a number. The fifth meter of each reel shall be marked with a 5, the tenth meter 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.

6. Service Cable

Traffic signal service cable shall be color coded, stranded copper No. 8 AWG wire, 3 conductor cable, type THWN.

7. Detection Wire and Sealant

a. Loop Detector Lead-In Cable

Loop detector lead-in cable shall be in accordance with IMSA 50-2 and shall be stranded 2 conductor No. 16 AWG, 19 strands of No. 29 wire.

The nominal capacitance between conductors shall be 57 pF/ft (187 pF/m) and 98 pF/ft (322 pF/m) 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. (6.3 mm) diameter.

c. Sealant

Prior to installing roadway loop wire in the roadway saw cuts, the saw cuts shall be cleaned in accordance with the requirements for the joint sealant to be used. After proper cleaning and installation of the loop wire, the saw cut shall be sealed with a joint sealant material in accordance with 906.02(a)1 or 906.02(a)2. The joint sealant material to be used 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. The joint sealant material shall be installed in accordance with the applicable sealant specification. 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 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 significant or objectionable surplus joint sealant on the pavement surfaces shall be promptly removed.

8. Ground Wire

The ground wire shall be copper wire No. 6, AWG soft-drawn, solid copper in accordance with ASTM B 3.

9. Splicing Kit

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 non-shielded cables rated up to 5 kilovolts and multi-conductor cables rated up to 600 volts.

922.07 Ground Rod and Connections

Ground rods shall be 1/2 in. (13 mm) in diameter by 8 ft (2.4 m) long with a machined point and chamfered top. They shall be made of steel with a molecularly bonded outer layer of electrolytically applied copper. The finished rod shall be cold-drawn and shall have the following minimum physical properties.

PHYSICAL PROPERTY	MINIMUM
Tensile strength	97,000 psi (668 MPa)
Yield strength, 0.2% offset	85,000 psi (586 MPa)
% of elongation	13 psi (90 kPa)

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, and copper.

922.08 Castings for Handholes

The ring and cover for handholes shall be in accordance with 910.05(b).

922.09 Entrance Switch

The entrance switch shall be a single pole, 50 amp, 120 volt circuit breaker in a NEMA type 3R enclosure. The minimum dimensions of the enclosure shall be: 5 in. (127 mm) wide, 3 3/4 in. (95 mm) deep, and 9 1/4 in. (235 mm) high. A 1 in. (25 mm) 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. (22 mm) to 1 3/4 in. (44 mm). The enclosure shall contain the circuit breaker, an insulated solid bar for connection of AC Neutral, a separate lug for attachment of earthground, have provisions for a padlock, and shall be surface mounted.

The enclosure shall be made of galvanized steel with a rust inhibiting treatment, and finished in the manufacturer's standard color of baked enamel.

922.10 Conduit and Fittings

(a) Steel Conduit

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. (3 mm). Conduit lock nuts 3/8 in. to 1 1/2 in. (10 mm to 38 mm) 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.

(b) Polyvinyl Chloride Conduit

PVC conduit shall be in accordance with ASTM D 1785, schedule 40. The PVC conduit fittings shall be in accordance with ASTM D 2466. Each length of pipe shall include a coupling.

922.11 Detector Housing

The entire housing casing shall be made from aluminum alloy in accordance with ANSI 320.

922.12 Certification

Unless otherwise specified, all materials covered herein shall have a type C certification in accordance with 916.

SECTION 923 – TEMPORARY TRAFFIC CONTROL DEVICES

923.01 Temporary Pavement Marking Tape

Temporary pavement marking tape shall be furnished in two colors and two types. It shall consist of a white or yellow reflecting film on a conformable backing which is a minimum of 4 in. (100 mm) wide, and is designed for marking either asphalt or concrete pavements.

The white or yellow reflective film on the tape shall be in accordance with highway colors. The tape shall have an average thickness, as determined by 5 micrometer readings, of no less than 20 mils (0.50 mm). The type I reflective film shall have glass beads uniformly distributed throughout the reflective film. Type I and type II reflective film shall have a reflective layer of glass beads bonded to the surface.

The tape shall be supplied in rolls ready for application and have a precoated, pressure sensitive adhesive on the backing which shall not require activation procedures. There shall be no more than three splices per 50 yds (46 m) of length. It shall be shipped in standard commercial containers so constructed as to ensure acceptance by the carrier and prevent damage during shipment and storage. It shall be capable of being stored at temperatures up to 100°F (38°C) for periods of one year without deterioration.

When the tape is applied in accordance with the manufacturer's recommended procedures, it shall be weather and traffic resistant and show no appreciable fading, lifting, or shrinkage during the useful life of the line. The material shall be of good

appearance, free from cracks, and edges shall be true, straight, and unbroken. The material shall be capable of performing satisfactory for a minimum of one year.

Type I tape shall be selected from the Department's list of approved Temporary Pavement Marking Tape, Type I. Temporary pavement marking tape type I will be placed and maintained on the Department's approved list in accordance with ITM 806.

Type I tape furnished under this specification shall be covered by a type C certification in accordance with 916.

The minimum reflective intensity values expressed as 0.12 Candlepower/ft^2/foot candle (0.12 Candela/m^2/lux) when tested in accordance with ASTM D 4061 shall be in accordance with the following table.

SPECIFIC LUMINANCE USING ENTRANCE ANGLE 86 DEGREE

Observation Angle	White		Yellow	
	0.2°	0.5°	0.2°	0.5°
Specific Luminance, Type I	1770	1270	1310	820
Specific Luminance, Type II	1000	760	820	510

923.02 Temporary Raised Pavement Marker

Temporary pavement marker shall be affixed with adhesive to the pavement surface. A temporary raised pavement marker shall consist of a shell, a reflective element, and an adhesive. The shell shall be black or the same color as the pavement marking being supplemented or replaced. The reflective element shall be either a reflective prismatic lens or reflective sheeting. A uni-directional marker shall meet the visual requirements of this specification when viewed from the front of the marker and a bi-directional marker shall meet the visual requirements when viewed from either direction. Two uni-directional markers placed back to back are an acceptable alternate for a bi-directional marker.

The dimensions of the front view of the marker shall be as follows.

DIMENSION	MINIMUM	MAXIMUM
Width of marker shell	3.8 in. (97 mm)	
Height of marker shell without adhesive	0.5 in. (13 mm)	
Height of marker shell with adhesive		1.0 in. (25 mm)
Area of prismatic lens reflecting surface	0.30 $in.^2$ (194 mm^2)	
Area of sheeting reflecting surface	1.0 $in.^2$ (645 mm^2)	

(a) Optical Requirements

The white and yellow reflective elements shall have the initial minimum reflectance values specified in the following tables when measured in accordance with ASTM E 809. The photometric characteristic to be measured shall be the coefficient of luminous intensity. This coefficient shall be expressed as candlepower per footcandle (candelas per lux). The entrance angle vertical component, Beta 1, shall be the clockwise angle formed from the vertical half plane, passing through the bottom front edge of the reflective element, to the face of the reflective element when viewed from the right side.

TABLE 1
REFLECTIVE SHEETING ELEMENT FOR GRADE 2 MARKERS

Observation Angle (degrees)	Entrance Angle Horizontal Component Beta 2 (degrees)	Coefficient of Luminous Intensity Candlepower/foot candle (candelas/lux)	
		White	Yellow
0.2	-4	1.0 (0.0929)	0.60 (0.0558)
0.5	-4	0.4 (0.0372)	0.24 (0.0223)

TABLE 2
REFLECTIVE SHEETING ELEMENT FOR GRADE 1 MARKERS

Observation Angle (degrees)	Entrance Angle Horizontal Component Beta 2 (degrees)	Coefficient of Luminous Intensity Candlepower/foot candle (candelas/lux)	
		White	Yellow
0.2	-4	1.00 (0.0929)	0.60 (0.0558)
0.5	+20	0.4 (0.0372)	0.24 (0.0223)
0.5	-4	0.4 (0.0372	0.24 (0.0223)

TABLE 3
REFLECTIVE PRISMATIC LENS ELEMENT

Observation Angle (degrees)	Entrance Angle Horizontal Component Beta 2 (degrees)	Coefficient of Luminous Intensity Candlepower/foot candle (Candelas/lux)	
		White	Yellow
0.2	+20	0.04 (0.00372)	0.24 (0.0223)
0.2	0	1.0 (0.093)	0.24 (0.0223)

The grade 2 marker does not require daytime visibility and target value. The shape, color, and finish of the grade 1 marker shall provide an adequate diffused specular daytime signal. A diffused specular daytime signal will be considered adequate when the area of the horizontal projection, as determined from a point of projection of the front view of the marker less the projected areas of the reflective element and non-specular materials, is a minimum of 144 in^2 (92 900 mm^2). A minimum of 96 in.^{2} (61 900 mm^2) of this projection shall be attributable to that portion of the front view greater than 0.125 in. (3 mm) above the reference plane. For purposes of this requirement, the reference plane shall be the horizontal plane passing through the base of the marker and the point of projection shall be the point located 490 ft (149.4 m) horizontally in front of the marker and 42 in. (1.1 m) above the referenced plane.

(b) Strength Requirements

The marker shall withstand a 10,000 lb (44.5 kN) load without cracking or permanent deformation. The testing procedure shall consist of centering a marker between the flat paralleled platens of a compression testing machine. A flat piece of 50-60 Shore A durometer rubber 6 in. by 6 in by 3/8 in. (150 mm by 150 mm by 10 mm) shall be centered on top of the marker. The load shall be slowly applied through the rubber to the top of the marker. Failure shall constitute either cracking or permanent deformation of the marker at any load less than 10,000 lb (44.5 kN).

(c) Adhesive

The adhesive shall be compatible with the marker materials and shall not cause deterioration of the marker or concrete and HMA pavements. The three types of acceptable adhesives shall be a pre-applied pressure sensitive adhesive, and adhesive pad, or an asphalt adhesive.

The asphalt adhesive shall be used only on concrete pavement surfaces and on HMA pavement surfaces which receive an additional pavement course of at least 3/4 in. (19 mm) thickness.

Pre-applied pressure sensitive adhesive shall be pre-qualified for use from a field evaluation.

The adhesive pad shall be sized to fit the marker's dimensions and shall consist of pressure sensitive, 100% solids, approximately 0.04 in. (1.0 mm) thick, with closed cell release paper on each side. The pressure sensitive adhesive, when applied with a minimum application pressure of 60 psi (414 kPa), shall possess a minimum tensile or shear strength of 15 psi (103 kPa) at 70°F (21°C) ambient air temperature. An adhesive primer shall be used to promote optimum adhesion when the adhesive pad is placed on old asphalt or concrete surfaces that have one of more additional courses. The adhesive primer shall be as recommended by the manufacturer of the adhesive pad. The adhesive primer shall not be used on the surface course.

The asphalt adhesive shall be applied using an appropriate melter or applicator and shall be in accordance with the following.

CHARACTERISTIC	REQUIREMENT
Specific Gravity	1.80
Weight per cubic foot (Mass per cubic meter)	110 lb (1762 kg)
Flash point per ASTM D 92	509°F (265°C)
Bitumen content per ASTM D 2172	25 - 30%
Filler content (by subtraction)	70 - 75%
Filler particle size	Over 85% passing #200 (75 µm) mesh sieve
Penetration at 77°F (25°C) per ASTM D 5	12 ± 4
Softening point (Ring and Ball) per ASTM D 36	221°F ± 5°F (105°C ± 3°C)
Recommended pouring temperature	400 - 425°F (204 - 218°C)
Shelf life	2 years
Packing	Silicone lined cardboard boxes containing approximately 62 lb (28.1 kg) each

Note: Material shall not contain rubber polymers.

(d) Acceptance Evaluation

Markers shall be selected from the Department's list of approved Temporary Raised Pavement Markers. Temporary raised pavement markers will be placed and maintained on the approved list in accordance with ITM 806.

923.03 Construction Warning Lights

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

The light from types A and B shall have a flash rate of 65 ± 10 pulsations per minute from -20°F (-29°C) to 150°F (66°C).

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.

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 nine degrees from the vertical plane through the axis of the optical system and two planes five degrees above and below the horizontal plane through the optical axis of the system.

For type A, the effective intensity shall not drop below 4.0 candles (4.0 cd) 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 (35 cd) 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 (2.0 cd) within the area specified herein during the first 168 h of continuous burning.

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 (Candelas per lux)
0	18 (1.67)
10	14 (1.40)
20	7 (0.65)

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

1. Size of Lens

The lens shall be no less than 7 in. (175 mm) in diameter including for a reflex-reflector ring of 1/2 in. (13 mm) 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 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

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

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 permitting it to be swiveled through a minimum 90 degrees 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

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 weephole 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 (215 lux.).

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 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 5 footcandles (54 lux). A minimum of two interim photo-controlled settings shall automatically increase or decrease the lamp intensity in direct proportion to the ambient light level.

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 (150 m).

(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.

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.

The battery bank shall consist of 12 v, 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.

Solar power assisted flashing arrow signs to be used shall be selected from the Department's list of approved 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.

FLASHING ARROW SIGN GENERAL SPECIFICATIONS

	TYPE A	TYPE B	TYPE C	SOLAR POWER ASSISTED
Minimum Board Size	2 ft (0.6 m) high x 4 ft (1.2 m) wide**	See Note Below	4 ft (1.2 m) high x 8 ft (2.4 m) wide	4 ft (1.2 m) high x 8 ft (2.4 m) 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		Same as Type A	 5 in head, 5 in shaft* 5 in head, 3 in shaft* 7 in shaft
Lamp Type	Sealed Beam - 12.8 v, not to exceed 3 A Ave. rated life - 300 h. Min. Candlepower - 1000 candles (1000 cd) Min. 9700 candles (9700 cd) Max.		Same as Type A	Sealed Beam - 12.8 v, not to exceed 3 A Average rated life - 300 h Min. Candlepower - 600 candles (600 cd) at normal voltage and > 250 candles (250 cd) at low voltage
Lens Color	Amber		Amber	Amber
Board Color	Flat Black		Flat Black	Flat Black
Flashing Rate	30-50 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, or Warning Bar
Minimum mounting height (to bottom of board)	7 ft (2.1 m)		7 ft (2.1 m)	7 ft (2.1 m)
Where Permitted	Where normal speed limit is less than 40 mph		All rural & urban locations	Stationary Operations Tangent Sections (See 801.15(a)
Required Minimum Visibility	0.5 mi (0.8 km)		1 mi (1.6 km)	1 mi (1.6 km)

* When flashing a single or double arrow(s), the lamp(s) nearest the arrow points shall not be illuminated.

** Either rectangular or arrow shaped black background sign will be permitted.

Note: General specifications for a type B flashing arrow sign are shown in the Federal MUTCD.

923.05 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.

923.06 Tubular Marker

The vertically placed portion of this device shall consist of high density polyethylene plastic in accordance with ASTM D 5203. The base material shall be butyl rubber in accordance with ASTM D 5900 or high impact polystyrene in accordance with ASTM D 4549. 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.

SECTION 924 – WELDING SUPPLIES

924.01 Welding Supplies

(a) Aluminum Alloy Base Metals

1. Bare Wire Electrodes and Welding Rods

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, ASTM B 297 or 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.

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 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.

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. (170 mm) in height x 24 in. (600 mm) in width x 30 in. (75 mm) in depth. The cabinet top shall be crowned or slanted to the sides to prevent standing water.

The cabinet, sunshields, doors, and all panels shall be fabricated of 1/8 in. (3 mm) minimum thickness aluminum. The only exception to this aluminum thickness is the detector rack, which shall be fabricated of 0.090 in. (2.3 mm) 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. (8 mm) minimum.

The cabinet, sunshields, doors, and all panels shall be fabricated from aluminum sheet in accordance with ASTM B 209 (ASTM B 209M), 5052-H32 aluminum sheet.

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 B3.0, “Welding Procedure and Performance Qualification”, and to the practices in accordance with AWS C5.6.

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. (0.02032 mm) and a minimum coating weight of 0.04 mg/mm^2. 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 (96.67°C). 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, 45-60 grams per liter, 160°F (71.1°C) for 5 minutes.
(b) Rinse in cold water.
(c) Etch in a solution of 11 g of sodium fluoride, plus 30-45 g of sodium hydroxide per liter of distilled water at 140-150°F (60-65°C) for 5 minutes.
(d) Rinse in cold water.
(e) Dissolve in a 50% by volume nitric acid solution at room temperature for 2 minutes.
(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 number 2, and each cabinet shall be equipped with two number 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. (180 mm) and shall be provided with a 5/8 in. (16 mm), 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 between the door gasket and the door frame.

The cabinet shall not include a police door nor have provisions for a police door.

The latching mechanism shall be a 3-point cabinet latch with nylon rollers. The center catch and pushrods shall be zinc-plated or cadmium-platted steel. Pushrods shall be turned edgewise at the outer supports and shall be 1/4 in. (6 mm) x 3/4 in. (19 mm), minimum. The nylon rollers shall have a minimum diameter of 3/4 in. (19 mm) and shall be equipped with ball bearings.

All cadmium plating shall be in accordance with the Society of Automotive Engineers, SAE-AMS-QQ-P-416, "Plating, Cadmium (Electrodeposited)". All zinc plating shall be in accordance with ASTM B 633-98E1, "Electrodeposited Coatings of Zinc on Iron and Steel".

The door's hinging shall be three or four bolt butt hinges. Each hinge shall have a fixed pin. Doors larger than 22 in. (60 mm) in width or 6 sq ft (0.5574 m^2) in area shall be provided with catches to hold the door open at both 90 degrees and 180 degrees, ± 10 degrees. The catches shall be 1/3 in. (8 mm) diameter, minimum, plated steel rods. The catches shall be capable of holding the door open at 90 degrees in a 56 mph (40 kph) 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 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 in. x 16 in. x 1 in. (300 mm x 400 mm x 25 mm). Two spare filters shall be provided with each cabinet.

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. (19 mm) and shall be capable of lifting 990 lbs (450 kg).

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.

A list of approved models will be maintained by the Department. Only models from the Department's list of approved ITS Controller Cabinets in effect as of the date of letting, or as otherwise specified, shall be used on the contract. Continued failure and repeated malfunctions of an approved controller or control equipment shall be cause to remove that model from the Department's list of approved products. A design change to an approved 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.

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.

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. (480 mm) 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 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. (75 mm) 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. (80 mm), inside diameter of

2.5 in. (63 mm) and a height of 0.72 in. (18 mm). 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.

(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".

(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 in. to 0.003 in. (0.0508 to 0.0762 mm). Labels shall conform to the designations on the cabinet diagrams.

(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 (125°C). It shall be rated 600 volt, AL9CU. The dimensions shall be 4 in. x 5.2 in. (100 x 132 mm) x 3.23 in. (82 mm) high. The block shall come with one polycarbonate safety cover per pole. Mounting screws shall be No. 10, 0.19 in. (4.83 mm) 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 1-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 - 14 AWG. Bolt size: #10. Tang length shall be 1/2 in. (13 mm). Width shall be 5/16 in. (8 mm). The lug shall be an Ilsco Model SLUH-35.

(i) Ground Bus

Rated to 600 volts. 12 taps per ground bar suitable for wire ranging from 6 AWG to 14 AWG. Main ground connection wire range from 4 AWG to 14 AWG. The ground bar shall have a length of 5 15/16 in. (150 mm), a height of 3/4 in. (19 mm), and a width

of 11/32 in. (9 mm). It 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, operational indictors (LED) 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 are 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 (-40°C to +60°C). External mount NEMA 1 standard enclosure. Standard size: 6 in. (150 mm) long x 6 in. (150 mm) wide x 4 in. (100 mm) depth. Weight: 8 lbs (3.63 kg). The TVSS shall be UL 1449 Second Edition Listed, 1283 Recognized and CUL. The unit shall be an Advanced Protection Technologies Model TE/1XF.

(k) Load Center Main Breaker

The load center main breaker shall be enclosed 2 pole, 240/240 volt AC, 60 amp. It shall have a 10,000 rms symmetrical ampere short circuit current rating. The circuit breaker enclosure shall be a Square D, Model QO2TR.

(l) Load Center Panelboard

The panelboard shall be a 120/240 volt AC, 600 volt, 8 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

The convenience receptacle shall be a duplex, 3-prong, NEMA type 5-15R grounding type outlet and shall be in accordance with UL Standard 943.

(n) Duplex Receptacle

A standard 3-prong, NEMA type 5-15R grounding type outlet shall be mounted on the power distribution panel.

(o) Terminal Strip Surge Protector

One 48 in. (1220 mm) surge protected terminal strip with ten 15A outlets shall be furnished and installed.

The terminal strip shall have a low profile aluminum housing measuring 1 1/2 x 1 3/16 in. (38 mm x 30 mm) and have a 14/3 SJT cord and a NEMA 5-15P plug. The spacing between the outlets shall be 4 in. (100 mm) 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 Standard 1449 with a 330 volt clamping level. The unit shall be a Wiremold Model 4810BCS with a 6 ft (2 m) cord.

(p) Door Open Switches

Four dry-contact, 1-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

A toggle switch 20 amp, DPDT with 0.125 in. (3 mm) 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 in. x 1.9 in. x 1.5 in. (48 mm x 48 mm x 38 mm) and rating 660 watt and 250 volt. The lampholder shall be a Leviton Model 9063.

(s) Lamps

Each lamb holder shall be provided with a 100 watt rugged service incandescent bulb.

(t) Circulating Fans

Three 110 cft/min (3 m^3/min), 4.7 in. x 4.7 in. x 1.5 in. (120 mm x 120 mm x 38 mm) 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 (~ -10°C to ~ +70°C) 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 (27°C). The fans shall be NMB Model 4715FS-12T-B50-D00.

(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. (200 mm) long by 1 1/2 in. (38 mm) wide and shall have two wire terminals. The strip heaters shall be UL Recognized. The heaters shall be Hotwatt Model CS-8.

(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 (2°C). The other thermostat shall activate the two circulating fans at the top of the cabinet when the internal cabinet temperature goes above 80°F (27°C). The thermostats shall be Thermodisc, Type AL-1.

(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. x 0.2 in. (65 mm x 6 mm). The terminal blocks shall be the Entretec part number 011527122 type M 4/6 D2.

(y) I/O Module

An isolated 8-Bit digital input module shall be provided and installed. It shall have 6 fully isolated inputs and 2 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 (-10°C) to 158°F (70°C). 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.

(aa) Padlocks

Padlocks shall be classified as a high security padlock with hardened shackles, laminated body, a minimum 4 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. (75 mm) and shall have a shackle length of 2 1/4 to 3 3/4 in. (56 to 94 mm) and a shackle diameter of 5/16 in. (8 mm). For padlock information, contact the ITS Operations Engineer.

(bb) Other Cabinet Equipment

In addition to the equipment specified above, the cabinet shall be furnished with all ancillary equipment, brackets, wiring ducts, hardware, etc, as is necessary to provide a neat and finished appearance. These items along with all associated cables, connectors, wiring, etc. 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.

(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.

All wire shall be type THHN with color and gage as shown on the plans with the exception of the microloop card rack wiring which will be 2-pair twisted with a shield and plentium 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.

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. 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 high density polyethylene plastic in accordance with ASTM D 5203. 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. (150 mm).

The reflective sheeting on the post shall be in accordance with 919.01(b) and shall have minimum dimensions of 3 in. (75 mm) by 8 in. (200 mm). 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.

When installed, the flexible post shall withstand, without damage, five vehicle impacts at ambient air temperatures of 32°F (0°C) and at 85°F (30°C) each. The vehicle impacts shall include both bumper and tire impacts. It shall be able to bend to an angle of 85 degrees from vertical and right itself to within 10 degrees of the vertical immediately and stand erect within 4 h within the same ambient air temperature range.

Only flexible delineator posts from the Department's list of approved Flexible Delineator Posts shall be used. Flexible delineator posts will be placed and maintained on the Department's approved list in accordance with ITM 806, procedure G.

926.02 Delineators

(a) Acrylic Plastic Delineators

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. (75 mm) with a minimum area of approximately 7 in.^{2} (4520 mm^2). 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 Candle Power/Footcandle (Candelas/lux)		
		Clear	Yellow	Red
0.1	0	119 (11.1)	79 (7.3)	28 (2.6)
0.1	20	47 (4.4)	28 (2.6)	11 (1.0)

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 (lux) of illumination at the reflector.

The opaque backing shall be made from aluminum sheet having a minimum thickness of 0.02 in. (0.5 mm). 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. (5 mm).

Only acrylic plastic delineator models and colors from the Department's list of approved Delineators shall be used. Acrylic plastic delineators will be placed and maintained on the Department's approved list in accordance with ITM 806, procedure G.

(b) Reflective Sheeting Delineators

Reflective sheeting delineators shall consist of reflective sheeting affixed to an aluminum backing material. The white delineator shall be 3 in. by 8 in. ± 1/8 in. (75 mm by 200 mm ± 3 mm). The yellow delineator shall be 5 in. by 5 in. ± 1/8 in. (125 mm by 125 mm ± 3 mm). The backing material shall be in accordance with 919.01(a) except the minimum thickness shall be 0.064 in. (1.6 mm). Reflective sheeting shall be in accordance with 919.01(b).

There shall be two mounting holes, 3/16 in. (5 mm) in diameter, with one at the top and one at the bottom. The holes shall be 6 in. ± 1/16 in. (150 mm ± 2 mm) 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.

Material furnished under this specification shall be covered by a type C certification in accordance with 916.

(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.

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 in.^{2} (4194 mm^2), 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).

Only barrier delineator models and colors from the Department's list of approved Delineators shall be used. Barrier delineators will be placed and maintained on the Department's approved list in accordance with ITM 806, procedure G.

(d) Temporary Barrier Delineator

Temporary barrier delineators shall consist of a type III sheeting in accordance with 919.01(b)1 affixed to a reboundable substrate. The delineator shall be 8 by 12 in. (200 by 300 mm) vertically mounted. The mounting bracket used to affix the delineator to the barrier shall not be more than 3 in. (75 mm) vertical.

INDEX OF PAY ITEMS

PAY ITEM	SECTION
Aggregate for End Bent Backfill	211.10
Aggregate for Shoulder Drains	608.05
Aggregate for Underdrains	718.10
Arch, Structural Plate	717.09
Asphalt for Dust Palative	407.08
Asphalt for Prime Coat	405.10
Asphalt for Seal Coat	404.10
Asphalt for Tack Coat	406.07
Asphalt Material for Underseal	612.07
Automatic Drainage Gate	721.05
B Borrow	211.10
Barricade	801.18
Barricade, III, Permanent	801.18
Barrier Delineator	602.06
Barrier, Direction Indicator	801.18
Bed Course Material	604.11
Bed Course Material	605.10
Bench Mark Post	615.14
Bench Mark Post, Reset	615.14
Bolt, Remove	711.70
Borrow	203.28
Borrow, Cohesive	616.12
Box Truss Sign Structure Foundation	802.12
Breaking Pavement	203.28
Bridge Bracket Assembly	802.12
Bridge Deck Overlay	722.14
Bridge Deck Overlay Patching	722.14
Bridge Deck Overlay, Additional	722.14
Bridge Deck Patching, Full Depth	722.14
Bridge Deck Patching, Partial Depth	722.14
Bronze Plates	702.28
Bronze Plates	711.70
Cable Span Sign Structure Foundation	802.12
Cable, Pole Circuit, THWH, No. ____ Copper, Stranded	807.19
Cable-Duct Marker	807.19
Cantilever Sign Support Foundation	802.12
Cased Test Holes	203.28
Casting Adjusted to Grade, Monument	615.14
Casting, Adjust to Grade	720.06
Casting, Furnish and Adjust to Grade	720.06
Catch Basin	720.06
Cellular Concrete Fill	216.12
Center Curb	605.10
Chemical Modification, Soils	215.11
Circuit Installation, Str. No. ____, Luminaires	807.19
Clean Steel Bridge, Br. No. ____	619.18
Clean Steel Bridge, Partial, Br. No. ____	619.18
Clearing and Grubbing	201.07

PAY ITEM	SECTION
Clearing Right-of-Way	201.07
Clearing Right-of-Way	202.13
CMA Base	403.12
CMA Intermediate	403.12
CMA Surface	403.12
Cofferdam	206.11
Compacted Aggregate No. 53	303.10
Compacted Aggregate No. 73	303.10
Compacted Aggregate, No. 53, Base	301.10
Concrete Anchor	715.12
Concrete Barrier	602.06
Concrete Barrier Glare Screen	602.06
Concrete Bridge Railing Transition	706.06
Concrete Culvert Extension, Precast Reinforced Concrete Box Sections	714.07
Concrete Paved Flowline, Arch, Structural Plate	717.09
Concrete, A, Substructure	702.28
Concrete, A, Superstructure	702.28
Concrete, B, Above Footings	702.28
Concrete, B, Footings	702.28
Concrete, C	702.28
Concrete, C, Superstructure	704.08
Concrete, C, Superstructure	705.05
Concrete, Foundation Seal	702.28
Concrete, Structures	714.07
Conduit, Steel, Galvanized	807.19
Connector Kit, Fused	807.19
Connector Kit, Unfused	807.19
Construction Sign	801.18
Contaminated Soil, Remove	202.13
Controller and Cabinet, Flasher	805.16
Controller and Cabinet, Phase	805.16
Controller Cabinet Foundation	805.16
Controller Cabinet Foundation, M, Modify to P-1	805.16
Cored Hole in Rock	701.15
Coring, PCCP	501.31
Cost Reduction Incentive No. ____	109.04
Cover Aggregate, Prime Coat	405.10
Cover Aggregate, Seal Coat	404.10
Cracks and Joints in Asphalt Pavement, Rout and Seal	408.08
Cracks and Joints in Asphalt Pavement, Seal	408.08
Cracks and Joints in PCCP, Filled	507.10
Cracks in PCCP, Rout and Seal	507.10
Culvert, Precast Reinforced Concrete Box Sections	714.07
Curb	605.10
Curb and Gutter	605.10
Curb Painting	808.12
Curb Ramp, Concrete	604.11
Curb, Monolithic	307.10

PAY ITEM	SECTION
Curb, Remove	605.10
Curb, Reset	605.10
D-1 Contraction Joint	503.08
Delineator	804.07
Delineator Post	804.07
Delineator Post, Flexible	804.07
Delineator with Post	804.07
Dense Graded Subbase	302.09
Detour Route Marker Assembly	801.18
Detour Route Marker Assembly, Multiple Routes	801.18
Disconnect Hanger	805.16
Drain Extension	619.18
Drain Pipe, Steel	702.28
Drain Tile	622.22
Drilled Hole	711.70
Drilled Hole for Flowable Backfill	213.09
Drilled Hole for Underseal	612.07
Drum, Permanent	801.18
Dynamic Pile Load Test	701.15
Embankment	203.28
Embankment Foundation Soils Treatment	203.28
Environmental Control, Br. No. ____	619.18
Erosion Control Blanket	621.13
Excavation, Common	203.28
Excavation, Dry	206.11
Excavation, Foundation, Unclassified	206.11
Excavation, Peat	203.28
Excavation, Rock	203.28
Excavation, Unclassified	203.28
Excavation, Waterway	203.28
Excavation, Wet	206.11
Excavation, X	206.11
Excavation, Y	203.28
Exploratory Cores	203.28
Exploratory Drilling	203.28
Fence	603.08
Fence Gate	603.08
Fence, Farm Field, Barbed Wire	603.08
Fence, Farm Field, Tension Wire	603.08
Fence, Reset	603.08
Fertilizer	621.13
Field Drilled Hole in Concrete	702.28
Field Office	105.19
Flasher Installation, Location No. ____	805.16
Flasher Modernization, Location No. ____	805.16
Flashing Arrow Sign	801.18
Flowable Backfill	213.09
Geogrid	214.07

PAY ITEM	SECTION
Geogrid, Subgrade	617.07
Geotextile for Underdrains	718.10
Geotextiles	616.12
Grated Box End Section	715.12
Grates, Basins, and Fittings, Cast Iron	702.28
Guardrail Connector System, W-Beam, Curved	601.13
Guardrail End Treatment	601.13
Guardrail End Treatment, _____, Temporary Bridge Approaches	713.09
Guardrail Transition, VH	601.13
Guardrail, Adjust Height	601.13
Guardrail, Remove	601.13
Guardrail, Reset	601.13
Guardrail, Terminal System, W-Beam Curved	601.13
Guardrail, Thrie-Beam	601.13
Guardrail, Thrie-Beam, Double Faced	601.13
Guardrail, Transition, ____	601.13
Guardrail, W-Beam	601.13
Guardrail, W-Beam, ____ Spacing, Temporary Bridge Approaches	713.09
Guardrail, W-Beam, Cable Terminal Anchor	601.13
Guardrail, W-Beam, Double Faced	601.13
Guardrail, W-Beam, Nested	601.13
Guardrail, W-Beam, Shop Curved	601.13
Guardrail, WR-Beam	601.13
Gutter, Concrete	607.06
Hand Rail	604.11
Handhole, Lighting	807.19
Handhole, Signal	805.16
Header, Cement Concrete	614.06
Header, Cement Concrete, Reconstruct	614.06
Hedge Rows	201.07
High Mast Tower Winch Drive	807.19
HMA Base, Mainline	402.18
HMA Base, Shoulder	402.18
HMA Base, Type _____	402.20
HMA for Approaches Type _____	610.06
HMA for Intermediate, Type _____	402.20
HMA for Sidewalk	604.11
HMA for Structure Installation	715.12
HMA for Temporary Pavement	402.20
HMA for Underdrains	718.10
HMA Intermediate, Mainline	402.18
HMA Intermediate, Shoulder	402.18
HMA Partial Depth Patch	507.10
HMA Patching, Type _____	304.12
HMA Rumble Strips	402.20
HMA Surface, Shoulder	402.18
HMA Surface, Type _____	402.20
HMA Wedge and Level, Type _____	402.20

PAY ITEM	SECTION
Houses and Buildings, Parcel No. _____, Remove	202.13
Impact Attenuator	601.13
Impact Attenuator Spare Parts Package	601.13
Impact Attenuator, Reset	601.13
Inlet	720.06
Inlet, type H with Slotted Drains	720.06
Inlet, type HA with Slotted Drains	720.06
Inspection Hole	616.12
Insulation Link, Non-waterproofed	807.19
Insulation Link, Waterproofed	807.19
ITS Controller Cabinet	809.09
ITS Controller Cabinet Foundation	809.09
Jacking and Supporting	711.70
Joint Material	604.11
Joints in PCCP, Filled	507.10
Joints in PCCP, Rout and Seal	507.10
Light Pole, High Mast, E.M.H.	807.19
Light Pole, Roadway, E.M.H., Mast Arm, Base	807.19
Light Structure, Remove	807.19
Lighting Foundation, Concrete, with Grounding	807.19
Line	808.12
Line, Remove	808.12
Linear Grading	203.28
Liner for Retention Pond	205.07
Loop Detector Delay Amplifier, Channel	805.16
Lumber and Timber, Treated	712.12
Lumber and Timber, Untreated	712.12
Luminaire, High Mast, _____, Watt	807.19
Luminaire, Roadway, _____, Watt	807.19
Magnetometer Detector	805.16
Mailbox Assembly, Double	611.05
Mailbox Assembly, Single	611.05
Maintaining Traffic	801.18
Maintaining Traffic, Br. No. ____	619.18
Manhole	720.06
Masonry Tree Well	622.22
Masonry Wall	622.22
Metal Parts	712.12
Microloop Detector	805.16
Milled HMA Shoulder Corrugations	606.03
Milled PCCP Shoulder Corrugations	606.03
Milling, Approach	306.10
Milling, Asphalt	306.10
Milling, Asphalt Removal	306.10
Milling, PCCP	306.10
Milling, Scarification/Profile	306.10
Milling, Transition	306.10
Miscellaneous Equipment for Traffic Signals	805.16

PAY ITEM	SECTION
Mobilization and Demobilization	110.04
Mobilization and Demobilization for Seeding	621.13
Modified Posts, Nested Guardrail	601.13
Monument	615.14
Monument, Re-establish	615.14
Mulched Seeding	621.13
Mulching Material	621.13
Multiple Compression Fitting, Non-waterproofed	807.19
Multiple Compression Fitting, Waterproofed	807.19
Outlet Protector	718.10
Overhead Balanced Cantilever Sign Structure Foundation	802.12
Overhead Sign Structure	802.12
Overhead Sign Structure, Remove	802.12
Overlay Dam	722.14
Paint Steel Bridge, Br. No. ____	619.18
Paint Steel Bridge, Partial, Br. No. ____	619.18
Parking Barrier	615.14
Patroller	801.18
Paved Side Ditch	607.06
Paved Side Ditch, Break	616.12
Pavement Message Marking	808.12
Pavement Message Marking, Remove	808.12
Pavement Removal	202.13
PCC Base	305.07
PCC Base Patching	305.07
PCCP	502.23
PCCP for Approaches	610.06
PCCP for Structure Installation	715.12
PCCP Patching, Full Depth	506.13
PCCP Patching, Partial Depth	506.13
Pedestrian Push Button	805.16
Pedestrian Signal Head	805.16
Pile Tip	701.15
Pile, Concrete, Steel Shell Encased	701.15
Pile, Reinforced Concrete, Steel Shell Encased, Epoxy Coated	701.15
Pile, Steel H, Epoxy Coated, HP	701.15
Pile, Steel H, HP	701.15
Pile, Steel H, Reinforced Concrete Encased, HP	701.15
Pile, Timber, Driven	701.15
Pile, Timber, Furnished	701.15
Pile, Timber, Treated, Driven	701.15
Pile, Timber, Treated, Furnished	701.15
Pipe Catch Basin	720.06
Pipe End Section	715.12
Pipe Extension, Circular	715.12
Pipe Extension, Deformed	715.12
Pipe Liner, Thermoplastic	725.05
Pipe, Drain Tile Terminal Section	719.08

PAY ITEM	SECTION
Pipe, End Bent Drain	715.12
Pipe, Relaid	715.12
Pipe, Sanitary Sewer	715.12
Pipe, Slotted Drain	715.12
Pipe, Slotted Vane Drain	715.12
Pipe, Type, Circular	715.12
Pipe, Type, Deformed	715.12
Pipe, Underdrain Outlet	715.12
Plank Floors, Ply	712.12
Plant, Annual	622.22
Plant, Aquatic	622.22
Plant, Biannual	622.22
Plant, Broadleaf Evergreen, Cone, Broad Upright	622.22
Plant, Broadleaf Evergreen, Globe, Dwarf	622.22
Plant, Broadleaf Evergreen, Spreading, Semispreading	622.22
Plant, Coniferous Evergreen, Cone, Broad Upright	622.22
Plant, Coniferous Evergreen, Globe, Dwarf	622.22
Plant, Coniferous Evergreen, Prostrate Broad Spreading, Semispreading	622.22
Plant, Deciduous Shrub	622.22
Plant, Deciduous Tree, Multi-Stem	622.22
Plant, Deciduous Tree, Single Stem	622.22
Plant, Ground Cover	622.22
Plant, Perennial	622.22
Plant, Root, Tuber, Corm, Bulb	622.22
Plant, Rose Grade	622.22
Pneumatically Placed Mortar	708.09
Porous Material for Root Protection	622.22
Portable Tower Lighting Drive System	807.19
Portland Cement Concrete Base	307.10
Present Structure, Str. No. ____, Remove	202.13
Present Structure, Str. No. ____, Remove Portions	202.13
Prismatic Reflector	808.12
Profiling PCCP	507.10
Profilograph, HMA	401.22
Profilograph, HMA	410.22
Profilograph, PCCP	501.31
QC/QA HMA, ____	410.22
QC/QA HMA, ____	401.22
QC/QA-PCCP	501.31
Quality Adjustments	109.05.1
Quality Assurance Adjustment	410.22
Quality Assurance Adjustment	502.23
Railing	706.06
Railing, Concrete	706.06
Reference Post	802.12
Regulated Asbestos Containing Materials, Remove	202.13
Regulated Materials, Dispose	202.13
Regulated Materials, Remove	202.13

PAY ITEM	SECTION
Regulated Materials, Transport	202.13
Reinforced Concrete Bridge Approach	609.14
Reinforcing Bars	703.08
Reinforcing Bars, Epoxy Coated	703.08
Reinforcing Steel	704.08
Reinforcing Steel	705.05
Repointing Masonry in Structures	710.07
Retrofit Load Transfer	507.10
Retrofitted Tie Bars	503.08
Right-of-Way Marker	615.14
Right-of-Way Marker, Reset	615.14
Riprap, Class _____	616.12
Riprap, Dumped	616.12
Riprap, Grouted	616.12
Riprap, Grouted	717.09
Riprap, Precast Concrete	616.12
Riprap, Revetment	616.12
Riprap, Uniform	616.12
Rivet, Remove	711.70
Road Closure Sign Assembly	801.18
Road Closure Sign Assembly, Permanent	801.18
Rubblized PCCP	305.07
Safety Metal End Section	715.12
Salvaged Road Material for _____	613.05
Saw Cut for Roadway Loop and Sealant	805.16
Scalping	201.07
Seal Coat	404.10
Sediment, Remove	205.07
Seed Mixture	621.13
Seedling	622.22
Service Point	807.19
Settlement Plate	204.06
Sidewalk, Concrete	604.11
Sidewalk, Concrete, Reconstruct	604.11
Sidewalk, Concrete, Re-Lay	604.11
Sign and Supports, Wide Flange, Remove	802.12
Sign Post	802.12
Sign Post, Square, Reinforced Anchor Base	802.12
Sign Post, Square, Unreinforced Anchor Base	802.12
Sign, “Do Not Disturb”	622.22
Sign, “Do Not Mow or Spray”	622.22
Sign, “Do Not Spray”	621.13
Sign, Double Faced, Sheet, With Legend	802.12
Sign, Overhead, Remove	802.12
Sign, Panel, Relocate	802.12
Sign, Panel, Remove	802.12
Sign, Panel, With Legend	802.12
Sign, Sheet Assembly, Relocate	802.12

PAY ITEM	SECTION
Sign, Sheet, and Supports, Remove	802.12
Sign, Sheet, Relocate	802.12
Sign, Sheet, Remove	802.12
Sign, Sheet, With Legend	802.12
Sign, Underpass, and Roadway Lighting Location Identification	807.19
Signal Cable	805.16
Signal Cantilever Structure, Mast Arm	805.16
Signal Detector Housing	805.16
Signal Interconnect Cable	805.16
Signal Pedestal	805.16
Signal Pole, Wood	805.16
Signal Service	805.16
Signal Strain Pole, Steel	805.16
Signal Support Foundation	805.16
Slopewall	616.12
Slopewall, Concrete	616.12
Snowplowable Raised Pavement Marker	808.12
Snowplowable Raised Pavement Marker, Remove	808.12
Sodding	621.13
Sodding, Nursery	621.13
Soil Pipe, Cast Iron	702.28
Span and Catenary for Flasher	805.16
Span, Catenary, and Tether	805.16
Splashpad, Riprap	205.07
Spring Box	720.06
Stake, Lateral	204.06
Stake, Settlement	204.06
Standpipe Piezometer	204.06
Static Pile Load Test	701.15
Steps, Concrete	604.11
Stockpiled Material	111.11
Stockpiled Selected Material	212.05
Stockpiled Selected Material, Salvaged	212.05
Structural Expansion Joint	111.11
Structural Expansion Joint	724.05
Structural Expansion Joint Seal, Replace	724.05
Structural Expansion Joint, Replace	724.05
Structural Member, Concrete	707.11
Structural Members, Concrete	111.11
Structural Members, Concrete	707.11
Structural Steel	111.11
Structural Steel	711.70
Structural Steel, Breakaway	802.12
Structural Steel, Field Cut	711.70
Structure Backfill	211.10
Structure, Reconstruct	720.06
Structures and Obstructions, Remove	202.13
Stud Shear Connectors	711.70

PAY ITEM	SECTION
Subbase for PCCP	302.09
Subgrade Treatment, Type _____	207.06
Surface Milling	722.14
Surface Seal	709.08
Temporary Bridge	713.09
Temporary Bridge and Approaches	713.09
Temporary Buzz Strips	801.18
Temporary Changeable Message Sign	801.18
Temporary Check Dams, Revetment Riprap	205.07
Temporary Check Dams, Straw Bales	205.07
Temporary Concrete Barrier	801.18
Temporary Concrete Barrier, Anchored	801.18
Temporary Crossover	801.18
Temporary Crossover Drainage Pipe	801.18
Temporary Crossover, _____, Refurbish	801.18
Temporary Ditch Inlet Protection	205.07
Temporary Illumination	801.18
Temporary Mulching	205.07
Temporary Panel Sign Supports	801.18
Temporary Panel Signs	801.18
Temporary Pavement Marking	801.18
Temporary Pavement Marking, Removable	801.18
Temporary Pavement Message Marking	801.18
Temporary Pavement Message Marking, Removable	801.18
Temporary Raised Pavement Marker	801.18
Temporary Sediment Basin	205.07
Temporary Sediment Trap	205.07
Temporary Silt Fence	205.07
Temporary Slope Drain	205.07
Temporary Traffic Signal	801.18
Temporary Traffic Signal with Detectors	801.18
Temporary Transverse Pavement Marking	801.18
Temporary Transverse Pavement Marking, Removable	801.18
Temporary Worksite Speed Limit Sign Assembly	801.18
Terminal Joint	503.08
Test Pile	701.15
Test Pile, Restrike	701.15
Testing for Asbestos	202.13
Testing for Wastes	202.13
Threaded Tie Bar Assembly	703.08
Threaded Tie Bar Assembly, Epoxy Coated	703.08
Topsoil	621.13
Traffic Signal Head	805.16
Traffic Signal Installation	805.16
Traffic Signal Modernization	805.16
Transverse Marking	808.12
Transverse Marking, Remove	808.12
Tubular Marker, Permanent	801.18

PAY ITEM **SECTION**

Underdrain, Patching 718.10
Underground Storage Tank, Liquid Waste Disposal 202.13
Underground Storage Tank, Remove and Dispose 202.13
Video Inspection for Underdrain 718.10
Water 621.13
Water for Reconditioning 305.12
Water for Shale 203.28
Water Monitoring Borehole 204.06
Welded Steel Wire Fabric 708.09
Wide Flange Sign Post Support Foundation 802.12
Widening with HMA, Type _____ 304.12
Widening with PCC Base 305.07
Wire, No. ____ Copper 807.19