INDIANA DEPARTMENT OF TRANSPORTATION
Driving Indiana's Economic Growth

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Mitchell E. Daniels, Jr., Governor
Michael B. Cline, Commissioner

AGENDA

December 20, 2012 Standards Committee Meeting

MEMORANDUM

December 10, 2012

TO: Standards Committee

FROM: Scott Trammell, Secretary

RE: Agenda for the December 20, 2012 Standards Committee Meeting

A Standards Committee meeting is scheduled for 09:00 a.m. on December 20, 2012 in the N955 Bay Window Conference Room. Please enter meeting through the double doors directly in front of the conference room.
immediately

The following agenda items are listed for consideration.

A. GENERAL BUSINESS ITEMS

OLD BUSINESS

(No items on this agenda)

NEW BUSINESS

1. Approval of the Minutes from the November 16, 2012 meeting.

B. CONCEPTUAL PROPOSAL ITEMS

OLD BUSINESS

(No items on this agenda)

NEW BUSINESS

(No items on this agenda)

C. STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND STANDARD DRAWINGS PROPOSED ITEMS

OLD BUSINESS

Item No. 09 11/16/12 (2012 SS) Mr. Walker pg 04

Recurring Special Provision:

203-R-562	DYNAMIC CONE PENETROMETER TESTING FOR EMBANKMENT

NEW BUSINESS

Item No. 01 12/20/12 (2012 SS) Mr. Boruff pg 08

SECTION 805	TRAFFIC SIGNALS
805-T-XXX	*ALTERNATIVE VEHICLE DETECTION METHODS*
805-T-XXX	*ANCILLARY TRAFFIC SIGNAL EQUIPMENT*
~~805-T-123~~	~~VIDEO VEHICLE DETECTOR SYSTEM~~
~~805-T-173~~	~~WIRELESS VEHICLE DETECTION SYSTEM~~
SECTION 922	TRAFFIC SIGNAL MATERIALS
922-T-XXX	*ANCILLARY TRAFFIC SIGNAL EQUIPMENT*
922-T-XXX	*ALTERNATIVE VEHICLE DETECTION METHODS*

STANDARD DRAWINGS:

805-SGLT-01	LOOP TAGGING SYSTEM
805-SDAC-01	*SIGNAL DUAL ARM CANTILEVERS DRAWING INDEX*
805-SDAC-02	*SIGNAL DUAL ARM CANTILEVERS POLE DIMENSIONS AND DETAILS*
805-SDAC-03	*SIGNAL DUAL ARM CANTILEVERS ARM DIMENSIONS AND DETAILS*
805-SDAC-04	*SIGNAL DUAL ARM CANTILEVERS BASE PLATE AND POLE TOP COVER DETAILS*
805-SDAC-05	*SIGNAL DUAL ARM CANTILEVERS ARM CONNECTION DETAILS*
805-SDAC-06	*SIGNAL DUAL ARM CANTILEVERS HANDHOLE AND I.D. TAG DETAILS*
805-SDAC-07	*SIGNAL DUAL ARM CANTILEVERS LOADING DIAGRAMS*
805-SDAC-08	*SIGNAL DUAL ARM CANTILEVERS FOUNDATION, DRILLED SHAFT TYPE E FOR DUAL ARMS 35’ OR LESS*
805-SDAC-09	*SIGNAL DUAL ARM CANTILEVERS FOUNDATION, DRILLED SHAFT TYPE F FOR DUAL ARMS GREATER THAN 35’ TO 45’*

BACKUP 01:

IDM Chapter 77-4; 77-5

Item No. 02 12/20/12 (2012 SS) Mr. Walker pg 106

207.04	SUBGRADE TREATMENTS
SECTION 214	GEOGRID
918.05	GEOGRID
918.05(a)	Type I
918.05(b)	Type II
918.05(c)	*Type III*

cc:
Committee Members (11)
FHWA (2)
ICA (1)

Mr. Walker
Date: 12/20/12

SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

REVISION TO SPECIAL PROVISIONS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: The Recurring Special Provision for the use of the Dynamic Cone Penetrometer needs revisions because of the addition of an ITM for this test procedure, to add a test procedure for the organic content, to establish the required moisture contents for new classifications of soils, and the need to eliminate the test section.

PROPOSED SOLUTION: Revise the RSP 203-R-562

APPLICABLE STANDARD SPECIFICATIONS: None

APPLICABLE STANDARD DRAWINGS: None

APPLICABLE DESIGN MANUAL SECTION: None

APPLICABLE SECTION OF GIFE: None

APPLICABLE RECURRING SPECIAL PROVISIONS: 203-R-562

PAY ITEMS AFFECTED: None

Submitted By: Ron Walker for the Office of Geotechnical Services

Title: Manager, Office of Materials Management

Organization: INDOT

Phone Number: 317-610-7251 x 204

Date: 12-5-12

APPLICABLE SUB-COMMITTEE ENDORSEMENT: None

REVISION TO SPECIAL PROVISIONS (OLD BUSINESS ITEM)

203-R-562 DYNAMIC CONE PENETROMETER TESTING FOR EMBANKMENT

(Note: Proposed changes shown as highlighted gray)

203-R-562 DYNAMIC CONE PENETROMETER TESTING FOR EMBANKMENT

(Revised XX-XX-XX)

The Standard Specifications are revised as follows:

SECTION 203, BEGIN LINE 835, DELETE AS FOLLOWS:

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.~~

SECTION 203, AFTER LINE 914, INSERT AS FOLLOWS:

203.24.1 Compaction Acceptance with DCP~~T~~

The compaction will be determined by dynamic cone penetrometer, DCP, testing, ~~DCPT~~, in accordance with ~~ASTM D 6951 using a 17.6 lb (8 kg) hammer~~ITM 509. The moisture content ~~shall~~will be ~~controlled within -3 and +2 percentage points of the optimum moisture content~~ determined in accordance with ~~AASHTO T 99~~ ITM 506. The compaction procedures shall be in accordance with 203.23.

The Department will establish the criteria for DCP~~T~~ acceptance of compaction by performing the sieve analysis, liquid limit, plastic limit, organic content, and optimum moisture and maximum density testing in accordance with ASTM D 1140, AASHTO ~~T 88, T 89,~~ T 90, ~~and~~ T 267, T 272 or T 99, respectively, on representative samples of the soils to be used. The required blow counts will be determined based on the laboratory tests ~~for each soil type~~.

The required moisture content shall be controlled within -3 percentage points and the optimum moisture content for silty and sandy soils, within -2 percentage points and +2 percentage points of the optimum moisture content for clay soils, and within -6 percentage points and the optimum moisture content for granular soils.

The maximum dry density and optimum moisture content for silty, sandy, and clay soils will be determined in accordance with AASHTO T 272. The maximum dry density and optimum moisture content for granular soils will be determined in accordance with AASHTO T 99.

~~*Test sections shall be constructed in the presence of a Geotechnical representative with the available equipment of the Contractor to determine the roller type, pattern, and the number of passes for verification of the blow counts for a 6 in. (150 mm) lift. The Office of Geotechnical Engineering will be contacted prior to construction of the test sections to determine the number of test sections required for the evaluation of*~~

REVISION TO SPECIAL PROVISIONS (OLD BUSINESS ITEM)

203-R-562 DYNAMIC CONE PENETROMETER TESTING FOR EMBANKMENT

~~*the DCPT process. The embankment shall be constructed in two 6 in. (150 mm) successive lifts placed in accordance with 203.23. The Engineer will select an area approximately 100 ft (33 m) long and 20 ft (6 m) wide within each lift for a test section. The test section in the second lift will be approximately in the same location as the test section in the first lift. The soil immediately below the test section in the first liftt shall be proofrolled in accordance with 203.26 prior to construction of the lift.*~~

~~*Moisture tests will be performed in accordance with ITM 506 at 2 random locations and DCPT will be performed at 4 random locations in each lift. The locations will be determined in accordance with ITM 802. The moisture content shall be controlled within -3 and +2 percentage points of the optimum moisture content. Blow counts greater than 10 or less than 4 will be discarded and a new random test location will be selected in the test section in that lift. If all of the test section blow counts are outside of the range of 10 to 4, the Office of Geotechnical Engineering will be contacted for determination of the target blow counts.*~~

COMMENTS AND ACTION (OLD BUSINESS ITEM)

203-R-562 DYNAMIC CONE PENETROMETER TESTING FOR EMBANKMENT

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: SECTION 203.23 pg 156. Recurring Special Provision affected: 203-R-562 DYNAMIC CONE PENETROMETER TESTING FOR EMBANKMENT Standard Sheets affected: NONE Design Manual Sections affected: NONE GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book ____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ ____ Revise RSP (No.____) Effective ____ Letting RSP Sunset Date: ____ Standard Drawing Effective ____ ____ Create RPD (No. ____) Effective ____ Letting ____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By _____ Addition or _____ Revision Frequency Manual Update Req'd? Y__N__ By _____ Addition or _____ Revision Received FHWA Approval? _____

SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

REVISION TO STANDARD SPECIFICATIONS, PROVISIONS AND DRAWINGS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED:

Sections 805 and 922 of the INDOT Standard Specifications are entirely superseded by RSPs 805-T-169 and 922-T-168. These recurring special provisions contain proprietary items that must be extracted before the RSP's can go into the Standard Specifications. Additionally there are some outdated ASTM/NEMA/etc references and signal indication backplates are not addressed.

Standard Drawing 805-SLGT-01 detailing the loop tagging table is not accurate and is redundant with plan details

Signal Cantilever Structures pay items do not meet INDOT project needs.

PROPOSED SOLUTION:

Develop recurring special provisions for the proprietary items only and move the remaining portions of the recurring special provisions into sections 805 and 922 of the Standard Specifications. Also specifications for signal backplates have been added and references to other publications have been updated.
Revise Standard Drawing 805-SLGT-01 by deleting the tagging table.
New Dual Arm Signal Cantilever Structures and foundation standard drawings have been developed to meet the latest AASHTO requirements.

APPLICABLE STANDARD SPECIFICATIONS: 805 & 922

APPLICABLE STANDARD DRAWINGS: 805-SGLT-01, 805-SDAC-01 thru 09

APPLICABLE DESIGN MANUAL SECTION: 77 (Old), 502 (New Draft)

APPLICABLE SECTION OF GIFE: N/A

APPLICABLE RECURRING SPECIAL PROVISIONS: 805-T-169, 805-T-173, 922-T-168

PAY ITEMS AFFECTED: Signal Cantilever Structures and their Foundations, Signal Indication Backplates

Submitted By: Richard Vancleave/Dave Boruff

Title: Supervisor, Roadway Standards and Policy/Manager, Traffic Administration
Organization: INDOT
Phone Number: (317) 232-5347/(317) 234-7975
Date: 11/26/2012
APPLICABLE SUB-COMMITTEE ENDORSEMENT: Traffic Standards Subcommittee, Traffic Signal Systems

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 805-TRAFFIC SIGNALS (changes shown as to existing RSP 805-T-169 TRAFFIC SIGNALS)

(Note: proposed changes shown as highlighted gray)

The Standard Specifications are revised as follows:

SECTION 805, BEGIN LINE 1, DELETE AND INSERT AS FOLLOWS:

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
Loop Detector Sealant	*906.02(a)*
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.

Joint sealant material shall be compatible with the roadway materials. If polyethylene duct loop wire is used, only sealant in accordance with 906.02(a)1 shall be used.

~~*Preformed pave-over loops shall be designed for use with HMA, SMA or PCCP as applicable*~~. *(note: statement moved to new RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS)*

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 805-TRAFFIC SIGNALS (changes shown as to existing RSP 805-T-169 TRAFFIC SIGNALS)

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~~*10*(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~~*10*(a).

The battery cabinet and program timing module for solar powered flashing beacons shall be from the Department's Approved List of Traffic Signal and ITS Control Equipment.

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 2 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 2 operating signal faces for each approach. When the new installations are completed, all 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, items designated in the contract documents, and field identified by the Department, as traffic signal equipment to be salvaged by the Department or local unit of government shall be stored at a secure site until such time as it is transported to the ~~District Office~~*designated location*, when designated as a pay item, or salvaged by the Department or local unit of government. The Contractor shall verify that the field identification placed by the Department has not been removed by vandalism or natural

causes. If the Contractor has reason to believe field identifications have been removed, it shall contact the Department. The Contractor shall be responsible for all damage or loss of this equipment and shall repair or replace the damaged or lost equipment as directed. All signal equipment removed and not designated to be salvaged shall become the property of the Contractor and shall be disposed of in accordance with 202.

All existing painted signal equipment to be reused, such as pedestals, bases, controller cabinets, ~~signal heads~~, signal weatherheads, pipe arms, shall be cleaned and painted with ~~two~~*2* coats of highway yellow enamel. *Existing signal heads to be reused shall be painted with 2 coats of black or highway yellow enamel as directed by the Engineer*. Aluminum poles and ~~mast arms~~*signal support structures* shall not be painted.

Existing concrete foundations, which have not been used in the new installation, shall be removed to a minimum of 4 in. ~~(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 Traffic Signal Construction Technician Level II certification which has been granted by the International Municipal Signal Association. Installation inspections, troubleshooting, maintenance and repair of these systems shall be accomplished by or in the presence of and under the responsible charge of an employee of the Contractor who holds a Traffic Signal Construction Technician Level II certification or a Traffic Signal Field Technician Level II 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, at a minimum, a 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 Construction Technicians, the Level II Traffic Signal Field Technicians and 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 Construction or Field Technicians or 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.

Flashing beacons shall flash at a rate for each beacon of 50 to 60 times per minute with the illuminated period from 1/2 to 2/3 of the total cycle. ~~*If a second beacon is specified, the 2 beacons shall flash alternately*~~*Second beacons, if specified, shall flash alternately with the exception of intersection control beacons which shall flash simultaneously.*

805.04 Pole Installation

Working drawings for strain poles or cantilever structures shall be provided in accordance with 105.02. Metal poles shall be erected on concrete foundations and shall be reasonably plumb after installation of signal heads. The handhole side of the pole shall be at right angles to the direction of the ~~mast~~*signal cantilever* arm or span, catenary, and tether. Signal cables shall be brought up inside the poles. Any steel pole, ~~mast~~*signal cantilever* arm, or hardware not galvanized ~~or painted with baked enamel~~ shall be painted with ~~2 coats of rust inhibiting aluminum paint~~*structural steel coating system in accordance with 619.09(a). The surface shall be prepared in accordance with 619.08(a), 619.08(b) and 619.08(d).* 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~~*Signal cantilever* arm and span mounted signal heads shall have 17.5 ft ~~(5.2 m)~~ minimum and ~~19~~22.5 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. *Flasher signal faces that supplement signs shall be mounted with the bottom of the housing at not less than 3 ft nor more than 13 ft above the edge of pavement. Flasher signal faces that supplement signs shall be directed towards oncoming traffic.* Pedestrian signal faces shall be mounted with the bottom of the housing at not less than 7 ft (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 1 conductor, *type* 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 5 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~~, *and Radio*~~ Installations

~~***(a) 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 housings, handholes, ~~pole~~ signal *pole* bases, and controller cabinets. *At the ends of each cable, the tag shall be placed between 4 and 8 in. from the end of the wire and on the outer jacket. At all other locations, the tag shall be placed in the middle of the length of cable stored at the location. The tag shall be 1/2 in. wide, thermal printed black on yellow or black on white, polyester or nylon tape with permanent adhesive and shall be water, chemical and scratch resistant. The font shall be arial, size 10. Tags shall be installed flag style around the cable with the backs of the tag ends placed together.* 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)~~1~~. Power

(b)~~2~~. Pedestrian Signal

(c)~~3~~. Pedestrian Actuation

(d)~~4~~. Signal ~~Phase Identification~~

(e)~~5~~. Detection Loop Identification

(f)~~6~~. Interconnect

Signal cables shall be tagged to identify the direction of travel. Detector lead-in cables shall be tagged throughout the installation with the corresponding loop tag information.

~~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.

~~(b) Radio Installations~~

~~1. General~~ *(note: statements moved to new RSP 805-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT)*

~~This work shall consist of furnishing and installing spread spectrum radio equipment for interconnecting traffic signal controllers utilizing materials from the Department's list of approved Traffic Signal and ITS Control Equipment. The Contractor shall furnish 2 copies of the instructions for hardware installation, programming and system commissioning.~~

~~2. Installation~~

~~*To receive maximum signal strength, the radio antennas shall be positioned by adjusting the antenna direction while monitoring signal strength through the telemetry radio. The radio antenna mounts shall be securely fastened to the poles. Coaxial cable shall be installed inside metal poles and conduits. External cable on poles shall not exceed 3 ft unless approved by the Engineer. Approved external cable runs exceeding 3 ft shall be secured using manufacturer specified hangers at a maximum spacing of 3 ft. Cable terminations shall be in accordance with the manufacturer's recommendations. Connectors outside of cabinets shall be sealed in accordance with the manufacturer's recommendations. The Contractor shall deburr any holes made in metal poles and install grommets for protection. Drip loops shall be provided between the antenna connector and the metal pole entrance or first pole clamp. Cable bends shall be in accordance with the manufacturer's specified bending radius.*~~

~~***3. Testing***~~

~~*Test of the radio interconnection system shall be performed after the installation is complete. Notice of the testing shall be provided to the district traffic office at least 2 work days prior to the test. The Contractor shall adjust the radio antennas to optimize the communication signal for the system. The strength of the communication signal shall be determined using computer software provided by the radio interconnection system manufacturer. The test shall be conducted with complete foliage on deciduous trees in the vicinity or on a date approved by the Engineer. The test results shall include the signal strength, site polling results using long message polling, and noise levels. The test results shall be above the minimum guidelines set by the radio interconnect system manufacturer.*~~

805.08 Controller Cabinet, Signal Service, and Detector Housing Installation

Three document packets shall be prepared in accordance with 922.02(b) for each cabinet. Each packet shall be labeled with the name of the contract number, the intersection, the commission number of the signal, and the date of installation. One packet shall be placed in the cabinet and the remaining 2 packets shall be submitted to the Engineer within 2 days after the signal is turned on. Information in the packets shall include all approved changes to the signal installation. All detector loop lead-in tags and detector rack labels shall reflect all approved changes to the signal installation.

Additional detector loop amplifier units and detector racks shall be supplied as directed by the Engineer. Additional detector racks shall include all cables or harnesses including, but not limited to a SDLC cable for each added rack, interface panels and a BIU to provide a complete and functional installation. Additional auxiliary BIU panels shall include all cables or harnesses including, but not limited to a SDLC cable for each additional auxiliary BIU panel, terminal strip on BIU panel and BIU to provide a complete and functional installation.

For signal cabinets installed by the Contractor, where no detector loop or lead-in work is included in the contract, the Contractor shall perform detector loop tagging,

testing and vehicle simulator testing in accordance with 805.09, only to the extent of documenting the test readings and confirming that all existing detector loops are connected correctly and all detector related equipment in the cabinet is operating correctly.

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 2 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 506.05 will not apply. A CMDS in accordance with 502.03 shall be submitted, however, utilization of the Department provided spreadsheet is not required. Where a portion of the road is closed or where there is no vehicular traffic, then class A concrete in accordance with 702 may be used. The concrete shall be placed flush with existing surface and shall be covered with a steel plate during the setting time.

805.09 Loop Wire Detector Installation

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.~~

(a) Layout

The number, size, arrangement, and locations of loops shall be as shown on the plans except that loop spacing shall be adjusted to avoid PCCP joints. Loops shall be of a regular octagon shape with sides of 2 1/2 ft in length or a circular shape with a diameter of 6 ft. Loops placed longitudinally adjacent in the same lane shall be spaced 15 ft from the center of one loop to the center of the next loop. Loops shall be arranged so

that no loop wire will be bent at an angle less than 120°. Regardless of configuration, the loop installation shall match the intention of the loop tagging table.

~~Loops~~ *Prior to installation, loop layout* shall be ~~of a regular octagon shape with side of 2.5 ft (0.75 m)~~ *approved* 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~~ *writing by the* District Traffic Engineer. The *Contractor shall notify the* District Traffic Engineer ~~shall be notified 48 h~~ *a minimum of 2 business days* prior to ~~such field review~~ *the date that loop layout approval is required. All roadway centerlines, edge-lines and stop-bars pertinent to loop layout shall be accurately and clearly identified at the time loop layouts are reviewed for approval. An outline shall be painted where the loops are to be placed. The Contractor shall ensure that the final installed location of each loop matches the intention and functionality of the approved layout for loop spacing, lane width and geometry.*

(b) Installation

All loops and lead-in cables shall be tagged according to the plans and 805.07.

~~1. Saw-cut Loops~~

The slots shall be saw-cut as shown on the plans. *A diamond cutting blade shall be used for sawing all loops. All saw-cut loops shall have individual saw cuts to the detector housing. Joints shall be overlapped such that the saw cut at the corner is full depth.* ~~Slots shall be thoroughly cleaned and dried before the installation of loop wires~~. *Prior to installing roadway loop wire in the roadway saw cuts, the saw cuts shall be cleaned in accordance with the manufacturer's requirements for the joint sealant to be used. After proper cleaning, the loop wire shall be installed. All loops shall be wired clockwise as viewed from above. Loops shall be wired with 4 turns or as specified then gently tamped with a blunt non-metallic tool. Backer rod 2 to 4 in. in length shall be spaced every 12 in. around the saw cut above the wire and gently tamped to hold the loop wire snug~~*~~ly~~* *in the bottom of the saw cut. Backer rod shall not be continuous around the saw cut. After installation of the loop wire, the saw cut shall be sealed with a joint sealant material. The sealant shall be poured into the saw cut making a water tight seal. The joint sealant material shall be installed in accordance with the manufacturer's recommendations and 906.02. However, the joint configuration shall not apply. A copy of the sealant manufacturer's written application instructions shall be submitted to the Engineer prior to any sealant operations. If the Contractor elects to use a sealant complying with 906.02(a)2, the sealant material shall be heated in a kettle or melter constructed as a double boiler with the space between the inner and outer shells filled with oil or other heat-transfer medium. This melter shall have a positive temperature control and a mechanical agitator. A backer rod shall be used for both cold applied sealants and hot poured sealants. The sealant material shall fill the saw cut as shown on the plans. All excess joint sealant on the pavement surfaces shall be promptly removed.*

~~The 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 4 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.)".

~~***2. Preformed Pave-over Loops***~~

~~*Preformed pave-over loops may be installed as a 1, 2, 3 or 4 loop configuration. Pave-over loops shall be secured in place prior to paving.*~~ *(note: statement moved to new RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS)*

(c) Splices

For each loop cable and lead-in cable entering a handhole, there shall be 6 ft of cable jacket remaining on each wire after the splice is complete. For each loop cable and lead-in cable entering a detector housing, there shall be 2 ft of cable jacket remaining on each wire after the splice is complete. For all loop splices, there shall be a maximum of 1/2 in. of non-jacketed wire measured from the end of each cable jacket to the edge of the splice waterproofing material. The splice of the loop wire and lead-in cable shall be soldered and waterproofed at the detector housing or handhole. Waterproofing shall consist of the use of heat shrink tubing which has an internal coating sealant material. The heat shrink tubing shall not be heated by means of a direct flame tool.

(d) Testing and Acceptance

All testing and acceptance procedures performed by the Contractor shall be performed in the presence of the Department personnel assigned by the Engineer. The Contractor shall notify the Engineer a minimum of 2 business days prior to the date testing is to be performed.

~~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.

1. Electrical Testing

~~(a)~~ *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)~~ *b.* Megohm Test Before Splice is Made at Detector Housing for Lead-in Cable

~~The 2 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, 1 megohm probe shall be connected to ground and the other probe shall be connected to 1 of the lead-in wires. The remaining lead-in wire shall be isolated. The test shall then be performed.~~

The 2 wires and shield of the lead-in cable at the cabinet shall be isolated and taped. The test shall consist of recording 4 readings taken at the detector housing or handhole as follows:

(1) Connect the 1st megohm probe to ground and the 2nd probe to the shield. Record the reading.

(2) Connect the 1st megohm probe to the 1st lead-in wire and the 2nd probe to the shield. Record the reading.

(3) Connect the 1st megohm probe to the 2nd lead-in wire and the 2nd probe to the shield. Record the reading.

(4) Connect the 1st megohm probe to the 1st lead-in wire and the 2nd probe to the 2nd lead-in wire. Record the reading.

The lowest of the 4 readings taken above shall be recorded on the testing document for acceptance.

~~(c)~~ *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 1 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 *shield of the*

lead-in shall be connected to ground at the cabinet. One megohm *probe shall then be connected to ground and the other probe connected to one of the lead-in wires* ~~test shall be performed at the cabinet on the end of the lead-in cable~~ *and the reading recorded.*

~~(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 2 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.~~

2. Delay Amplifier Settings and Vehicle Simulator Test

After all detector loop testing is complete, the detector amplifiers shall be installed and settings adjusted for proper operation at the intersection.

The frequency setting shall be adjusted using the amplifier's display so that adjacent loops in the roadway that are connected to different loop amplifiers have a minimum difference of 5 kHz. This operating frequency setting does not apply to loops that are adjacent to each other in the roadway but are connected to the same loop amplifier.

The sensitivity setting shall be adjusted using the amplifier's display. With an average size front wheel drive vehicle with the front axle centered over the back loop of a series of loops, the sensitivity shall be adjusted in accordance with the manufacturer's recommendations.

The count output shall be enabled for all loops designated as counting loops. The number of loops setting shall be set for loops designated for counting purposes and shall be set to the number of loops connected to that loop amplifier.

This test shall be performed by dragging a test vehicle across the loops using a non-conducting string. The test vehicle shall be fabricated with an 8 ft length of No. 6 bare copper wire formed into a 2 1/2 ft diameter circle. The 2 ends shall then be electrically spliced. The test shall be started with all detector amplifiers turned 'Off' except for one ~~(1)~~ approach. All amplifiers for that approach shall be turned 'On' and adjusted to the proper settings. All traffic for the approach being tested shall be stopped and not allowed to cross any loops during the test procedure for that approach. The simulator shall be dragged slowly across each loop system in the same direction as to simulate a vehicle driving through the loop system. As the simulator crosses each loop an IMSA level II certified Signal Technician shall verify that a call is displayed exclusively on the corresponding loop amplifier, controller detector input and controller phases. After completely verifying the loops on the first approach the amplifiers shall be left

'On', and the amplifiers for the next approach to be tested shall be turned 'On' and adjusted to the proper settings. The same procedure shall be followed for each remaining approach. With large intersections, as the test proceeds, it may become difficult to verify that the calls are going to the correct detector inputs. In this case, traffic control shall be used to stop vehicles before reaching the loops for as many approaches as needed to accurately complete the testing to the inspector's approval. Testing may be paused between lanes to allow traffic to clear.

~~(e)~~ *3.* Acceptance Criteria

The Contractor shall record all test readings, in triplicate, on tabular forms provided by the Department or by copying the 1 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.~~ *a.* 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.~~ *b.* Resistance shall be less than or equal to 8 ohms.

~~3.~~ *c.* *Induced AC voltage* ~~Voltage~~ shall be less than or equal to 3 V.

~~4.~~ *d.* ~~Induced A.C. voltage and leadage~~ *Leakage* 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~~ *Other Vehicle Detection Systems*

When required, the Contractor shall furnish and install an alternative vehicle detection system from the Department's list of approved Traffic Signal and ITS Control Equipment.

~~(a) Testing~~ *(note: statement moved to new RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS)*

~~Before installation of M*m*agnetometer or M*m*icroloop probes the Contractor shall confirm the adequacy of the magnetic field intensity, to be sure that the range is suitable for their operation.~~

~~*The Contractor shall demonstrate that the microloop count data recorded in the controller's detector log is within 5% of count data obtained visually over a 15-minute period for every detector installation. The test shall be performed by the Contractor in the presence of the Engineer. If detector sensitivity or calibration settings are adjusted in order to meet this test, the new settings shall be recorded on the wiring diagram in the cabinet.*~~

~~***(b) Installation***~~

~~Arrangement of probes shall be located at maximum distance from steel support under bridges*metal objects as per manufacturer's recommendation*. 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.~~

~~*PVC conduit for the microloop detector probes shall be directionally pushed beneath the pavement at the depth and slope determined by the manufacturer to ensure proper carrier and probe installation. The Contractor shall repair any damage to the pavement that occurs during the installation. The microloop detector probe location in each lane shall be per the manufacturer's recommendation.*~~

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~~ *200* 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, *HDPE, and Fiberglass* Conduit

The method of installing PVC, *HDPE and rigid fiberglass* conduit underground shall be the same as for steel conduit where applicable except trenches for the conduit *in areas with class X material as described in 206.02* shall be backfilled with 2 in. ~~(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.

Schedule 40 PVC, HDPE, or rigid fiberglass conduit may be used for conduit placed in trenches with expansion fittings used every 200 ft unless otherwise indicated on the plans. Schedule 80 PVC or HDPE shall be used for conduit that is jacked or bored. Schedule 80 PVC or rigid fiberglass shall be used for conduit on bridges or other structures. A No. 6 AWG copper or No. 14 AWG aluminum ground wire shall be included in all PVC, HDPE, and rigid fiberglass conduit.

805.13 Foundations

Foundations for traffic signal ~~poles~~*structures*, cabinets, and pedestals of the type specified shall be constructed, or existing M foundations shall be modified, as shown on the plans or as directed. Pedestal bases shall be plumb and firmly attached to the anchor bolts either by using leveling nuts or shims if top of the foundation is not level. Grouting shall be used when necessary to fill any gap between pedestal base and foundation. Pipe pedestals shall be screwed tightly into the bases and secured with a stainless steel pin. Power and signal cables shall then be pulled from the base into the cabinet. Curing of concrete shall be in accordance with 702.22.

Foundations for traffic signal cantilever structures shall be constructed as shown on the plans or as directed. The foundation concrete shall be placed monolithically and

shall have no construction joint. Structure bases shall be plumb and attached to the anchor bolts using leveling nuts. A tooled line or other type of permanent marking shall be provided on the top of the foundation to indicate the direction of the conduits. 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 cantilever structure,* ~~*signal*~~ *single arm; signal cantilever structure, combination arm;* ~~*signal cantilever structure, pole section 2, pole diameter 17 in.; signal cantilever structure, pole section 2, pole diameter 24 in.;*~~ *signal cantilever structure, single arm, combination arm; signal cantilever structure, dual arm; signal cantilever structure, drilled shaft foundation type; signal cantilever structure, spread footing foundation type;* signal support foundation~~,~~*;* signal service~~,~~*;* disconnect hanger~~,~~*;* ~~magnetometer detector,; microloop detector probe,;~~ loop detector delay amplifier~~,~~*; loop detector delay counting amplifier; loop detector rack;* ~~*auxiliary BIU panel;*~~ ~~*radio antenna; radio interconnect; radio splitter*~~*;* *signal backplate;* signal handhole~~,~~*;* signal detector housing~~,~~*;* span catenary and tether~~,~~*;* and span catenary for flasher will be measured by the number of units installed.

The pay length for a signal cantilever arm or combination arm will be the length shown in the Schedule of Pay Items.

Conduit of the type specified will be measured by the linear foot ~~(meter)~~ from outside to outside of foundations. Signal cable and signal interconnect cable will be measured by the linear foot ~~(meter).~~

~~*Preformed pave-over loops will be measured by the number of loops placed. Each loop will be measured only once, regardless of the number of signal cable turns. Signal cable from preformed pave-over loops to handholes, detector housings or from loop to loop will not be measured for payment.*~~ *(note: statement moved to new RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS)*

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.

~~*Radio, interconnection system testing*~~, ~~T~~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.

Traffic signal equipment removal ~~and~~*will be measured per each installation to be removed.* ~~t~~*T*ransportation of salvageable signal equipment will not be measured.

805.16 Basis of Payment

~~*Radio, interconnection system testing*~~, ~~T~~traffic signal installation, *and* 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~~,~~*;* ~~*radio antenna; radio interconnect; radio splitter; signal steel strain pole,;*~~ signal ~~wood~~ pole~~,~~*;* ~~signal cantilever structure~~, *signal cantilever structure, ~~signal~~ single arm; signal cantilever structure, combination arm; ~~signal cantilever structure, pole section 2, pole diameter 17 in.; signal cantilever structure, pole section 2, pole diameter 24 in.;~~ signal cantilever structure, single arm, combination arm; signal cantilever structure, dual arm; signal cantilever structure, drilled shaft foundation type; signal cantilever structure, spread footing foundation type;* signal support foundation~~,~~*;* signal pedestals~~,~~*;* signal service~~,~~*;* disconnect hanger~~,~~*;* ~~magnetometer detector,; microloop detector~~,*;* loop detector delay amplifier~~,~~*; loop detector delay counting amplifier; loop detector rack; ~~auxiliary BIU panel;~~ signal backplate;* 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,~~ ~~s~~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).~~

Conduit of the type specified will be paid for at the contract unit price per linear foot. The cost of any backfill, ground wire, or expansion fittings shall be included in the cost of conduit.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 805-TRAFFIC SIGNALS (changes shown as to existing RSP 805-T-169 TRAFFIC SIGNALS)

~~*Preformed pave-over loops will be paid at the contract unit price per each*~~. *(note: statement moved to new RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS)*

The removal of existing traffic signal equipment designated to be removed will be paid for at the contract ~~lump sum~~ *unit* price *per each* for traffic signal equipment, remove *for each location removed*. When designated as a pay item, the transportation of salvageable signal equipment will be paid for at the contract lump sum price for transportation of salvageable signal equipment.

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**
~~*Auxiliary BIU Panel*~~	~~*EACH*~~
Backplate, Signal	*EACH*
Conduit _____ type	*LFT*
Controller and Cabinet, _____, _____ Phase type no.	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. _____ *type*	LS
~~Flasher Modernization, Location No. _____~~	~~LS~~
Handhole, Signal	EACH
Loop Detector Delay Amplifier, _____, _____ Channel *type* no.	EACH
~~Loop Detector Delay *Counting* Amplifier, _____ Channel =no.~~	~~EACH~~
Loop Detector Rack	*EACH*
~~Magnetometer Detector~~	~~EACH~~
~~Microloop Detector *Probe*~~	~~EACH~~
Miscellaneous Equipment for Traffic Signals	LS
Pedestrian Push Button, _____, *type*	EACH

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 805-TRAFFIC SIGNALS (changes shown as to existing RSP 805-T-169 TRAFFIC SIGNALS)

Pedestrian Signal Head, _____, _____ .....EACH
type lens size

~~*Radio Antenna*~~ ~~.....EACH~~

~~*Radio, Interconnect*~~ ~~.....EACH~~

~~*Radio, Interconnection System Testing*~~ ~~.....LS~~

~~*Radio Splitter*~~ ~~.....EACH~~

Saw Cut for Roadway Loop and Sealant .....LFT ~~(m)~~

Signal Cable, _____, No. _____ Copper, _____ C/ _____.....LFT ~~(m)~~
type conductors/size

~~*Signal Cable, Preformed Pave-Over Loop*~~ ~~.....EACH~~

~~Signal Cantilever Structure, Mast Arm _____ ft (m) ..... EACH~~
~~length~~

Signal Cantilever Structure, ~~Signal~~ Single Arm _____ ft .....EACH
length

~~*Signal Cantilever Structure, Pole Section 2, Pole Diameter 17 in.*~~ ~~.....EACH~~

~~*Signal Cantilever Structure, Pole Section 2, Pole Diameter 24 in.*~~ ~~.....EACH~~

Signal Cantilever Structure, Combination Arm ____ ft .....EACH
length

Signal Cantilever Structure, Single Arm ____ ft, Combination Arm ____ ft .....EACH
length length

Signal Cantilever Structure, Dual Arm ____ ft, ____ ft .....EACH
length length

Signal Cantilever Structure, Drilled Shaft Foundation, _____.....EACH
type

Signal Cantilever Structure, Spread Footing Foundation, _____.....EACH
type

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~~ *type* ~~-~~ 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 Equipment, Remove ..... ~~LS~~*EACH*

Traffic Signal Head, _____ ~~Way, _____~~ Section, _____ .....EACH

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 805-TRAFFIC SIGNALS (changes shown as to existing RSP 805-T-169 TRAFFIC SIGNALS)

no. ~~no.~~ lens sizes & colors
Traffic Signal Installation, _____, Location No. _____ .....LS
type
~~Traffic Signal Modernization, _____, Location No. _____ .....LS~~
~~type~~
Transportation of Salvageable Signal Equipment.....LS

The cost of the solar panel, battery cabinet, program timing module, signal heads, wiring, and all hardware required to complete the installation shall be included in the cost of flasher installation or flasher modernization.

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 ~~2 loop detector racks,~~ all wiring, hardware, anchor bolts, and associated equipment required to operate the intersection shall be included in the cost of controller and cabinet. ~~The cost of any additional loop detector racks shall be included in the cost of loop detector rack.~~

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, *any accessible pedestrian signal components*, and all hardware required to complete the installation shall be included in the cost of pedestrian push button.

The cost of 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.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 805-TRAFFIC SIGNALS (changes shown as to existing RSP 805-T-169 TRAFFIC SIGNALS)

The cost of signal pole section 1 and single arm shall be included in the cost of the signal cantilever structure, single arm.

The cost of signal pole section 2 and combination arm shall be included in the cost of the signal cantilever structure, combination arm.

The cost of signal pole section 1, 2 and single arm, combination arm shall be included in the cost of the signal cantilever structure, signal arm, combination arm; when structure with single arm and combination arm is required in the same contract.

The cost of signal pole and dual arms shall be included in the cost of the signal cantilever structure, dual arm.

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 probe. The cost of all hardware and work required to provide and install signal cable from microloop detector probe, including extra-low voltage (home-run), from the handhole adjacent to the detector probe to the controller cabinet shall be included in the cost of signal cable.*~~ *(note: statement moved to new RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS)*

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 signal cable from preformed pave-over loops to handholes, detector housings or from loop to loop shall be included in the cost of the preformed pave-over loop.*~~ *(note: statement moved to new RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS)*

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 805-TRAFFIC SIGNALS (changes shown as to existing RSP 805-T-169 TRAFFIC SIGNALS)

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 to repair or replace damaged or lost salvageable traffic signal equipment shall be at the Contractor's expense.

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.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

PROPOSED NEW RSP 805-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT

805-X-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT

(note: statements from RSP 805-T-169)

(Adopted xx-xx-xx)

Description

This work shall consist of furnishing and installing spread spectrum radio equipment for interconnecting traffic signal controllers at signalized intersections in accordance with 105.03.

Materials

The Contractor shall select radio equipment materials from the Department's list of approved Traffic Signal and ITS Control Equipment. The Contractor shall furnish 2 copies of the instructions for hardware installation, programming and system commissioning.

Construction Requirements

To receive maximum signal strength, the radio antennas shall be positioned by adjusting the antenna direction while monitoring signal strength through the telemetry radio. The radio antenna mounts shall be securely fastened to the poles. Coaxial cable shall be installed inside metal poles and conduits. External cable on poles shall not exceed 3 ft unless approved by the Engineer. Approved external cable runs exceeding 3 ft shall be secured using manufacturer specified hangers at a maximum spacing of 3 ft. Cable terminations shall be in accordance with the manufacturer's recommendations. Connectors outside of cabinets shall be sealed in accordance with the manufacturer's recommendations. The Contractor shall deburr any holes made in metal poles and install grommets for protection. Drip loops shall be provided between the antenna connector and the metal pole entrance or first pole clamp. Cable bends shall be in accordance with the manufacturer's specified bending radius.

Testing

Test of the radio interconnection system shall be performed after the installation is complete. Notice of the testing shall be provided to the district traffic office at least 2 work days prior to the test. The Contractor shall adjust the radio antennas to optimize the communication signal for the system. The strength of the communication signal shall be determined using computer software provided by the radio interconnection system manufacturer. The test shall be conducted with complete foliage on deciduous trees in the vicinity or on a date approved by the Engineer. The test results shall include the signal strength, site polling results using long message polling, and noise levels. The test results shall be above the minimum guidelines set by the radio interconnect system manufacturer.

Method of Measurement

Radio antenna, radio interconnect, radio splitter will be measured by the number of units installed.

Radio, interconnection system testing will not be measured for payment.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

PROPOSED NEW RSP 805-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT

Basis of Payment

Radio, interconnection system testing will be paid for at the contract lump sum price.

If specified as pay items, radio antenna, radio interconnect, radio splitter will be paid for at the contract unit price per each.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Radio Antenna	EACH
Radio, Interconnect	EACH
Radio, Interconnection System Testing	LS
Radio Splitter	EACH

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

PROPOSED NEW RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS

805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS

(Adopted xx-xx-xx)

Description

This work shall consist of furnishing and installing one or more of the following vehicle detection methods in accordance with 105.03.

(a) Wireless Vehicle Detection Systems (note: statements from RSP 805-T-173)

1. Materials

Only models from the Department's approved materials list for traffic signal control equipment shall be used.

2. Construction Requirements

Prior to the installation, the Contractor shall test all in-pavement sensors and demonstrate proper operation and communication between the in-pavement sensors and the receiver processor and wireless repeater, if required. Prior to the installation, the Contractor shall demonstrate that each in-pavement sensor shall be installed within range of its corresponding receiver processor, using wireless repeaters as necessary.

All in-pavement sensors assigned to either a receiver processor or wireless repeater shall be located within a 120° arc measured from the receiver processor or wireless repeater.

The Contractor shall install each in-pavement sensor in the roadway according to the manufacturer's recommendations and as shown on the plans. Holes cored in the pavement shall be cleaned and dried before installing in-pavement sensors. The cored pavement shall be backfilled according to the manufacturer's recommendations.

Receiver processors and wireless repeaters shall be mounted on traffic signal steel strain, or cantilever poles, or signal pedestals on type A foundations. The mounting height of receiver processors above the pavement surface shall be between 20 ft and 35 ft. The mounting height of wireless repeaters above the pavement surface shall be between 13 ft and 35 ft.

The minimum distance between a receiver processor and wireless repeater mounted on the same structure shall be 2 ft. This distance may be increased to enable better communication between the devices.

After installation, the Contractor shall demonstrate successful communication between each in-pavement sensor, receiver processor, and wireless repeater to the Engineer.

(b) Magnetometers and Microloops (note: statements from RSP 805-T-169)

1. Testing

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.

The Contractor shall demonstrate that the microloop count data recorded in the controller's detector log is within 5% of count data obtained visually over a 15-minute period for every detector installation. The test shall be performed by the Contractor in the presence of the Engineer. If detector sensitivity or calibration settings are adjusted in order to meet this test, the new settings shall be recorded on the wiring diagram in the cabinet.

2. Installation

Arrangement of probes shall be located at maximum distance from metal objects as per manufacturer's recommendation. 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.

PVC conduit for the microloop detector probes shall be directionally pushed beneath the pavement at the depth and slope determined by the manufacturer to ensure proper carrier and probe installation. The Contractor shall repair any damage to the pavement that occurs during the installation. The microloop detector probe location in each lane shall be per the manufacturer's recommendation.

(c) Preformed Pave-over Loops (note: statements from RSP 805-T-169)

Preformed pave-over loops shall be designed for use with HMA, SMA or PCCP as applicable. Only models from the Department's approved materials list for traffic signal control equipment shall be used. Loop wire shall be installed in accordance with 805.09. Preformed pave-over loops may be installed as a 1, 2, 3 or 4 loop configuration. Pave-over loops shall be secured in place prior to paving.

(d) Video Detection (note: statements from RSP 805-T-123)

1. Description

The video vehicle detector system is comprised of CCD video image sensors and a machine vision processor as separate units. The system shall be capable of monitoring vehicles on a roadway via processing of video images and shall provide detector outputs to a traffic signal controller.

2. Materials

Only models from the Department's list of approved Traffic Signal Control Equipment shall be used. Video vehicle detector systems will be placed and maintained on the Department's approved list after being evaluated and approved by the Department. Manufacturers wishing to have their system considered should contact the Signal Shop at INDOT's Logistical Support Center.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

PROPOSED NEW RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS

The video vehicle detector system shall include a minimum of 4 CCD video image sensors, the machine vision processor, set-up and operating software, all connectors, and miscellaneous equipment necessary for the installation and operation of the system.

A 10 year operational warranty or standard manufacturer's warranty, whichever is longer, shall be provided for each Machine Vision Processor.

A 5 year operational warranty or standard manufacturer's warranty, whichever is longer, shall be provided for each CCD video image sensor. The effective date for the beginning of the warranty shall be the traffic signal turn-on date as noted on form IC 636A. A written copy of the warranty shall be presented to the Engineer prior to final acceptance of the contract.

The warranty shall service all defects in material or workmanship of the equipment. The manufacturer shall not be responsible for damage caused by negligence, severe weather acts such as lightning, flood, etc., or use of the equipment in a manner not originally intended. Temperatures between -30°F and +165°F will not be considered severe weather acts. The vendor or manufacturer shall be responsible, during the warranty period, for transportation costs of items requiring warranty service to and from the Signal Shop at INDOT's Logistical Support Center. A maximum turn-around time for service of all defects in material and workmanship of equipment shall be no longer than 60 calendar days. Continued failure, repeated malfunctions, or exceeding the maximum turn-around time for warranty service will be cause to remove that model from the Department's list of approved models.

Method of Measurement

Wireless magnetometer detectors; contact closure cards; receiver processors; wireless repeaters; magnetometer detector; microloop detector probe; video vehicle detector systems; will be measured by the number of units installed.

Preformed pave-over loops will be measured by the number of loops placed. Each loop will be measured only once, regardless of the number of signal cable turns. Signal cable from preformed pave-over loops to handholes, detector housings or from loop to loop will not be measured for payment.

Basis of Payment

If specified as pay items, wireless magnetometer detectors; contact closure cards; receiver processors; wireless repeaters; magnetometer detector; microloop detector; Preformed pave-over loops; and video vehicle detector systems will be paid for at the contract unit price per each.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Contact Closure Card	EACH
Receiver Processor	EACH
Wireless Magnetometer Detector _____	EACH

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

PROPOSED NEW RSP 805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS

	type
Wireless Repeater	EACH
Magnetometer Detector	EACH
Microloop Detector Probe	EACH
Signal Cable, Preformed Pave-Over Loop	EACH
Video Vehicle Detector System	EACH

The cost of coring the pavement, sealant, and all work necessary for proper installation and operation of the in-pavement sensors shall be included in the cost of the wireless magnetometer detector.

The cost of cables, connectors, set-up and operating software, access boxes, rack mounted expansion cards, and all hardware necessary to complete the installation shall be included in the cost of the contact closure cards.

The cost of required mounting equipment, cables, connectors, and miscellaneous equipment necessary for proper installation and operation of the receiver processors shall be included in the cost of the receiver processors.

The cost of required mounting equipment, connectors, and miscellaneous equipment necessary for proper installation and operation of the wireless repeaters shall be included in the cost of the wireless repeaters.

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 probe. The cost of all hardware and work required to provide and install signal cable from microloop detector probe, including extra-low voltage (home-run), from the handhole adjacent to the detector probe to the controller cabinet shall be included in the cost of signal cable.

The cost of signal cable from preformed pave-over loops to handholes, detector housings or from loop to loop shall be included in the cost of the preformed pave-over loop.

The CCD video image sensors (cameras), machine vision processor, set-up and operating software, all connectors, miscellaneous equipment necessary for the installation and operation of the system, and the warranty shall be included in the cost of the video vehicle detector system.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 922 – TRAFFIC SIGNAL MATERIALS (changes shown as to existing RSP 922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT)

The Standard Specifications are revised as follows:

SECTION 922, DELETE LINES 1 THROUGH 1850.

SECTION 922, AFTER LINE 1, INSERT AS FOLLOWS:

SECTION 922 – TRAFFIC SIGNAL MATERIALS

922.01 Description

All traffic signal materials and equipment shall be in accordance with the NEMA TS2-2003 Standards Publication, and be compatible with the Department's current inventory of signal equipment, unless specifically outlined in the following specification.

922.02 Traffic Signal Control Equipment

Models shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment, unless otherwise specified.

(a) Model Approval

Each model of controller assembly, CA, and all major units, as defined in NEMA TS2-2.1.1, will be tested and evaluated by the Department's Logistical Support Center, and approved prior to use. The CA, as defined by NEMA TS2-1.1.7, as being a complete electrical unit, shall include major units operational in a TS2 environment. Major units of the CA are defined as controller unit, CU; malfunction management unit, MMU; bus interface unit, BIU; cabinet power supply; load switches; vehicle detector equipment; cellular modems; radio modems, and flasher. The evaluation of a product will be considered when the Department receives the preliminary product evaluation submittal form. The Department will advise the manufacturer or vendor, of the date of delivery at which time a presentation of the product will be required accompanied by the product brochure, the operational manual containing procedures for all features incorporated in the CU's design, and the maintenance manual containing all schematics, pictorial parts layouts, components parts listings, and documented theory of operation. Certification in accordance with 922.02(d) shall also accompany the preliminary product evaluation form. If a product has TS2 communicative capabilities, then a data analysis interpretation offered in a decimal form expressing frames by an SDLC protocol analyzer shall accompany the initial documentation as well. When accuracy of documentation is validated, the evaluation period may commence. In addition, all computer system software applicable to a manufacturer's product shall work with the Department's current operating systems so that upgrades will not be needed to recognize the full potential of the product. Any product under evaluation that has an operational failure occurring during the bench test procedure will be rejected and returned to the submitter. The product will not be considered for future evaluation without a cover letter documenting failures encountered and changes to the design to correct the failures. A presentation by the manufacturer of the product in question and explanation of why the product failed will be required. Resubmittal of the original product will be expected for

testing, evaluation, and approval. Furthermore, 2 more rejections of a product submitted for evaluation will be cause to deny approval of that model permanently.

The controller model shall be fully NTCIP 1202 compliant, and be capable of logging time-stamped controller event data at 100 ms resolution. The events collected shall be logged in the INDOT specified data file format and shall include but are not limited to, start and termination of all phase green, amber, and red, pattern changes, and all detector actuations and terminations. Data log file shall be accessible for standard FTP retrieval directly from the controller model's internal FTP server via the IP addressable RJ-45 Ethernet port.

Continued failures indicative of a trend, repeated random malfunctions, or NEMA non-compliance of an approved product shall be cause to remove that model from the Department's list of approved Traffic Signal and ITS Control Equipment. If the manufacturer makes any changes to an approved model of major unit and/or controller cabinet terminal/facilities to correct a non-NEMA compliant or safety issue, the Department is to be notified immediately. The manufacturer will be required to correct all existing equipment purchased by the Department either directly, by contract, or through agreement prior to the change being incorporated at the manufacturer's production level.

A design change to an approved model of a CA or any major unit will require a submittal of documented changes. At the discretion of the Department, resubmission of the model for testing, evaluation, and approval may be required. The permanent addition or removal of component parts or wires, printed circuit board modifications, or revisions to memory or processor software, are examples of items that are considered to be design changes.

(b) Controller Assemblies or Major Units Furnished and Installed by the Contractor

A CA, as defined by NEMA TS2-1.1.7, shall be provided by the Contractor and shall be built to the specifications of the intersection design.

Each CA shall be supplied with 3 documentation packets. The documentation shall be provided in both paper hard copy and electronically as specified for each document. Each packet shall consist of:

1. *One complete set of wiring and schematic diagrams for all of the CA's panels, racks and wiring; the electronic document shall be ~~Adobe~~ (.pdf) and have a minimum of 1 indexed page for each paper sheet.*

2. *A parts list indicating contract number, vendor, category, manufacturer, model, serial number, software/firmware version as applicable, and inventory number of all major units incorporated in the*

CA; the electronic document shall be ~~MS Excel~~ (.xls) and the blank worksheet shall be obtained from the Department's Logistical Support Center.

3. An 11 by 17 in. intersection design plan; the electronic document shall be ~~Adobe~~ (.pdf).

4. A completed Department approved loop tagging table; the electronic document shall be ~~MS Excel~~ (.xls) and the blank worksheet shall be obtained from the Department's Logistical Support Center.

5. Packet number 2 shall also include a paper hard copy and an indexed and searchable electronic pdf format file of the instructional programming manual identical in nature to that approved for use during the evaluation of each product and shall include a TS2 type 2 to TS2 type 1 adapter harness.

All electronic documents shall be saved to CD (compact disk, CD-R or CD-RW) in the specified format for each document. Each packet shall be labeled with the name of the intersection, the contract number, the commission number and the date of installation. Packet destinations shall be as per 805.08.

A 60-day burn-in period of traffic control equipment shall be required prior to acceptance of the contract. The Contractor shall be responsible for all costs associated with vendor or manufacturer warranty service until acceptance of the contract, or acceptance of that portion of the contract where the traffic control equipment is installed.

(c) Warranty

~~A 5-year~~ The manufacturer's or vendor's warranty shall be provided for the following components: all major units operating in a TS2 environment, ~~.~~ Llight emitting diode, LED, signal indications, ~~shall have a 5-year manufacturer's or vendor's warranty. Video detection equipment shall have a 10-year manufacturer's or vendor's warranty period on processors, integrated camera/processor units, rack mount cards, hubs, minihubs and camera interface panels. CCD video cameras shall have a 5-year manufacturer's or vendor's warranty. L~~load switches and flashers ~~shall have a 2-year manufacturer's or vendor's warranty~~. Warranty periods shall commence from the date of field placement of the device or on the date of signal turn-on as shown on the IC 636A form if purchased through a contracting agent.

(d) Certification of NEMA TS2 Traffic Control Equipment

The following certifications shall be furnished.

1. Certification of a Production Run Model

A certification representing each model of approved major unit of a CA shall be on file with the Department. A certification of a production run model for a CU will be valid for a maximum period of 5 years from the date of approval or unless a significant change is made in the CU. If a significant change is made, a new certification shall be submitted. A significant change shall be the addition or deletion of any function or feature in the control unit, or any other change as defined in 922.02(a) to the circuitry in the product.

2. Certification of Environmental Testing

A certification shall be furnished with each major unit approval request indicating it has been tested and is in accordance with the tests from NEMA TS2-2. The certification shall specify the model and serial number of the product being tested. A complete log of each test shall be provided to the Department and will be maintained by the Department. The log shall show which, if any, controller component failed during the test, when it failed, and what steps were taken to repair the controller. The log shall include the date of testing, name and title of person conducting the tests, a record of conditions throughout the tests, and a temperature and humidity verses time chart. The maximum report interval of any chart shall be 24 h. The chart shall be from a recording machine used to monitor the status of the environmental chamber during testing.

(e) NEMA TS2 Fully Actuated Solid State Controller Unit, CU

The following requirements are the minimum for the design and operation of a 16 channel fully actuated solid state CU. The NEMA TS2 configuration will consist of 2 types of CU's, type A1 and type A2, as defined in NEMA TS2-3.2.

The CU shall be in accordance with NEMA TS2 Standards, all provisions contained herein, and the Department's specifications. Manufacturer specific enhancements are acceptable; however, no function or device shall preclude the interchangeability of a CU with another CU of like NEMA specification within a controller assembly.

1. General Requirements

The CU shall be microprocessor based and both versions shall contain a 3-port configuration and shall operate in the NEMA TS2 type A1 environment.

The CU shall include provisions for time-of-day programming. The CU shall be capable of a minimum of 50 programmed events and be in accordance with NEMA TS2-3.8.

A removable nonvolatile EEPROM module or removable serial, flash-based, non-volatile data module shall be utilized in each CU to maintain all programmed data. A real-time clock shall be either battery-backed or powered by a super capacitor and active during a power outage so as to provide complete time keeping functions and leap year corrections. A switch or other means shall be provided to turn off or disconnect battery

power during storage. This shall be accomplished without physical removal of the battery. Batteries within the CU shall be turned off or disconnected during storage and shipment.

Programming and maintenance manuals for approved CU's shall be identical in nature to that approved for use during the evaluation period of the CU. The Department shall be notified of any changes to the manuals.

Serial number and model numbers shall be permanently applied on or near the front of circuit boards of the CU and viewable without removing or disconnecting the board. Serial number and model number of the main frame shall be permanently applied externally on top or on the front panel.

2. CU Requirements

The requirements set forth herein refer to a type A1 and A2 CU. Where differences occur between types, it will be designated.

The CU shall have, as a minimum, the internal diagnostics defined by NEMA TS2-3.9.3.

The CU shall monitor and log the status of events as specified in NEMA TS2-3.9.3.1.5 in non-volatile memory and shall be selectable via program entry and be retrievable by the system computer via NEMA port 2 or 3. In addition, the CU shall have the ability to log an MMU fault as it occurs. A minimum of 16 entries shall be stored in non-volatile memory. When capacity is exceeded, the oldest entry will be replaced by the newest. Logged entries shall at minimum contain the date and time denoted in military style with minute resolution, description of the fault as it would appear on the MMU, and the status of each of the channel inputs at the time the fault occurred, clearly denoting the presence of activity on a channel.

The CU shall be capable of all inputs and outputs listed by controller type in NEMA TS2-3. Pedestrian timing shall be provided on all phases of a CU. Unless otherwise indicated on the plans, the CU, when delivered, shall be programmed to initialize in phase 2 and phase 6 green, however, the CU shall be keyboard programmable to permit initialization in any color and phase. Initialization shall occur after a recognized power interruption, upon MMU reset, or upon return from manual or time-of-day flash. The CU shall be programmable from a closed loop computer system, a laptop computer using the RS232 port, front panel programming, and by downloading from another like CU through the RS232 port.

Keystroke buttons shall be clearly marked as to function. All programming buttons and indicators pertinent to the operation of a phase shall be on the front of the CU and shall have programmable phase omitting and phase skipping capabilities.

The TS2 type A2 CU shall be in accordance with all applicable requirements for a type A2 CU as defined by NEMA TS2-3 and shall contain a full compliment of connectors.

The CU shall have an RJ-45 ethernet port on the front panel and ethernet module that provide 10/100 base T interface in half or full duplex and which supports auto-configuration of the link parameters.

3. Internal Modules

All plug-in modules shall be equipped for easy removal or installation without the use of tools and shall be readily accessible for maintenance. All internal module plugs and edge card plugs shall have the corresponding pin connector position labeled with the first and last numbers or the first and last letters.

4. CU Enclosure

The enclosure shall be of adequate strength to protect the components during normal handling. The keypad, liquid crystal display and all interface connectors required for the operation and standard field adjustments shall be mounted on the front panel. Fusing shall be on the front panel of the CU and shall provide protection from internal or external overload.

The front panel of the controller shall be fastened to the frame such that no special tools shall be required to remove or replace printed circuit board modules nor to gain access through the front panel. All hinges shall have stainless steel pins.

5. Firmware and Software Revisions

The Department's Logistical Support Center shall be notified each time an update or revision of the firmware or software is released, explain the changes, and the benefits of the change. The Department will determine if and to what extent a revision is to be placed into field operation and may fully re-evaluate the CU with the revision.

(f) NEMA TS2 Cabinet, Auxiliary Equipment, and Terminal and Facilities, TF, Requirements

These standards define the minimum requirements for a TS2 type A1 cabinet, both inside and out. The performance and construction of the cabinet shall be in accordance with the applicable requirements of NEMA TS2 sections 4, 5, 6, and 7. The serial number and model number of the auxiliary equipment shall be permanently applied externally on or near the front of the product. Programming and maintenance manuals for approved products shall be identical in nature to that approved for use during the evaluation period of the product. The Department shall be notified of all changes to the documentation. Manufacturer specific enhancements are acceptable, however no function or device shall preclude the interchangeability of an auxiliary product with another product of like NEMA specification within a controller assembly.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 922 – TRAFFIC SIGNAL MATERIALS (changes shown as to existing RSP 922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT)

1. Controller Cabinet Requirements

The NEMA TS2 type A1 controller cabinet shall be in accordance with the following requirements.

a. General

The cabinet and the shelves shall be fabricated of aluminum. The cabinet shall be 1/8 in. minimum thickness sheet aluminum or 1/4 in. minimum thickness die-cast aluminum. The cabinet exterior and interior including shelves shall have a sandblasted, roughened, or chemically etched finish that reduces gloss, reflection, and glare.

The main cabinet door shall use a Corbin lock No. 2 and each cabinet shall be furnished with 2 No. 2 keys. The lock shall open in a counterclockwise motion only. The door shall be capable of being opened and stopped in at least the following 2 ranges of degree opening as measured from the face of the cabinet door on the hinged side: 80 to 100°, and 170 to 190°. The door shall be hinged on the right side of the cabinet. The main door and the police panel door shall close against a weatherproof and dustproof gasket seal, which shall be permanently bonded to the cabinet. A standard police panel key shall be provided with each cabinet.

A rain channel shall be incorporated into the design of the main door panel to prevent liquids from entering the enclosure. A 1 1/2 in. deep drawer shall be provided in the cabinet, mounted directly beneath the controller support shelf. The drawer shall have a hinged top cover and shall be capable of accommodating 1 complete set of cabinet prints and manuals. This drawer shall support 50 lb in weight when fully extended. The drawer shall open and close smoothly. Drawer dimensions shall make maximum use of available depth offered by the controller shelf and be a minimum of 24 in. wide.

b. Switches, Auxiliary, and Environmental Feature Requirements

The cabinet shall have a police door and a police control panel within the main door. The police panel shall have 2 different switches, 1 switch for field indication cutoff and 1 switch to transfer between automatic signal control and flashing operation. The switches shall be protected from water when the cabinet door is open.

A test switch panel shall be mounted on the inside of the main door. The test switch panel shall include, as a minimum, the following switches. An auto/flash switch shall be installed so that when in the flash position, power shall be maintained to the controller and the intersection shall be placed in flash. A stop time switch shall be installed so that when in the 'On' position the controller shall be stop-timed in the current interval. A controller equipment power On/Off switch shall be installed which shall control AC power to the CU, MMU, and cabinet power supply. All switches mounted on the switch panel on the inside of the main door shall have in place a mechanism to prevent accidental activation of the switch. "Locking bat" type switches or side switch guards are acceptable. Switch guards, if used, shall be in place for each

switch, shall be made of the same material as the cabinet, and shall permit the operation of the switch without the use of tools.

All switch functions shall be permanently and clearly labeled. Hand written labeling will not be permitted.

The cabinet shall include all required wiring, connectors and adapters to provide full compatibility and interchangeability with either a TS2 type A1 or type A2 controller.

c. Receptacle

The cabinet shall contain 1 duplex convenience outlet and a lamp receptacle that is actuated and turns on when the door is open and goes off upon closing of the door and an internal On/Off switch which can override the preceding. The convenience outlet shall be duplex, 3-prong, NEMA type 5-15R grounding outlet in accordance with NEMA WD-6, with ground-fault circuit interruption as defined by the National Electric Code. These units shall be protected with a 15-ampere cartridge fuse wired ahead of the multibreakers. An additional outlet shall be provided in each cabinet and shall be a duplex, 3-prong, NEMA type 5-15R grounding outlet wired after the cabinet surge protection. This unit shall be protected with a 10-ampere cartridge fuse.

Master cabinets shall have an additional duplex, 3-prong, NEMA type 5-15R grounding outlet wired after the cabinet surge protection. This outlet shall be powered by the 10-ampere circuit breaker and through a separate power interrupt switch providing separate control of the master CU power supply.

d. Fan and Filter

The cabinet shall contain a thermostatically controlled ventilating fan and a vent with a commercially classified uniform 1 in. thick filter. The thermostat shall be manually adjustable from 90 to 115°F. The fan shall be mounted internally at the top and toward the front of the cabinet to exhaust out the front top lip of the cabinet. The fan shall be rated at a minimum of 100 cu ft per minute as designated by NEMA TS2-7.9.1. The thermostat shall be located within 6 in. of the fan.

The filter size will be according to the provisions for the type of cabinet as stated in NEMA TS2-7.9.2.3 and shall be a replaceable pleated air filter with a minimum efficiency reporting value, MERV, rating of 5 or higher as defined by the ASHRAE 52.2-~~1999~~2007 specification. The cabinet ventilation shall be in accordance with NEMA TS2-7.9.

Each inductive device, including the fan, shall have a separate power surge protection.

2. Load Switch and Flasher Requirements

The cabinet shall contain a jack mounted type 3 solid state non-repairable flasher in accordance with NEMA TS2-6.3 electrical and physical dimensions.

The pedestrian load switch and the signal load switch shall be an approved unit meeting all electrical and physical dimension requirements in accordance with NEMA TS2-6. The load switch shall not use a printed circuit board to transmit the 115V AC line input or signal buss output. Each load switch shall offer 3 indicators, 1 for each circuit indicating the status of the input to the load switch.

The load switch signal outputs shall be brought to a separate terminal strip for hook-up of the signal displays. Load switches inputs shall be capable of being programmed for flash, overlap, vehicular, or pedestrian phases with the use of a standard slotted or phillips screwdriver via the cabinet terminal strip. The load switch input programming of the TS2 type A1 CU shall be accomplished through front panel data entry of a TS2 type A1 or a TS2 type A2 CU.

3. Terminal and Facilities Requirements

a. General Requirements

The TF layout shall be in accordance with NEMA TS2-5.2.7. The cabinet shall contain a main TF panel complying with NEMA TS2- 5 standards. The model number of the main panel shall be permanently applied to the front of the panel, where it is easily readable, without removing or disconnecting the panel. Each controller input and output circuit shall terminate on the main TF panel or on a supplementary panel. The phase arrangement of the controller shall coincide with the channel arrangement of the load switches and MMU. All outputs on channels 9 through 12 field connections shall have a 1μF capacitor placed at each output terminal on the front of the TF panel. All TFs within the cabinet shall be readily accessible for field connection without removing the controller or associated equipment and for maintenance in the cabinet. All stranded wiring shall be tinned. A 24 volt relay shall be used on the TF to remove 24V DC from the common side of the load switches, effectively taking the mercury relay out of the circuit when the signal is put in mechanical flash. The TF panel shall be hinged at the bottom and capable of swinging down, to allow accessibility of the wiring and terminals at the rear of the panel. The backpanel shall be attached to the cabinet such that access to the backside of the backpanel, for maintenance purposes, shall be accomplished without the use of special tools or removal of auxiliary panels, shelving, or other cabinet appurtenances. A bracket extending at least half the length of the NEMA load switch shall support all load switches.

Terminals shall be consecutively numbered on both sides of the TF panel and shall be in compliance with the appropriate schematic diagrams. All positions for load switches, flasher, and mechanical relays shall have reference designators on both sides of the TF panel. All nomenclature shall be on or adjacent to the component or terminal.

All nomenclature shall be machine produced and not handwritten. Cabinet prints shall identify the function of each terminal position.

CU and MMU harness cables shall be of sufficient length to allow units to be placed on either shelf or on top of the cabinet while remaining in operational mode. RS485 port 1 communications cable shall also be of sufficient length to allow any port 1 cable to be utilized with any TS2 unit within the CA. The RS485 harness shall be constructed of a high quality shielded communications cable. The TF panel shall contain a resistor/capacitor network circuit which will provide an external restart pulse to initiate the startup sequence upon initialization from flash.

Remote flashing shall be provided for all signal circuits. Unless otherwise indicated on the plans, phases 2 and 6 shall be wired to flash yellow. All other phases shall be wired to flash red. Flashing for signal circuits shall be activated on 1 circuit for odd numbered phases and on the other circuit for even numbered phases.

b. Power Panel Requirements

A transparent plexiglass cover shall be provided over the CA power supply panel. The cover shall leave the switches on the breakers exposed as well as leave access to terminals at the bottom of the panel for wiring purposes. No terminals on the power panel shall have silicon protectant on them in lieu of the plexiglass cover. The panel shall contain a multi-breaker with one 10 A circuit breaker to provide overload protection to the CU, MMU, BIU, +12/24V DC cabinet power supply, and detection devices. It shall also contain 1 main circuit breaker of 35 or 40 A, to provide over-load protection to the signal and flash buss load. All breakers shall have line and load terminals clearly labeled. The signal bus shall be connected to the incoming AC line through a mercury contact switch or a solid state control device functionally equivalent to the NEMA 5.4.2.3 specified contact switch. The terminals for AC + and − input to the cabinet shall be capable of accepting a No. 6 wire.

With the CA 10 A and main 35 or 40 A circuit breakers 'Off' (tripped), all units inside the cabinet and the intersection display shall be 'Off'. With the 10 A breaker 'On' and main 35 or 40 A circuit breaker 'Off', the signal output shall be 'Off' and the major units within the cabinet shall function. With the 10 A breaker 'Off' and main 35 or 40 A circuit breaker 'On', the intersection shall be in flash mode and all units within the cabinet will be 'Off'.

The cabinet shall contain a 50 kA 8 x 20 µs surge suppressor. The surge suppressor shall be a 120V AC, 15 A, minimum 2-stage parallel/series type device and protect lines: line-neutral, line-ground and neutral-ground, have a maximum continuous operating voltage of 140V AC, maximum clamp voltage of 350 volts and device status indicators of green/good and red/failed. The device shall plug into a NEMA 12 position terminal base wired before and in parallel with the 35 or 40 A main signal buss circuit breaker and in series with the 10 A circuit breaker for the solid state equipment and

provide for a tool-free replacement of the device. There shall be a minimum of 2 electrical receptacles on the equipment side of the device for future auxiliary equipment. The surge suppressor shall operate between -30 to 165°F. The dimensions of the unit shall not exceed 4 1/2 in. wide by 7 in. long by 3 1/2 in. deep.

All equipment capable of operating at 12 or 24V DC typically powered by an individual receptacle type power supply shall have a power cable permanently wired into the cabinet and the device shall be powered by the cabinet TS2 power supply.

4. MMU Requirements

The cabinet shall contain a MMU and shall be in accordance with the standards of NEMA TS2- 4. The MMU shall be wired to monitor each load switch output.

5. BIU Requirements

All BIU's shall be in accordance with NEMA TS2 ~~1998~~ 2008, Section 8. Edge mounted printed circuit boards and rack cards shall not have jumper wire modifications unless the jumper wires are permanently bonded to the PCB over its entire length. BIU's shall be supplied with each cabinet to allow for maximum phase and function utilization for which the cabinet is designed.

6. Loop Amplifier Units and Rack Requirements

a. General

All loop amplifier units shall be in accordance with NEMA TS2-6 and shall follow type C, 2 channel with delay and extend, as stated in NEMA TS2-6.5.2.2.1. All amplifiers shall be selected from the Department's List of Approved or Prequalified materials for each type of amplifier. In addition, loop amplifiers shall have an LCD display or a RS232 serial data connection and software interface capable of displaying loop status including but not limited to operating frequency and -ΔL/L, diagnostics, and all amplifier settings and operating parameters. Edge mounted printed circuit boards and rack cards shall not have jumper wire modifications unless the jumper wires are permanently bonded to the PCB over its entire length.

All detection components including amplifiers, racks, auxiliary BIU, interface panels, lead-ins, and all connecting harnesses shall provide 1 count output channel per lane of each approach within project limits.

All loop amplifiers designated for counting shall meet all requirements as above and shall additionally transmit channel 1 and 2 count pulses on the edge connection assigned to channels 3 and 4 respectively. Counting amplifiers shall be configured with count outputs mapped to and recorded in the CU detector logs. The status output of each active counting channel (3 and/or 4) shall be set to logic ground by software configuration within the amplifier or externally by use of jumper card in the adjacent slot.

An auxiliary BIU panel may be used strictly for count outputs (channels 3 and/or 4 only); in this configuration, the status outputs for those count output channels may be wired to logic ground on the BIU panel. The status outputs for all standard output channels shall provide accurate status data at all times. All detector input data to the CU shall remain accurate at all times.

All ~~size 5~~ ~~(M)~~ and ~~size 6~~ ~~(P-1)~~ cabinets shall incorporate a 16 channel detector rack, configuration No. 2, as per NEMA TS2-5.3.4 and shall allow operation of a 2 channel detector in each slot and the capability of operation of a 2 channel counting amplifier in each even-numbered slot with the respective count outputs in each odd numbered slot. The number of detector racks provided shall be determined by the loop tagging table. All ~~size 3~~ ~~(G)~~ cabinets shall incorporate an 8 channel detector rack, configuration No. 1, as per NEMA TS2-5.3.4.

All detector loop panels and detector racks shall be labeled according to the loop tagging table and as follows.

All detection shall be labeled in such a way that the numbering for any loop is consistent throughout the cabinet; the loop terminated as Loop or Detector 17 shall be Detector Channel 17 in the detector rack and Detector Input 17 to the controller.

b. Loop Termination Panel

Each loop lead-in panel shall be labeled on the upper left corner with the loop numbers that are terminated on that panel as follows: (1-16), (17-32), (33-48), (49-64). Each loop termination point shall be labeled with the corresponding loop number. Example: For panel 17-32: loops terminated on this panel will start with 17 and end with 32.

c. Detector Rack

Each detector rack shall be labeled at the bottom of the rack with a continuous label. The label shall be 1 in. wide, thermal printed black on clear, white or matte polyester tape with permanent adhesive, water, chemical and scratch resistant printed with 4 lines of Arial, size 10 font. Below the BIU shall be the BIU number and detector channel numbers that are contained within the rack as follows: (1-16), (17-32), (33-48), (49-64). This area shall also contain the intersection for diamond interchanges controlled from 1 cabinet. Each slot shall be labeled below the module with the corresponding loop tag information; the count output number portion of the information shall be under the first part of the tag information. For each 2-channel module, channel 2's label shall be below channel 1's label.

7. Cabinet Power Supply Requirements

The TS2 cabinet power supply shall adhere to the guidelines of NEMA TS2-5.3.5. The power supply shall be encased on all sides so that no circuitry is exposed to the user.

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~~8. Cellular Modems~~ *(Note: deleted below sections moved to proposed new RSP 922-T-XXX Ancillary Traffic Signal Equipment)*

~~a. Service Provider~~

~~All data, power and antenna cables and all supplemental hardware shall be provided. The modem shall be compatible with the Department's current cellular carrier/provider (Verizon as of 07/07) and the traffic control device and closed loop communications software that it is supplied for.~~

~~b. Modem Hardware~~

~~Cell modems shall be Airlink Raven CDMA C3211 or similar modem with the following specifications: The cellular modem shall be capable operating in CDMA dual mode (both 800 MHz cellular and 1.9 GHz PCS bands), supporting both circuit switched and 1XRTT packet switched services. The operating voltage range shall include 12V and 24V DC and shall draw less than 250 mA while transmitting and receiving at 12V DC. The modem shall have LED indications for power, signal status/strength, and TX/ RX either separately or combined. The serial interface shall be RS232 with a DB9 (male or female) connector.~~

~~c. Modem Antenna~~

~~The RF antenna connection shall be a 50 Ω TNC connector. The antenna shall be a low profile, puck style, flat mount dual band, (800 and 1900 MHz) with low loss RG58 cable and TNC connector.~~

~~d. Modem Software~~

~~The modem configuration shall be editable and viewable with MS-Windows provided software or with proprietary software that is included and designed to run on a MS-Windows operating system. The software shall auto-detect connection parameters and display settings when connected.~~

~~e. Installation~~

~~Service and activation shall be requested and/or confirmed for each cellular device to be installed prior to installation. The ESN and 10-digit phone number shall be clearly labeled on the exterior of the modem. The cellular modem shall be installed, configured and tested to allow data communication from the central closed loop software to the field master and subsequent secondary controllers, or directly to a secondary controller per the design. All data, power and antenna cables and all supplemental mounting hardware shall be installed. The modem shall be powered by the cabinet power supply from a terminal location on the cabinet back panel or the power distribution panel. A low profile antenna shall be mounted externally and the mounting location includes a watertight seal. The antenna shall have no more than 3 ft excess RG58 cable in the cabinet.~~

~~9. Radio Interconnect Using Spread Spectrum Radio Modems~~

~~Spread spectrum radio modems for communications between local controllers and the system master controller shall be on the Department's list of approved Traffic Signal and ITS Control Equipment and shall be in accordance with ASTM E 2158, and as set out herein.~~

~~The spread spectrum radio modems shall provide all the needed features to communicate with NEMA TS2 type 1 and type 2 traffic signal controllers in a coordinated closed loop system. The radio modems shall be software configurable to be either a master, repeater, repeater/slave, or slave radio. The radio modem shall require no user license from the FCC; operate in the 900 MHz range, and be of frequency hopping spread spectrum, FHSS, technology; support data rates from 1.2 kbps to 115.2 kbps asynchronous; have a receiver sensitivity of at least -110 dBm; have a minimum RF output level of 1 watt; have a minimum of 50 user-selectable hopping patterns and a minimum of 50 RF non-overlapping channels allowing multiple systems to operate in the same line-of-sight path; operate as a transparent RS232, or RS422/RS485, or FSK 1200 baud types of links for use in a point-to-multipoint system; have an external SMA female type or N-female RP-TNC female antenna connector; and be supplied with power supply for 120V AC operation. The modems shall be rack or shelf mounted in standard NEMA TS2 type 1 or type 2 cabinets. The modems shall have an operation temperature of -40 to 176°F, have a maximum current draw of 500 mA for the transmission of 1 watt of RF output power, while operating on 12V DC. Lighting and transient protection on all data lines and antenna connector, and AC/DC power distribution, shall be provided with the system.~~

~~The spread spectrum radio modems must include a Windows based, configuration software package, which will include a graphical user interface, GUI, allowing for ease of programming, through pre-written drivers for all Department approved traffic controllers and have the ability to automatically determine, and connect, at their radios baud, stop and parity settings. The configuration software must allow for signal level, RSSI, data integrity, message polling, and spectral analysis testing. The software must also permit all the radios within a system to be configured from a single location. All radio equipment and cables shall be delivered preconfigured and ready for field operation.~~

~~The manufacturer, or vendor, shall supply with each modem, the operational manual containing procedures for all features incorporated in the modem.~~

~~a. Transient Protection~~

~~Transient protection shall be installed between the radio modem and the field antenna. The transient protection shall be flange mounted in the cabinet and have a minimum transient current of 40 kA for 8 x 20 µs pulse, an insertion loss or < 0.1 dB, have an operating frequency in the 900 MHz range, allow throughput energy to be < 220~~

~~*µJ for 6 kV /3 kA @ 8/20 µs waveform, have throughput voltage≤ 144 Vpk, and turn –on voltage shall be ± 600 volts. The unit impedance shall be 50 Ω.*~~

~~***b. Antennas***~~

~~*The antenna for the radio modem at the system master/local controllers shall be capable of providing a transmission range adequate for communication with all radio modems or repeaters in the system and must be configured as a single omni, single yagi, or dual yagi (2 single yagi antennas on differing alignments) for each radio as described below.*~~

~~***(1) Omni Antennas***~~

~~*All omni antennas shall be capable of producing between 6 dBd and 10 dBd (8.15 dBi and 12.15 dBi) of gain while operating in, and covering the entire 902-930 MHz frequency range. The voltage standing wave ratio, VSWR, of the omni antenna shall be 1.5:1 or less when the antenna coax feed impedance is 50 Ω. Omni antennas shall be fabricated of fiberglass, brass, copper, and/or aluminum and shall be rated for wind velocities of at least 100 mph. The minimum length of the omni antenna shall be 60 in. and it shall be designed and fabricated with a fiberglass radome with a minimum diameter of 2 in. to prevent ice from collecting directly on the driven element. All omni antennas shall have a cableless N-female connector directly affixed and sealed to the antenna body. All hardware and fastenings devices shall be fabricated from stainless steel.*~~

~~***(2) Yagi / Dual-Yagi Antennas***~~

~~*All yagi antennas shall be capable of producing between 10 dBd and 13 dBd (12.15 dBi and 15.15 dBi) of gain while operating in, and covering the entire 902-930 MHz frequency range. The voltage standing wave ratio,VSWR, of the omni antenna shall be 1.5:1 or less when the antenna coax feed impedance is 50 Ω. The front to back ratio must be at least 20 dB for each yagi antenna. Yagi-directional antennas shall be fabricated of either anodized or powder coated 6061/T6 aluminum rod and seamless drawn pipe and shall be rated for wind velocities of at least 100 mph. All yagi antennas shall have a cableless N female connector directly affixed and sealed to the antenna body. The yagi antenna shall be designed and fabricated so that polarization changes (vertical to horizontal) can be made on the antenna mount without adjusting the mast. Single yagis shall be connected by a low loss N-female "T" splitter/coupler and LMR-400 cable to form dual-yagi systems. All hardware and fastenings devices shall be fabricated from stainless steel.*~~

~~***c. Antennas Cable and Hardware***~~

~~*The coaxial cable used as the transient protection to antenna lead shall have no greater than 3.8 dB loss per 100 ft of length and shall be LMR-400.*~~

~~*All LMR-400 connections are to be stripped, deburred, and crimped using the ST-400-EZ LMR-400 stripping tool, DBT-01 LMR-400 deburring tool, and a 0.429 in. hex*~~

~~*crimp die for solderless LMR-400 connections respectively. All connections shall be completely sealed by heat shrinking double walled, adhesive lined shrink tubing for weather proofing and strain relief.*~~

~~*Cables shall be included to interface the radio equipment to the transient protection. The antenna mounting hardware shall securely attach the antenna to the strain pole/cantilever arm. The coaxial cable fitting on the antenna shall not support the weight of the coaxial cable run to the base of the strain pole/cantilever arm.*~~

~~***d. Data Cables***~~

~~*Cables shall be included to interface the radio equipment to the system master, co-located secondary controller, remote secondary controllers and any communication interface panels as needed. Cables shall include strain relief back shells designed to mate and lock with the telemetry connector on the system master and local controllers. All radio equipment and cables shall be delivered preconfigured and ready for field operation.*~~

~~*All miscellaneous equipment necessary to complete the installation shall be as specified by the radio modem manufacturer.*~~

(g) Cabinets

1. ~~Size 3 (G)~~ Cabinet ~~(Size 3)~~

The ~~size 3 (G)~~ G cabinet shall be pedestal-mounted or pole-mounted. As per NEMA TS2-5.3, the TS2 type 1 G cabinet, at minimum, shall house an 8-load switch bay (configuration 2) terminal and facilities panel and shall have 1 adjustable shelf located 12 in. below the top of the cabinet. The bottom of the cabinet shall be reinforced to ensure a secure pedestal mounting. The G cabinet shall have dimensions of 25 in. wide, 38 in. high, 18 in. deep with a tolerance of + 4 in. in any or all dimensions.

A cabinet slipfitter shall be used to attach the cabinet to the pedestal. The slipfitter shall fit a 4 1/2 in. outside diameter pipe and shall have a minimum of 3 set screws equally spaced around the slipfitter.

A vent of adequate size shall be provided. The size of the vent and the filter requirements shall be in accordance with the manufacturer's recommendations.

2. ~~Size 5 (M)~~ M Cabinet ~~(Size 5)~~

As per NEMA TS2-5.3, the TS2 type1 ~~(M)~~ cabinet, as a minimum, shall house at minimum an 8-load switch bay (configuration 2) terminal and facilities panel and shall have 2 adjustable shelves with the first shelf located 15 in. below the top of the cabinet and the second located 7 in. below the first shelf.

The M cabinet shall be ground-mounted on a concrete foundation at locations and dimensions as shown on the plans.

The M cabinet shall have dimensions of 30 in. wide, 48 in. high, and 16 in. deep with a tolerance of ± 2 in. in any or all dimensions.

Anchor bolts shall be steel in accordance with ASTM A 36. Diameter of the bolt shall be 1/2 in. or 5/8 in. and the minimum length shall be 15 in. plus 3 in. right angle hook on the unthreaded end.

The top 6 in. of the bolt shall be threaded with 13 NC threads on 1/2 in. bolts and 11 NC threads on 5/8 in. bolts. The hexagon nut, the flat washer, and the threaded end of the bolt shall be 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.

The cabinet shall include 1 loop detector rack.

3. ~~Size 6 (P-1)~~ P-1 Cabinet (Size 6)

The ~~size 6 (P-1)~~ P-1 cabinet shall be ground mounted on a concrete foundation at locations and dimensions as shown on the plans with anchor bolts in accordance with 922.02(g)2. As per NEMA TS2-5.3, the TS2 type 1 P-1 cabinet, at minimum, shall house a 16-load switch bay (configuration 3) terminal and facilities panel and shall have 2 adjustable shelves with the first shelf located 20 in. below the top of the cabinet and the second located 7 in. below the first shelf a minimum of 30 in. above the bottom of the cabinet, the second located 12 in. above the first shelf.

The cabinet shall be 44 in. wide, 52 in. high, and 24 in. deep with a tolerance of ± 3 in. in any or all dimensions. Maximum exterior dimensions shall be 47 in. wide, 63 in. high, and 34 in. deep.

The cabinet shall include 2 loop detector racks.

4. ~~Size 7 (R)~~ R Cabinet (Size 7)

The ~~size 7 (R)~~ R cabinet shall be ground mounted on a concrete foundation at locations and dimensions as shown on the plans with anchor bolts in accordance with 922.02(g)2. As per NEMA TS2-5.3, the TS2 type 1 R cabinet, at minimum, shall house a 16-load switch bay (configuration 3) terminal and facilities panel and shall have 3 adjustable shelves with the first shelf located a minimum of 30 in. above the bottom of the cabinet, the second located 12 in. above the first shelf and the third located 8 in. above the second shelf. All shelves shall be adjusted so that the second shelf is located 63 in. ±3 in. above the top of the concrete footpad.

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The cabinet shall be 44 in. wide, 72 in. high, and 24 in. deep with a tolerance of ± 3 in. in any or all dimensions. Maximum exterior dimensions shall be 47 in. wide, 83 in. high, and 34 in. deep.

The cabinet shall include 3 loop detector racks.

5. Flasher - Two Circuit Alternating Flasher

Two circuit alternating flasher shall be solid state.

a. General

The solid state flasher shall periodically interrupt a source of alternating current line power. Solid state shall mean electrical circuits, the active components of which are semi-conductors, to the exclusion of electromechanical devices or tubes.

The flasher shall be a type 3 solid state flasher conforming to NEMA TS1-1989 ~~Section 8 of the NEMA Standards Publication TS1-1983~~. 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 3 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 95V and 135V AC 60 Hz. No degradation of performance shall be experienced in environmental changes from -20 to 165°F and 0 to 90% relative humidity.

b. Cabinet Requirements

The cabinet shall be weatherproof and fabricated from cast aluminum or aluminum sheeting with a minimum thickness of 1/8 in. The cabinet door shall be the entire front of the cabinet and shall be hinged on the right or left side of the cabinet. A Corbin No. 2 lock and 2 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. deep, 12 in. wide, and 12 in. high. The maximum dimensions shall be 18 in. deep, 15 in. wide, and 18 in. high.

The cabinet shall have 2 pole plates for stainless steel band mounting of the cabinet on a pole with a minimum diameter of 4 in. and a maximum diameter of 18 in. Two blank cover plates shall be provided. Two hub plates for 1 in. diameter conduit shall

be provided with gaskets, 8 bolts at 4 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 sq in., and a minimum of 1 louvered and screened vent towards the top of the cabinet.

The panel in the cabinet shall be capable of being removed and reinstalled with simple hand tools. A 25 ampere radio interference filter and surge arrestor wired ahead of a 15 ampere circuit breaker shall be mounted on the panel. A terminal block capable of the following electrical connections shall be mounted on the panel.

Circuit 1 - for connection of field signals (flash circuit 1)
Circuit 2 - for connection of field signals (flash circuit 2)
Circuit 3 - for connection of field signals (field neutral)
AC plus - capable of accepting a No. 6 wire
AC minus - capable of accepting a No. 6 wire
Ground lug - capable of accepting a No. 6 wire

922.03 Signal Head Components

The components shall be in accordance with the Institute of Transportation Engineers for Adjustable Face Vehicular Traffic Control Signal Heads. All new traffic signal and flasher installations that include new indications shall be fitted with LED modules. All LED indications shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.

(a) General

The signal faces shall be sectional in construction, requiring 1 section for each lens and furnished in the nominal size of 12 in.. Each section of a face shall have a rectangular silhouette when viewed from the front or the rear.

(b) Housing, Door, and Visor

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° increments. Hub openings in the top and bottom of the signal housing shall accommodate standard 1 1/2 in. bracket arms. The thickness of the hub at the top and bottom of the housing shall be a maximum of 1 in. and a minimum of 3/8 in.. The 12 in. door shall have 2 simple locking devices. The door on the hinged side shall be attached with hinge pins. Each lens shall have the standard cap type visor. All screws, latching bolts, locking devices, and hinge pins shall be stainless steel.

(c) ~~LED Traffic Signal Indicator~~ Signal Indications

1. LED Signal Indications

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All LED indications shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.

All LED indications shall have a permanent indelible sticker affixed to the back of the module indicating month and year of initial installation.

All LED indications provided shall be individually listed on a parts list indicating the contract number, vendor, category, manufacturer, model, serial number, and inventory number. Hard copy and electronic copies shall be provided. The electronic document shall be MS Excel (.xls) format and the blank worksheet shall be obtained from the Department's Logistical Support Center.

2. Incandescent Signal Indications

All new traffic signal and flasher installations that include new indications shall be fitted with LEDs in accordance with 922.03. The minimum design requirements for replacement light bulbs to be used in a traffic signal face shall be in accordance with the Institute of Transportation Engineers standard for traffic signal bulbs.

(d) Wiring

The field wiring leads shall be terminated with screw spade lug type connectors. The LED module wiring leads shall be terminated with 1/4 in. female type connectors for ease of connection to the terminal block.

(e) Section Coupling

Any method to connect 2 or more sections together may be used, if the following requirements are met:

1. *Two or more sections, when jointed together, shall maintain structural integrity when loaded in accordance with Institute of Transportation Engineers Standards.*

2. *The opening between joined sections shall accommodate two 1/2 in. cables.*

3. *The maximum length of bolts used to connect sections together shall be 4 in.*

Nuts, bolts, and 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.

(f) Terminal Block

The ~~yellow~~black section of the 3-section or 2-section signal head and each 1-section signal head shall be equipped with a 5-position terminal block for termination of

field wiring. Each section shall have provisions for two 5-position terminal blocks. Each terminal screw shall have a 1/4 in. corresponding spade tab. The terminal block shall have a minimum spacing between screw connections of 1/2 in.. The height of the insulating ridge between screw connections shall be a minimum of 19/32 in. from the base of the terminal blocks.

(g) Material Requirements

1. Polycarbonate Signal Head

The housing, door, and visor of the section shall be made of ultraviolet and heat stabilized polycarbonate. The 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~~ black in accordance with 909.02(b).

2. 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~~black enamel, 2 coats, oven baked and in accordance with 909.02(b) ~~except the inside surface of the visor shall be painted nonreflecting flat black~~.

(h) Signal Backplates

The traffic signal backplate shall be made of sheet aluminum. The sheet aluminum shall have a nominal thickness of 0.063 in. and shall be according to ASTM B 209, Alloy 5052. The backplates shall be composed of one piece. The backplate shall be designed to be attached to a signal face without interfering with the opening and closing of the traffic signal door. It shall be rectangular in shape with round corners and shall be of such dimensions as to give an exposed margin of 5 in. on each side.

The surface of the backplate shall be louvered to allow wind to penetrate and reduce wind loading. The louvers shall cover a minimum of 20 percent of the surface area of the backplate.

The reflective backplate shall have a 2 in. wide yellow retroreflective strip applied to the outside perimeter of the backplate. When retroreflective sheeting is specified, the sheeting shall be Type IV sheeting in accordance with 919.01(b) and applied in the orientation for the maximum angularity according to the manufacturer's recommendations.

The aluminum backplates 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 nonreflecting flat black.

~~(h~~i) Certification

A material certification shall accompany each order certifying that a signal head from a normal production run within the past 12 months, passed the Institute of Transportation Engineers criteria for breaking strength and deflection. Deflection testing is not required in the certification for polycarbonate signal heads.

922.04 Pedestrian Signal ~~Head~~ Components

(a) Pedestrian Signal Head

A pedestrian signal shall be 1 section and rectangular in shape. The dimensions of each side may vary from 18 to 19 in., including the visor and the hinges. The signal shall contain 2 figures with 2 different colored messages. The first figure shall transmit an upraised hand symbol message, and the second figure shall transmit a walking person symbol message. All new installations including new pedestrian indications shall use Light Emitting Diodes with countdown displays. All pedestrian LED indications shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment. The pedestrian signal shall be in accordance with the standard of the Institute of Transportation Engineers for Pedestrian Traffic Control Signal Indications.

~~(a)~~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. pipe. The openings shall have a common vertical centerline through the housing to permit 360° rotation after it is mounted. The openings shall have a serrated ring which permits locking of the housing in 5° increments throughout the entire 360° 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.

Each signal shall be provided with a visor.

~~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(c).

~~(b)~~2. Message

The upraised hand and walking person symbols shall each be a minimum of 11 in. in height. The width of the upraised hand symbol shall be a minimum of 7 in.. The width of the walking person symbol shall be a minimum of 6 in.. Message configuration, color, and size shall be in accordance with the standard of the Institute of Traffic Engineers for Pedestrian Traffic Control Signal Indications.

Each pedestrian signal shall be completely wired internally, and ready for connection of the field wiring. A suitable terminal block for connection of the internal wiring and the incoming field wires to the pedestrian signal head shall be provided in the signal housing.

The light source shall be designed and constructed so that if an electrical or mechanical failure occurs, the upraised hand and walking person symbols shall also remain dark.

(b) Pedestrian Push-Button

Pedestrian push-button assemblies shall be ADA compliant, vandal and weather resistant, be pressure activated with minimal movement, and cannot be stuck in a closed or constant call position. A red latching LED and audible tone shall be provided for confirmation of an actuation call.

1. Housing

The pedestrian push-button housing shall be constructed of aluminum alloy according to ASTM B 308 6061-T6 and powder coated yellow, and furnished with suitable mounting hardware.

2. Latching LED

The normal state of the LED shall be off. When the push button is pressure activated, the LED shall be lighted and remain on until the beginning of the walk phase. The latching relay shall be mounted in the signal cabinet, controlling two pedestrian phases.

3. Actuator

The actuator shall be stainless steel with a solid state electronic Piezo switch rated for a minimum of 20 million cycles with no moving plunger or moving electrical contacts. The operating voltage shall be 12-24 VAC/DC. The actuator's nominal operating force shall be approximately 1 lb (4.45 N).

4. Sign

The pedestrian information sign shall be according to the MUTCD. The legend on the sign shall either be all words or a combination of words and symbol to match the pedestrian signal. The sign base shall be sheet aluminum in accordance with 919.01(b).

922.05 ~~Signal Bulbs~~Blank

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 922 – TRAFFIC SIGNAL MATERIALS (changes shown as to existing RSP 922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT)

All new traffic signal and flasher installations that include new indications shall be fitted with LEDs in accordance with 922.03. The minimum design requirements for replacement 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:

(a) Incandescent Bulbs

1. Bulbs shall be 67 watt, 116 watt, or 150 watt for different kinds of indications, as specified below.

INDICATION	*WATTAGE*
9 in. pedestrian	*67*
12 in. pedestrian	*116*
18 in. pedestrian	*116*
12 in. red	*150*
12 in. yellow and green	*116*
12 in. yellow and green arrows	*150*
Optically programmed heads	*150*

All bulbs shall have medium size, brass bases.

2. Bulbs shall be designed for use in a horizontal position or a base-down position.

3. The light center length shall be 2 7/16 in. for 67 watt bulbs and 3 in. for 116 watt and 150 watt bulbs.

4. The filament shall be C9 design with a minimum of 7 supports. The 2 voltage supply leads may be counted as 2 of the 7 supports.

5. The maximum, overall bulb length for 67 watt and 116 watt bulbs shall be 4 3/8 in. and for 150 watt bulbs shall be 4 3/4 in..

6. All bulbs shall be clear and shall be 130 volt.

7. The 150 watt bulb shall be P25 or A21 size and shape.

8. The 67 watt and 116 watt bulbs shall be A21 size and shape.

9. All bulbs shall have 6,000 h minimum burning life.

~~***(b) Blank***~~

922.06 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 pins or hex head bolts and nuts with lock washers, shall be 0.062 in.. The span hanger bolt where the eye-bolt or the balance adjuster is attached shall be 5/8 in. diameter.

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 5° increments.

There shall be no thread in contact with a wearing surface. Locking rings shall have a minimum thickness of 3/16 in. and a maximum thickness of 1/4 in. from the base of the ring to the serration peaks. The inside diameter shall be 2 in. and the outside diameter shall be 2 7/8 in..

The terminal block shall have an 18-point terminal block permanently engraved or etched with sequential numbers indicating the circuits. The terminal block shall not have a method of connection which allows a screw point to damage wires when the wires are securely connected. Each point of connection shall accommodate a minimum of four No. 14 gauge wires.

The disconnect hanger shall have 2 side entrance holes on opposite sides capable of receiving a 1 1/2 in. plastic or rubber insert to reduce water infiltration. It shall be capable of supporting signal faces in the ambient temperature range of -35 to 120°F ~~(-37 to 49° C)~~ without failure.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 922 – TRAFFIC SIGNAL MATERIALS (changes shown as to existing RSP 922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT)

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 2 J-bolts, lock washers, and hex head nuts adequate in size to securely fasten the hanger to a messenger cable up to 1/2 in. in diameter.

A type C certification in accordance with 916 shall be provided.

922.07 Free Swinging Signal Support Assemblies

(a) Clearance

The maximum allowable space or play between the hanger assembly and the eyebolt of the balance adjuster and between the balance adjuster and the weatherhead clevis, at points where they are attached to each other by rivet pins or hex head bolts and nuts with lock washers, shall be 0.062 in.. No bushings or shims will be allowed in this assembly.

(b) Balance Adjuster

The balance adjuster shall consist of a hex head bolt, a lock washer, and nuts for securing the main body of the balance adjuster onto and around the threads of the eye-bolt to prevent any twisting or turning of the adjuster.

(c) Span Hanger

The span hanger, balance adjuster, weatherhead, and all related hardware shall be made of a non-corrosive metal or shall be 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. of exposed threads. The weatherhead shall have 2 set screws to fasten the nipple to the weatherhead. If the weatherhead and threaded pipe has a slip-in connection, the locking device shall be a double nut assembly. If the weatherhead and threaded pipe has a screw-in connection, the locking device shall be a double set screw assembly.

The span hanger shall be furnished with 2 each of J-bolts, lock washers, and hex head nuts. The J-bolt shall be a minimum of 1/4 in. diameter and shall have sufficient threads to be able to secure the hanger to a 1/4 in. or to a 1/2 in. span cable.

(d) Tether Bracket

The tether bracket shall attach to a 1/8 in. to 1/4 in. messenger cable and prevent the bottom of the head from moving side-to-side on the cable. Where backplates are installed on the signal heads; the tether bracket shall be of the proper length for the backplate so that the cable is mounted below the bottom of the backplate to avoid interference with head alignment and damage to the backplate.

(e) Pipe Arm Assemblies

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 922 – TRAFFIC SIGNAL MATERIALS (changes shown as to existing RSP 922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT)

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. 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. 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. outside diameter and one locking ring shall have a 2 3/8 in. outside diameter.

ASSEMBLY MAXIMUM	*ALLOWABLE WEIGHT*
2 Way	*19 lbs*
3 Way	*25 lbs*
4 Way	*28 lbs*

922.08 Signal Cantilever Mount Signal Bracket

The bracket shall permit the following 4 adjustments:

(a) rotational adjustment about bracket axis;

(b) vertical adjustment;

(c) rotational adjustment about signal cantilever arm; and

(d) rotational adjustment right and left from vertical plane

The bracket shall be fastened to the supporting arm or structure with stainless steel bands. The bracket shall adjust to fit all sizes of round, octagonal, elliptical, or other shape structure without special tools or equipment.

The bracket shall attach to the signal by clamping the signal head both top and bottom and shall be designed to accommodate the specified signal configuration. Each bracket shall be complete with all necessary hardware to attach the traffic signal to the bracket and the bracket to the support.

All electrical wiring shall be concealed within the bracket, except that which runs from the bracket to the signal cantilever arm.

Upper and lower arms shall be cast from aluminum in accordance with ASTM B 26, alloy 713.0-T5 or 356.0-T6. The vertical support tube shall be extruded from aluminum in accordance with to ASTM B 241, 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, class C.

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 922 – TRAFFIC SIGNAL MATERIALS (changes shown as to existing RSP 922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT)

922.09 Pedestal Poles and Cast Aluminum Pedestal Bases

The pedestal base used for mounting pedestrian signal heads or control cabinets shall be in accordance with 922.09(a). The length of the pedestal pole shall be as shown in the plans.

(a) Cast Aluminum Pedestal Base

A pedestal mounted G cabinet shall have a cast aluminum pedestal base. The cabinet and pedestal base shall be ground mounted on a concrete type A foundation at locations and dimensions as shown on the plans.

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, alloy ANSI 356.0 - T6. The square base shall include an access door and anchor bolts with nuts and washers. The base shall be 13 3/8 in. square and 15 in. in height ± 1/4 in.. The weight shall be 22 lbs ± 5%.

The base shall be designed to support a 150 lbs axial load and 11 sq ft of signal head area rigidly mounted. For design purposes, the distance from the bottom of the base to the center of the signal head area is 18 ft. In addition to the dead load, the base shall be designed to withstand wind and ice loads on the specified signal head area and on all surfaces of the support, in accordance with the AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals. Wind speeds used for design shall be based on a 10 year mean recurrence interval and a wind drag coefficient of 1.2 or as shown in the plans. The base shall contain an access door, which is 8 by 8 1/4 in. ± 1/4 in. with a stainless steel hex head bolt for attaching the door.

The base shall be attached to a foundation by 4 anchor bolts, with an anchor bolt circle of 12 3/4 in.. Slotted lugs shall be integrally cast into the 4 corners of the base for attachment of the anchor bolts. The anchor bolts shall be steel in accordance to ASTM A 36. The diameter of the anchor bolt shall be 3/4 in. with a minimum length of 18 in. ± ½ in., plus 2 1/2 to 3 in. right angle hook on the unthreaded end. The top 4 in. of the bolt shall be threaded with 10 NC threads. The threads, plus 3 in., shall be 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 2 hex head nuts in accordance with ASTM A 325 and 3 washers. Two of the washers shall have a minimum 2 in. and maximum 2 1/8 in. outside diameter and be in accordance to ANSI B 27, type B regular series and one shall be a nominal 3/4 in. series W washer, in accordance with ASTM F 436.

The cast aluminum pedestal base shall be in accordance with the dimensions and requirements shown in 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. outside diameter. The threads inside the top of the base shall be 4 in. national standard pipe threads. The pole shall be either a steel pedestal pole or an aluminum pedestal pole.

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.. The pole shall weigh approximately 10.8 lbs/ft. The length of the pole shall be as shown on the plans. The pole shall have full depth national standard pipe threads on one end of the pole. The length of threads shall be 2 1/2 in.. The pole shall be galvanized, after threading, in accordance with ASTM 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 for seamless aluminum alloy, schedule 40, 6061-T6. The outside diameter of the pole shall be 4 1/2 in.. The length of the pole shall be as shown on the plans. The pole shall weigh approximately 3.7 lbs/ft. The pole shall have full depth national standard pipe threads on one end of the pole. The length of threads shall be 2 1/2 in. and protected by a suitable shield. The pole shall have a spun finish.

(c) Pole Cap

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. outside diameter pole. A set screw using a 3/4 in. No. 12 hex head machine screw shall be supplied to hold the cap on the pole. A standard foundry draft will be allowed on the casting.

A pole cap made from spun aluminum shall be in accordance with ASTM B 209, alloy 1100-0. The cap shall fit tightly when placed on the end of the pole.

922.10 Signal Supports

All welding shall be in accordance with 711.32. Welds shall generate the full strength of the shaft. Only longitudinal continuous welding will be permitted on the pole

shaft. Contacting joint surfaces shall be cleaned before fabrication then sealed by means of welding. Working drawings shall be submitted in accordance with 105.02.

(a) Steel Strain Pole

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. of the base. The handhole minimum size shall be 5 by 8 in. 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. The pole shall be galvanized after fabrication in accordance with ASTM A 123.

All hardware, handhole cover and latching device, band type steel polebands, 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, class C. 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/sq ft.

The polebands shall fit the pole as planned. The wire rope shall not be in contact with any 90° edges or with any threads on the band. The pole band material shall be in accordance with ASTM A 572, grade 50; ASTM A 606; or ASTM A 36 with minimum yield of 50,000 psi. The minimum width of the bands shall be 3 in. and the bands shall be capable of supporting the pole design load. Each half of the band shall be stamped with the corresponding size number.

The pipe coupling for the weatherhead and base plate shall be installed prior to galvanizing. The threads shall be cleaned of all excess galvanizing. An internal J-hook shall be installed near the top of the pole for wire support.

The steel strain pole shall be capable of supporting a 8,000 lb load applied horizontally 18 in. below the top of the pole with a maximum allowable deflection of 0.16 in. per 100 lb of load. The pole shall be tapered 0.14 in./ft of length.

A one piece base plate shall be secured to the base of the pole and shall develop the full strength of the pole. The base plate material shall be in accordance with ASTM A 36, A 572, or A 588. The base plate shall have 4 holes of adequate size to accommodate 2 1/4 in. anchor bolts. The bolt circle shall have a 22 in. diameter and bolt square of 15 1/2 in..

Four high strength steel anchor bolts, 2 1/4 in. in diameter and 96 in. long, including the hook, shall be furnished with each pole. Each bolt shall have 2 hex nuts and 2 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 with a minimum yield strength of 55,000 psi or ASTM A 36, special quality, modified to 55,000 psi or approved equal. The threaded end of the anchor bolt shall have 12 in. of 4 1/2 NC threads and shall be galvanized the length of the threads, plus 3 in.. The threaded end shall be 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. from the centerline of the anchor bolt to the end of the L. In lieu of the standard bend a steel plate 4 1/2 sq in. and 1 1/4 in. thick may be welded to the embedded end of the anchor bolt.

(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~~, Standard UC4B 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

All traffic signal cantilever structures, with or without combination arm, shall be as shown on the plans.

There shall be no threads in the wearing surface plane at the point of connection between the clevis clamp and the signal face assembly. The clevis clamp shall have an 11/16 in. diameter bolt hole to receive the signal face assembly.

The signal cantilever structure pole, sections 1 and 2, signal arm, and combination arm shall be a round or multi-sided tapered tube, except the upper 4 to 6 ft of a signal pole may be non-tapered. The pole and arms taper rate shall be 0.14 in./ft. ~~The signal cantilever structure poles shall have a reinforced handhole as shown on the plans~~. A 1/2 in. 13 NC threaded grounding nut or approved equivalent shall be provided and be accessible through the handhole. The pole cap shall be secured in place with setscrews. The pole shall be provided with a removable pole cap and integral wire

support hook for the luminaire electrical cable. The cable shall be attached to the hook by a service drop clamp.

The signal cantilever arm and combination arm, if required, shall be attached to the pole as shown on the plans. The arms shall have cable inlets as shown on the plans. All signal heads on the arm shall be attached as shown on the plans and installed parallel to the horizontal plane and centered to the cantilever arm. The cantilever arms shall be used as an enclosed raceway for wiring and shall be free of burs or rough edges.

The pole top luminaire for roadway lighting, if required, shall be installed on these structures as shown on the plans.

2. Base Plate

A one piece anchor base shall be supplied as shown on the plans. Four removable bolt covers shall be provided with each base and each cover shall attach to the upright portion of the body of the base by means of 1 hex head cap screw.

3. Materials

The signal cantilever pole, arms, base plates, arm flange plates, gusset plates, ring stiffeners, and pole splice plates shall be in accordance with ASTM A 595 or A 572 with a minimum yield strength of 50,000 psi.

4. Hardware

Bolts for the pole splice shall be in accordance with ASTM A 490 and shall be galvanized. The contact area for both pole splice plates shall be class B in accordance with AASHTO 10.32.3c with a minimum slip coefficient of 0.5. The surfaces shall be blast cleaned with class B coatings. The arm flange plate connection bolts shall be in accordance with ASTM A 325. All other hardware shall be in accordance with ASTM A 307 and 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. A cast pole cap shall be in accordance with ASTM A 126 and shall be galvanized with a minimum coating of 2 oz/sq ft.

5. Anchor Bolts

Four steel anchor bolts, each fitted with 2 hex nuts and 2 flat washers, shall be furnished with each pole. The anchor bolt shall be as shown on the plans with a minimum of 15 in. of 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 steel for the bolt shall be in accordance with ASTM F 1554, with a yield strength of 36,000 psi or 55,000 psi, or approved equal.

6. Finish

All steel material shall be fully galvanized. Galvanizing shall take place after all welding is accomplished and holes cut.

7. Working Drawings

Working drawings and design calculations shall be submitted in accordance with 105.02.

(d) Downguys, Anchors, Rods, and Guards

Pole anchors shall be 8 way expanding with a minimum area of 135 sq in. when expanded or a 10 in. diameter screw anchor. They shall have a minimum holding strength of 10,000 lb. They shall be painted and in accordance with ASTM A ~~569~~ 575. Anchor rods for expanded anchors shall be 3/4 in. diameter steel and for screw anchors shall be 1 1/4 in. diameter steel, 8 ft long, in accordance with ASTM A 659, 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 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. The nonmetallic guy guard shall be a helical pigtail which shall resist upward movement, a lock strap to secure the lower end, and a guy guard sleeve. Non-metallic guy guards shall be gray or yellow.

(e) Support Cable

1. Messenger Cable

Messenger cable shall be zinc-coated steel wire strand, contain 7 wires, and have a nominal diameter of 3/8 in.. The cable shall be in accordance with ASTM A 475, Siemens-Martin Grade.

2. Span, Catenary, and Downguy Cable

Span, catenary, and downguy cable, shall be aircraft cable for non-aircraft use, and shall be 3/8 in. nominal diameter, made of stainless steel wire, and consist of 7, 19 wire flexible steel strands. The 3/8 in. cable shall have a minimum breaking strength of 12,000 lbs. It shall be in accordance with Military Specifications MIL-W-83420D.

3. Tether and Support Cable

Tether and support cable shall be aircraft cable, for non-aircraft, and shall be 3/16 in. nominal diameter, made of stainless steel wire, and consist of 7, 7-wire flexible steel strands. The 3/16 in. cable shall have a minimum breaking strength of 3,700 lbs. It shall be in accordance with Military Specifications MIL-83420D.

4. Cable Hardware

a. Messenger Hangers

Messenger hangers shall be either a 3-bolt clamp or a 3/8 by 1 3/4 in. steel hanger with a 90° bend extending from the pole 3 3/4 in.. The hanger shall have a curved groove and clamp capable of receiving a 5/16 to 1/2 in. cable.

The messenger shall be clamped by two 1/2 in. high carbon steel bolts. The angle hanger shall be mounted with a 5/8 in. through bolt and a 1/2 in. lag screw. The 3-bolt clamp shall be mounted with a 5/8 in. through bolt. The angle hanger shall be in accordance with ASTM A 575. The bolts shall be in accordance with NEMA PH 23.

b. Cable Ring

Cable rings shall be galvanized steel in accordance with IMSA 51-1.

c. Clamps

Clamps shall be made of 3/8 in. steel and in accordance with ASTM A 575.

Two bolt clamps shall be a minimum of 3 3/4 in. long and 1 1/4 in. wide with two 1/2 in. bolts which shall clamp cable of 1/8 to 1/2 in. diameter.

Three bolt clamps shall be a minimum of 6 in. long and 1 5/8 in. wide with three 5/8 in. bolts which shall clamp cable of 5/16 to 1/2 in. diameter.

The bolt heads shall be large enough to provide maximum clamping area and shall have oval shoulders to prevent the bolts from turning while tightening. The bolts shall be in accordance with NEMA PH 23.

d. Servi-Sleeves

Servi-sleeves shall be 1 1/4 to 2 1/4 in. in length and shall hold the size of the cable specified. The sleeves shall be in accordance with ASTM A 659.

e. Straight Eye-Bolts

Straight eye-bolts shall be 3/4 in. diameter drop forged steel, a minimum of 14 in. long, and have 6 in. of thread. The steel washers shall be 2 1/4 by 2 1/4 by 3/16 in. in size with a 13/16 in. hole in the center. All parts shall be in accordance with ASTM A 575 and shall be galvanized in accordance with ASTM A 123.

f. 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. mounting bolt and have a full rounded thimble eye for protection of the guy cable.

922.11 Signal Cable

(a) Hook-up Wire

Signal hook-up wire shall be stranded 1 conductor wire, type THW 7 strand No. 14 AWG, with a thermoplastic sheath 3/64 in. thick and a 600 volt rating. Insulation shall be color coded, as required, and labeled with gauge, voltage rating, and insulation type.

(b) Signal Control Cable

Signal control cable shall be in accordance with IMSA 19-1 or 20-1 and shall be stranded No. 14 AWG wire.

(c) Service Cable

Traffic signal service cable shall be color coded, stranded copper No. 8 AWG wire, 3 conductor cable, type THWN.

922.12 Signal Interconnect

(a) Integral Messenger Interconnect Cable

Integral aerial interconnect cable shall be figure "8" self-supporting type cable consisting of a messenger cable and 7 conductors No. 14 AWG signal cable in accordance with IMSA 20-3.

(b) 6 Pair/19 Telemetry Cable

6 pair telemetry cable shall contain 6 twisted pairs of 19 gauge conductors and shall be in accordance with IMSA 40-2 for underground application and IMSA 40-4, integral messenger, for aerial application.

(c) Fiber Optic Interconnect Cable

~~*Fiber optic cable shall contain 6 stranded multimode, graded index, optic fibers with a minimum of 1 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 62.5/125 µm 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*~~.

Fiber optic cable shall contain twelve (12) strand multimode, graded index, optic fibers with a minimum of one non-metallic central strength member. The cable shall be gel-free design, loose tube, all dielectric construction, suitable for outdoor use in conduit or on aerial supports. Each length of fiber optic cable in nonmetallic conduit shall include a No. 14 AWG aluminum or No. 6 AWG copper tracer wire.

Each individual fiber shall be 2.5/5 mils (62.5/125 µm) diameter, core/color-coded clad, and each color-coded set of fibers shall be encased in a loose tube buffer with water blocking tape on the outside and fully water blocked inside using craft-friendly, water-swellable yarns. The fiber optic cable shall be constructed with Kevlar braid and outer polyethylene jackets as a minimum. If an inner jacket is used it shall be PVC. Maximum attenuation of the cable shall be 4.0 dB/km nominal, measured at room temperature at 850 nm. The bandwidth shall not be less than 160 MHz/km, also at 850 nm. Each fiber shall be continuous with no factory splices except for joining standard length cables to form longer, continuous jacketed cable to fit installation requirements. The cable shall have standard nylon rip cords. Kevlar rip cords will not be accepted.

The cable shall be in accordance with the generic requirements for optical fiber and optical fiber cable per ANSI/ICEA S-104-696 design and test criteria.

The exterior of the polyethylene outer cable jacket shall be stenciled so that every 16.6 ft (5 m) on each reel is marked with a number. The 16.6 ft (5 m) of each reel shall be marked with a 5, the 32.2 ft (10 m) marked with a 10, and so on until the end of the reel. The stencil shall be applied to the outer jacket using permanent ink and shall be permanently engraved into the jacket to provide long lasting readability.

(d) Radio Interconnect Using Spread Spectrum Radio Modems

Spread spectrum radio modems for communications between local controllers and the system master controller shall be on the Department's list of approved Traffic Signal and ITS Control Equipment.

922.13 Detection Components

(a) Loop Detector Lead-in Cable

Runs 700 ft and less of 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.

Runs greater than 700 ft shall use 14 AWG wire. The nominal capacitance between conductors shall be 57 pF/ft and 98 pF/ft between one conductor and the other conductor connected to the shield.

(b) Roadway Loop Wire

Roadway loop wire shall be 14 AWG gauge IMSA 51-7 duct-loop wire with polyvinyl chloride or polyethylene outer jacket of 1/4 in. diameter.

(c) Other Vehicle Detection Systems

Other vehicle detection systems shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.

~~***(c) Preformed Pave-Over Loops***~~ ***(Note: Below statements moved to proposed new*** *RSP 922-T-XXX* ALTERNATIVE VEHICLE DETECTION METHODS***)***

~~*All components of preformed pave-over loops designed for HMA paved-over application shall have a minimum temperature rating of 300°F. Preformed pave-over loops shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.*~~

~~*The size of a preformed pave-over loop shall be 6 ft diameter, 18.9 ft circumference round or 6 ft octagonal, 20 ft perimeter. The loops placed in the same lane shall be spaced 15 ft from the center of one loop to the center of the next loop.*~~

~~*Preformed pave-over loops may be constructed as a single loop or as 2, 3 or 4 loops in series. Each individual loop shall be wired with 4 turns of wire unless otherwise specified. Loops constructed in a series shall also be wired in series.*~~

~~***(d) Microloop Detectors***~~

~~*Materials for microloop detectors shall be selected from the Department's approved materials list. The microloop detectors selected shall be capable of counting vehicles in addition to detecting vehicle presence.*~~

~~*Each microloop detector location shall include the following items:*~~

~~*1. Non-invasive probe, lead-in cable and carriers for microloop detector as shown on the plans;*~~

~~*2. 3 in. diameter schedule 80 PVC conduit containing the probes, lead-in cable and carriers;*~~

~~*3. Buried service wire encapsulation kit compatible with microloop detector for all splicing between the lead-in cable and the home run cable;*~~

~~*4. Installation kit, one for each conduit containing probes;*~~

~~*5. All mounting hardware, conduit bushings, wiring, connectors, grounding wires, ground rods, grounding cables, etc., necessary to complete the microloop detector location installation.*~~

922.14 Ground Wire

The ground wire shall be copper wire No. 6, AWG soft-drawn, solid copper in accordance with ASTM B 3.

922.15 Splicing Kit

Splicing kits shall contain a 2 piece, transparent snap-together mold body and include an epoxy and sealing compound contained in a unipak. It shall be capable of insulating and splicing nonshielded cables rated up to 5 kilovolts and multi-conductor cables rated up to 600 volts.

922.16 Ground Rod and Connections

Ground rods shall be 1/2 in. in diameter by 8 ft long with a machined point and chamfered top. They shall be made of steel with a molecularly bonded outer layer of electrolytically applied copper. A single electrode shall have a maximum resistance to ground of 25 ohms. Single electrodes that do not have resistance to ground of 25 ohms or less shall be augmented by additional electrodes, grids, or plates until resistance to ground of 25 ohms or less is achieved. Resistance shall be measured using a 3-point ground tester using the fall of potential method. Data, graphs, resistance in ohms, date of test, make and model of ground tester, and the individual's initials performing the test shall be recorded and submitted to the District Office. Resistance in ohms shall be tagged at the ground connection.

The finished rod shall be cold-drawn and shall have the following minimum physical properties:

PHYSICAL PROPERTY	*MINIMUM*
Tensile strength	*97,000 psi*
Yield strength, 0.2% offset	*85,000 psi*
% of elongation	*13 psi*

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.

922.17 ~~Castings for~~ Handholes

(a) Concrete Handhole

The concrete shall be in accordance with section 702. The bar or welded cage mesh steel reinforcement shall be capable of supporting HS-20-44 loading. Furnish reinforcement as shown on the plans or in accordance with the manufacturer's design. If reinforcement deviates from the plans, provide calculations showing that the modified design supports HS-20-44 loading. The ring and cover for handholes shall be in accordance with 910.05(b).

(b) Polymer Concrete Handhole Box and Cover

A handhole box of polymer concrete shall be reinforced with a heavy weave fiberglass. The heavy duty enclosure and cover shall be designed and tested to -50 °F, with a compressive strength of at least 11,000 psi. The cover shall have a friction coefficient of at least 0.5.

1. Polymer Concrete Handhole Box

Furnish a heavy duty, nominal 17 inch by 30 inch by 12 inch handhole box, that is rated for 5,000 pounds over a 10 inch by 10 inch area and that is stackable.

2. Polymer Concrete Handhole Cover

Furnish a handhole cover with a service load of at least 22,000 pounds over a 10 inch by 10 inch area. The cover shall be marked with a logo imprint of "INDOT TRAFFIC SIGNAL". Secure the cover with stainless steel, 300 series, 3/8 inch, 16NC hex bolts and washers.

922.18 Entrance Switch

The entrance switch shall be a double pole, 50 A, 120V AC circuit breaker in a NEMA type 3R enclosure in accordance with NEMA 250-2008. The minimum dimensions of the enclosure shall be: 5 in. wide, 3 3/4 in. deep and 9 1/4 in. height. A 1 in. rain-tight detachable hub shall be supplied in the top of the enclosure. The enclosure shall have knockouts on the sides, bottom and back with diameters of 7/8 in. to 1 3/4 in.. The enclosure shall contain the circuit breaker, an insulated solid bar for connection of AC neutral, a separate lug for attachment of 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.

All wire terminations and breaker to buss-bar contact points inside the enclosure shall be coated with an anti-oxidant to prevent oxidizing and corrosion of components.

922.19 Conduit and Fittings

(a) Steel Conduit

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 2 hole straps with a minimum thickness of 1/8 in.. Conduit lock nuts 3/8 to 1 1/2 in. in size shall be made of steel. Other sizes shall be made of either steel or malleable iron. All conduit lock nuts shall be galvanized. Other nuts shall be either stainless steel or galvanized steel.

(b) Polyvinyl Chloride, PVC, Schedule 40 or 80 Conduit

Conduit, fittings, and accessories shall be manufactured from polyvinyl chloride meeting ASTM D 1784 and shall comply with all the applicable requirements of NEMA TC2 and UL 651. Each length of pipe shall include ~~tracer wire and~~ a coupling.

(c) Fiberglass Conduit

Rigid fiberglass conduit and fittings shall be filament wound consisting of E-glass and corrosion resistant epoxy resin manufactured for use at temperatures from -40 to 230° F. Rigid fiberglass conduit shall be pigmented with carbon black for ultraviolet protection and fire resistant per UL 94. All rigid fiberglass conduit shall have tracer wire, be heavy walled, HW, and meet the specifications, labeling and testing of ANSI/NEMA TC~~14~~ 9.

(d) High Density Polyethylene, HDPE, Schedule 40 or 80 Conduit

Conduit, fittings, and accessories shall be smooth wall, Type III, Grade P-33, Category 5, Class C, coilable, high density polyethylene (HDPE) meeting the requirements of ASTM D 1248, ASTM D 3350, and ASTM D 3485.

The wall thickness and outside diameter dimensions shall be in accordance with ASTM D 1785 for Schedule 40 or 80 material. The Department will allow no more than 3 percent deviation from the minimum wall thickness specified and the wall thickness range shall be within12 percent in accordance with ASTM D 3035.

Schedule 40 HDPE conduit shall be marked in accordance with ASTM D 3485 with the producer code and designation type indicated. Schedule 40 HDPE conduit shall be produced from material with an orange color and ultraviolet stabilization code of C, D, or E in accordance with ASTM D 3350. Schedule 40 HDPE conduit for use above ground shall be black.

922.20 Detector Housing

REVISION TO STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

SECTION 922 – TRAFFIC SIGNAL MATERIALS (changes shown as to existing RSP 922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT)

The entire housing casting shall be made from aluminum alloy in accordance with ANSI 320.

922.21 Certification

Unless otherwise specified, all materials covered herein shall have a type C certification in accordance with 916.

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW RSP 922-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT

(Note: content for this proposed RSP originated from 922-T-168, see proposal sheet for this item. Revised original statements are highlighted gray)

922-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT

The Standard Specifications are revised as follows:

SECTION 922, BEGIN LINE(TBD, at §922.02(f)7), INSERT AS FOLLOWS:

7. Cabinet Power Supply Requirements

The TS2 cabinet power supply shall adhere to the guidelines of NEMA TS2-5.3.5. The power supply shall be encased on all sides so that no circuitry is exposed to the user.

8. Cellular Modems

a. Service Provider

All data, power and antenna cables and all supplemental hardware shall be provided. The modem shall be compatible with the Department's current cellular carrier/provider (Verizon as of 07/07) and the traffic control device and closed loop communications software that it is supplied for.

b. Modem Hardware

Cell modems shall be Airlink GX440 (4G) or similar modem with the following specifications: The cellular modem shall be capable operating in CDMA dual mode (both 800 MHz cellular and 1.9 GHz PCS bands), supporting both circuit switched and 1XRTT packet switched services. The operating voltage range shall include 12V and 24V DC and shall draw less than 250 mA while transmitting and receiving at 12V DC. The modem shall have LED indications for power, signal status/strength, and TX/ RX either separately or combined. The serial interface shall be RS232 with a DB9 (male or female) connector.

c. Modem Antenna

The RF antenna connection shall be a 50 Ω TNC connector. The antenna shall be a low profile, puck style, flat mount dual band, (800 and 1900 MHz) with low loss RG58 cable and TNC connector.

d. Modem Software

The modem configuration shall be editable and viewable with MS-Windows provided software or with proprietary software that is included and designed to run on a MS-Windows operating system. The software shall auto-detect connection parameters and display settings when connected.

e. Installation

Service and activation shall be requested and/or confirmed for each cellular device to be installed prior to installation. The ESN and 10-digit phone number shall be clearly labeled on the exterior of the modem. The cellular modem shall be installed,

configured and tested to allow data communication from the central closed loop software to the field master and subsequent secondary controllers, or directly to a secondary controller per the design. All data, power and antenna cables and all supplemental mounting hardware shall be installed. The modem shall be powered by the cabinet power supply from a terminal location on the cabinet back panel or the power distribution panel. A low profile antenna shall be mounted externally and the mounting location includes a watertight seal. The antenna shall have no more than 3 ft excess RG58 cable in the cabinet.

9. Radio Interconnect Using Spread Spectrum Radio Modems

Spread spectrum radio modems for communications between local controllers and the system master controller shall be on the Department's list of approved Traffic Signal and ITS Control Equipment, and as set out herein.

The spread spectrum radio modems shall provide all the needed features to communicate with NEMA TS2 type 1 and type 2 traffic signal controllers in a coordinated closed loop system. The radio modems shall be software configurable to be either a master, repeater, repeater/slave, or slave radio. The radio modem shall require no user license from the FCC; operate in the 900 MHz range, and be of frequency hopping spread spectrum, FHSS, technology; support data rates from 1.2 kbps to 115.2 kbps asynchronous; have a receiver sensitivity of at least -110 dBm; have a minimum RF output level of 1 watt; have a minimum of 50 user-selectable hopping patterns and a minimum of 50 RF non-overlapping channels allowing multiple systems to operate in the same line-of-sight path; operate as a transparent RS232, or RS422/RS485, or FSK 1200 baud types of links for use in a point-to-multipoint system; have an external SMA female type or N-female RP-TNC female antenna connector; and be supplied with power supply for 120V AC operation. The modems shall be rack or shelf mounted in standard NEMA TS2 type 1 or type 2 cabinets. The modems shall have an operation temperature of -40 to 176°F, have a maximum current draw of 500 mA for the transmission of 1 watt of RF output power, while operating on 12V DC. Lighting and transient protection on all data lines and antenna connector, and AC/DC power distribution, shall be provided with the system.

The spread spectrum radio modems must include a Windows based, configuration software package, which will include a graphical user interface, GUI, allowing for ease of programming, through pre-written drivers for all Department approved traffic controllers and have the ability to automatically determine, and connect, at their radios baud, stop and parity settings. The configuration software must allow for signal level, RSSI, data integrity, message polling, and spectral analysis testing. The software must also permit all the radios within a system to be configured from a single location. All radio equipment and cables shall be delivered preconfigured and ready for field operation.

The manufacturer, or vendor, shall supply with each modem, the operational manual containing procedures for all features incorporated in the modem.

a. Transient Protection

Transient protection shall be installed between the radio modem and the field antenna. The transient protection shall be flange mounted in the cabinet and have a minimum transient current of 40 kA for 8 x 20 μs pulse, an insertion loss or < 0.1 dB, have an operating frequency in the 900 MHz range, allow throughput energy to be < 220 μJ for 6 kV /3 kA @ 8/20 μs waveform, have throughput voltage≤ 144 Vpk, and turn –on voltage shall be ± 600 volts. The unit impedance shall be 50 Ω.

b. Antennas

The antenna for the radio modem at the system master/local controllers shall be capable of providing a transmission range adequate for communication with all radio modems or repeaters in the system and must be configured as a single omni, single-yagi, or dual-yagi (2 single-yagi antennas on differing alignments) for each radio as described below.

(1) Omni Antennas

All omni antennas shall be capable of producing between 6 dBd and 10 dBd (8.15 dBi and 12.15 dBi) of gain while operating in, and covering the entire 902-930 MHz frequency range. The voltage standing wave ratio, VSWR, of the omni antenna shall be 1.5:1 or less when the antenna coax feed impedance is 50 Ω. Omni antennas shall be fabricated of fiberglass, brass, copper, and/or aluminum and shall be rated for wind velocities of at least 100 mph. The minimum length of the omni antenna shall be 60 in. and it shall be designed and fabricated with a fiberglass radome with a minimum diameter of 2 in. to prevent ice from collecting directly on the driven element. All omni antennas shall have a cableless N-female connector directly affixed and sealed to the antenna body. All hardware and fastenings devices shall be fabricated from stainless steel.

(2) Yagi / Dual-Yagi Antennas

All yagi antennas shall be capable of producing between 10 dBd and 13 dBd (12.15 dBi and 15.15 dBi) of gain while operating in, and covering the entire 902-930 MHz frequency range. The voltage standing wave ratio,VSWR, of the omni antenna shall be 1.5:1 or less when the antenna coax feed impedance is 50 Ω. The front to back ratio must be at least 20 dB for each yagi antenna. Yagi-directional antennas shall be fabricated of either anodized or powder coated 6061/T6 aluminum rod and seamless drawn pipe and shall be rated for wind velocities of at least 100 mph. All yagi antennas shall have a cableless N-female connector directly affixed and sealed to the antenna body. The yagi antenna shall be designed and fabricated so that polarization changes (vertical to horizontal) can be made on the antenna mount without adjusting the mast. Single yagis shall be connected by a low loss N-female "T" splitter/coupler and LMR-400 cable to form dual-yagi systems. All hardware and fastenings devices shall be fabricated from stainless steel.

c. Antennas Cable and Hardware

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW RSP 922-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT

The coaxial cable used as the transient protection to antenna lead shall have no greater than 3.8 dB loss per 100 ft of length and shall be LMR-400.

All LMR-400 connections are to be stripped, deburred, and crimped using the ST-400-EZ LMR-400 stripping tool, DBT-01 LMR-400 deburring tool, and a 0.429 in. hex crimp die for solderless LMR-400 connections respectively. All connections shall be completely sealed by heat shrinking double walled, adhesive lined shrink tubing for weather proofing and strain relief.

Cables shall be included to interface the radio equipment to the transient protection. The antenna mounting hardware shall securely attach the antenna to the strain pole/cantilever arm. The coaxial cable fitting on the antenna shall not support the weight of the coaxial cable run to the base of the strain pole/cantilever arm.

d. Data Cables

Cables shall be included to interface the radio equipment to the system master, co-located secondary controller, remote secondary controllers and any communication interface panels as needed. Cables shall include strain relief back shells designed to mate and lock with the telemetry connector on the system master and local controllers. All radio equipment and cables shall be delivered preconfigured and ready for field operation.

All miscellaneous equipment necessary to complete the installation shall be as specified by the radio modem manufacturer.

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW RSP 922-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS

(Note: content for this proposed RSP originated from 922-T-168, see proposal sheet for this item)

922-T-XXY ALTERNATIVE VEHICLE DETECTION METHODS

SECTION 922, BEGIN LINE (TBD, §922.13) DELETE AND INSERT AS FOLLOWS:

922.13 Detection Components

(a) Loop Detector Lead-in Cable

Runs 700 ft and less of 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.

Runs greater than 700 ft shall use 14 AWG wire. The nominal capacitance between conductors shall be 57 pF/ft and 98 pF/ft between one conductor and the other conductor connected to the shield.

(b) Roadway Loop Wire

Roadway loop wire shall be 14 AWG gauge IMSA 51-7 duct-loop wire with polyvinyl chloride or polyethylene outer jacket of 1/4 in. diameter.

~~***(c) Other Vehicle Detection Systems***~~

~~*Other vehicle detection systems shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.*~~

(c) Preformed Pave-Over Loops

All components of preformed pave-over loops designed for HMA paved-over application shall have a minimum temperature rating of 300°F. Preformed pave-over loops shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.

The size of a preformed pave-over loop shall be 6 ft diameter, 18.9 ft circumference round or 6 ft octagonal, 20 ft perimeter. The loops placed in the same lane shall be spaced 15 ft from the center of one loop to the center of the next loop.

Preformed pave-over loops may be constructed as a single loop or as 2, 3 or 4 loops in series. Each individual loop shall be wired with 4 turns of wire unless otherwise specified. Loops constructed in a series shall also be wired in series.

(d) Microloop Detectors

Materials for microloop detectors shall be selected from the Department's approved materials list. The microloop detectors selected shall be capable of counting vehicles in addition to detecting vehicle presence.

Each microloop detector location shall include the following items:

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW RSP 922-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS

1. *Non-invasive probe, lead-in cable and carriers for microloop detector as shown on the plans;*

2. *3-in. diameter schedule 80 PVC conduit containing the probes, lead-in cable and carriers;*

3. *Buried service wire encapsulation kit compatible with microloop detector for all splicing between the lead-in cable and the home run cable;*

4. *Installation kit, one for each conduit containing probes;*

5. *All mounting hardware, conduit bushings, wiring, connectors, grounding wires, ground rods, grounding cables, etc., necessary to complete the microloop detector location installation.*

(e) Wireless Vehicle Detection Systems (Note: statement from existing 805-T-173)

The wireless vehicle detection system, WVDS, is comprised of wireless in-pavement magnetometers, contact closure cards, receiver processors, and wireless repeaters installed for a signalized intersection. The system shall be capable of monitoring vehicles on a roadway via detection of changes in inductance caused by the presence or passage of a vehicle and shall provide detector outputs to a traffic signal controller.

The WVDS shall include in-pavement magnetometers, a minimum of 2 receiver processors, the required mounting equipment, cables, rack mounted cards, set-up and operating software, all connectors, and miscellaneous equipment necessary for the installation and operation of the system. If required, the WVDS shall also include wireless repeaters.

Only models from the Department's approved materials list for traffic signal control equipment shall be used.

Ethernet cable for wireless vehicle detectors shall be outdoor rated and UV shielded.

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

805-SGLT-01 LOOP TAGGING SYSTEM (with markups)

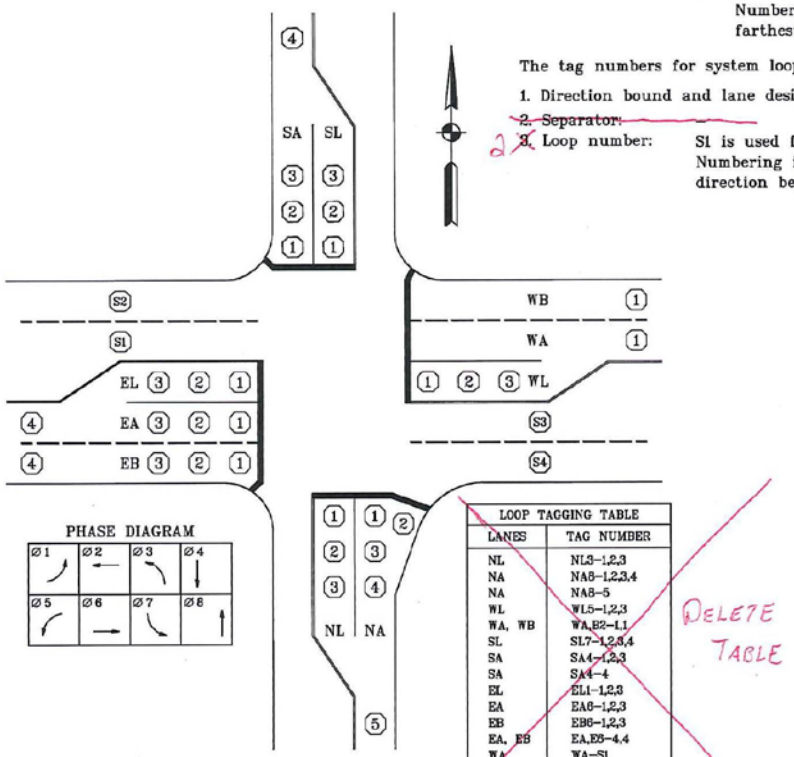
LOOP TAGGING SYSTEM

Each loop lead-in cable ~~(2C/16)~~ shall be tagged according to the designation shown on the plans. The tag numbers for lead-in cable shall be assigned as follows:

1. Direction bound: N, S, E, or W.
2. Lane designation: L = Left turn.
   A = Through lane closest to centerline of roadway.
   B = Next lane out from centerline of roadway.
   Alphabet is continued to lane closest to edge of pavement.
3. Phase number: 1 through 8.
4. Separator: –
5. Loop number: 1 = Loop closest to stop line.
   2 = Next loop away from stop line.
   Numbering is continued to loop farthest from stop line.

The tag numbers for system loops shall be assigned as follows:

1. Direction bound and lane designation are the same as for lead-in cable.
2. ~~Separator:~~
3. Loop number: S1 is used for the southernmost approach. Numbering is continued in a clockwise direction beginning with S2.



PHASE DIAGRAM

LOOP TAGGING TABLE	
LANES	TAG NUMBER
NL	NL3–1,2,3
NA	NA8–1,2,3,4
NA	NA8–5
WL	WL5–1,2,3
WA, WB	WA,B2–1,1
SL	SL7–1,2,3,4
SA	SA4–1,2,3
SA	SA4–4
EL	EL1–1,2,3
EA	EA6–1,2,3
EB	EB6–1,2,3
EA, EB	EA,E5–4,4
WA	WA–S1
WB	WB–S2
EA	EA–S3
EB	EB–S4

DELETE TABLE

INDIANA DEPARTMENT OF TRANSPORTATION

LOOP TAGGING SYSTEM

MARCH 1995

STANDARD DRAWING NO. E 805–SGLT–01

ANTHONY L. UREMOVICH REGISTERED No. 18095 STATE OF INDIANA PROFESSIONAL ENGINEER
DESIGN STANDARDS ENGINEER

DETAILS PLACED IN THIS FORMAT 11-15-99

/s/ Anthony L. Uremovich 11-15-99
DESIGN STANDARDS ENGINEER DATE

/s/ Firooz Zandi 11-15-99
CHIEF HIGHWAY ENGINEER DATE

ORIGINALLY APPROVED 3-01-95

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW 805-SDAC-01 SIGNAL DUAL ARM CANTILEVERS

INDEX	
SHEET NO.	SUBJECT
1	Index
2	Pole Dimensions and Details
3	Arm Dimensions and Details
4	Base Plate and Pole Top Cover Details
5	Arm Connection Details
6	Handhole and I.D. Tag Details
7	Loading Diagrams
8	Foundation, Drilled Shaft Type E, for Dual Arms 35' or Less
9	Foundation, Drilled Shaft Type F, for Dual Arms Greater Than 35' to 45'

INDIANA DEPARTMENT OF TRANSPORTATION

SIGNAL DUAL ARM CANTILEVERS
DRAWING INDEX

SEPTEMBER 2013

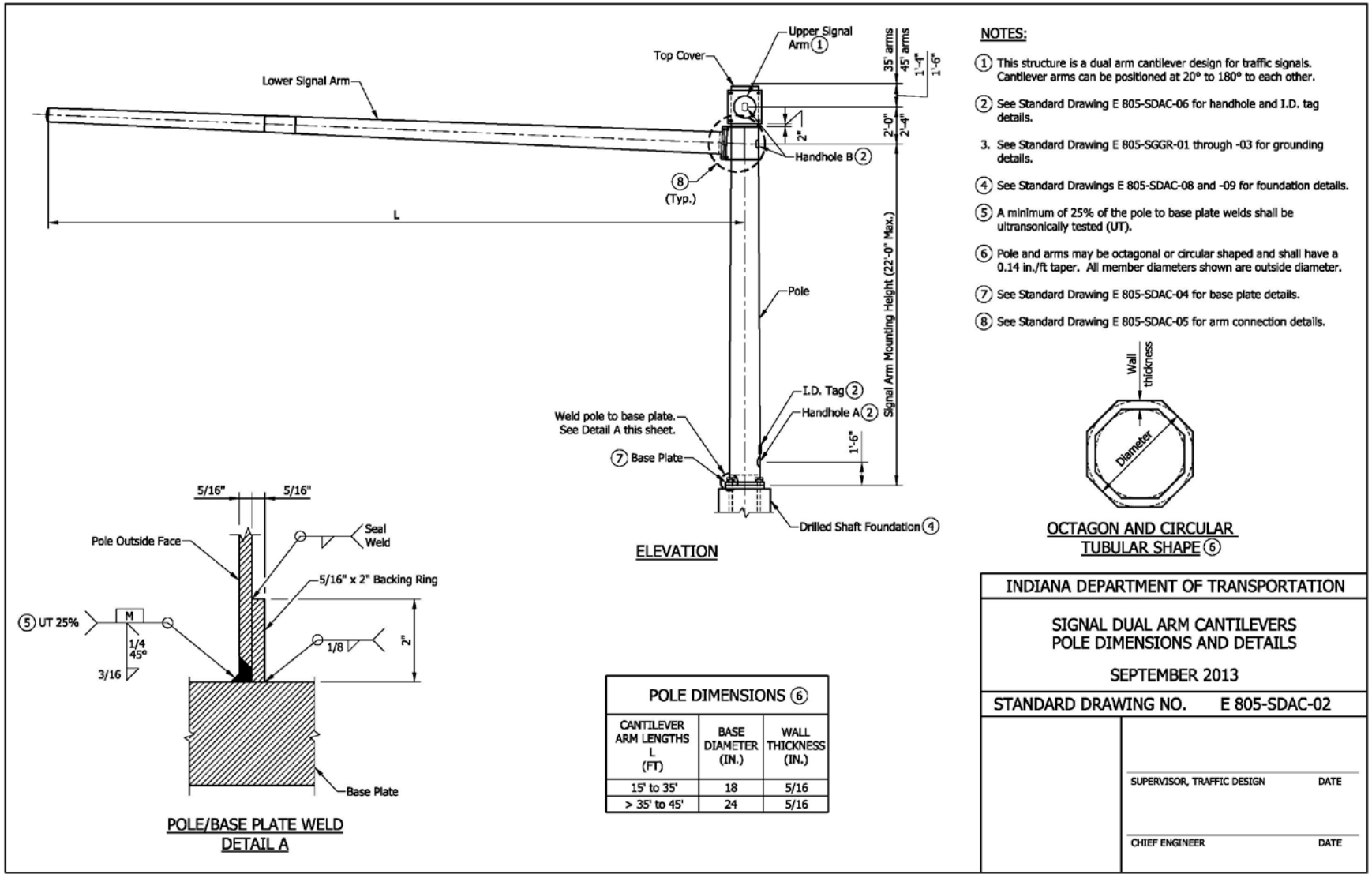
STANDARD DRAWING NO. E 805-SDAC-01

SUPERVISOR, TRAFFIC DESIGN DATE

CHIEF ENGINEER DATE

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW 805-SDAC-02 SIGNAL DUAL ARM CANTILEVERS

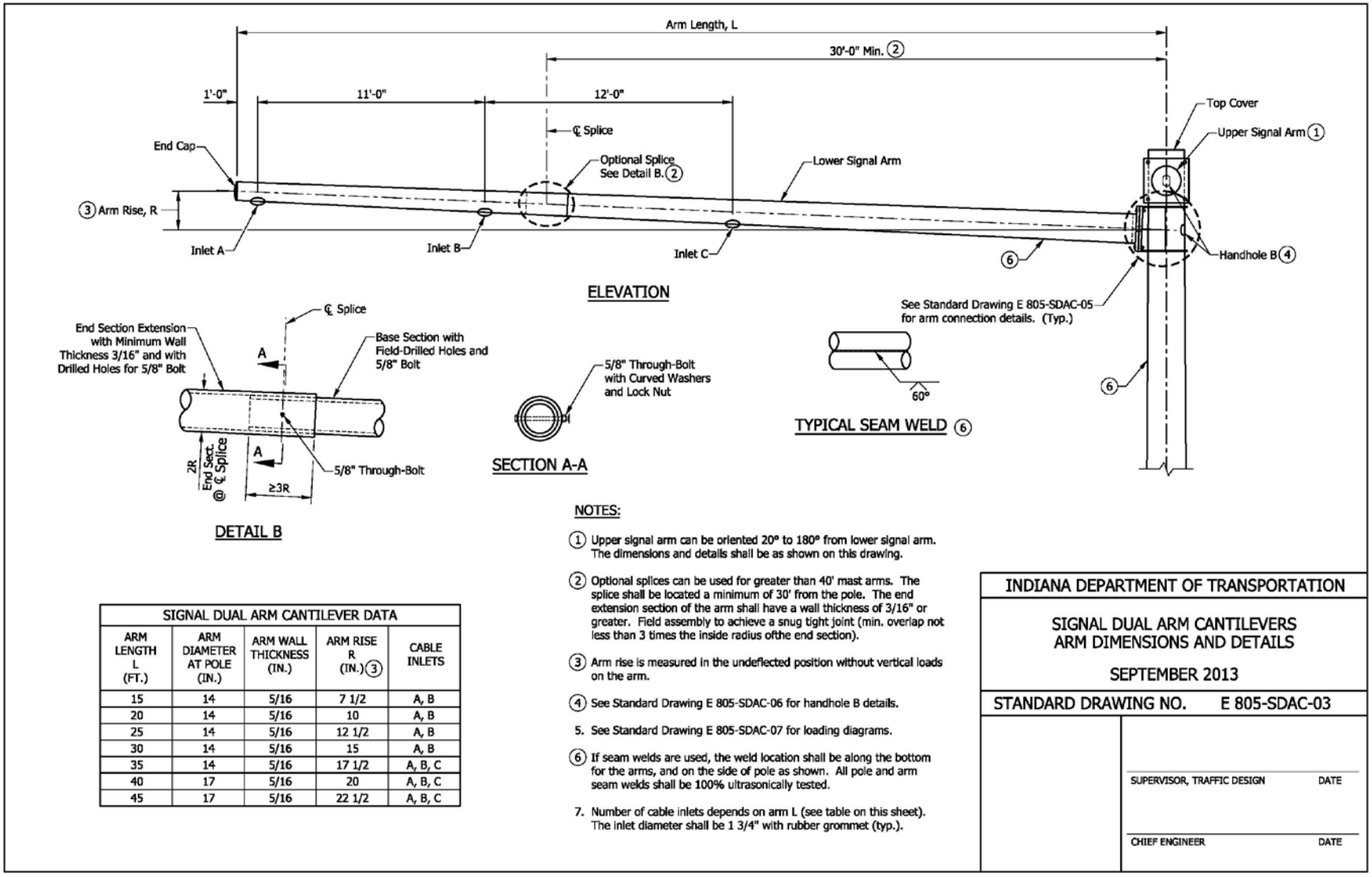


POLE DIMENSIONS (6)

CANTILEVER ARM LENGTHS L (FT)	BASE DIAMETER (IN.)	WALL THICKNESS (IN.)
15' to 35'	18	5/16
> 35' to 45'	24	5/16

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW 805-SDAC-03 SIGNAL DUAL ARM CANTILEVERS



SIGNAL DUAL ARM CANTILEVER DATA				
ARM LENGTH L (FT.)	ARM DIAMETER AT POLE (IN.)	ARM WALL THICKNESS (IN.)	ARM RISE R (IN.) (3)	CABLE INLETS
15	14	5/16	7 1/2	A, B
20	14	5/16	10	A, B
25	14	5/16	12 1/2	A, B
30	14	5/16	15	A, B
35	14	5/16	17 1/2	A, B, C
40	17	5/16	20	A, B, C
45	17	5/16	22 1/2	A, B, C

NOTES:

(1) Upper signal arm can be oriented 20° to 180° from lower signal arm. The dimensions and details shall be as shown on this drawing.

(2) Optional splices can be used for greater than 40' mast arms. The splice shall be located a minimum of 30' from the pole. The end extension section of the arm shall have a wall thickness of 3/16" or greater. Field assembly to achieve a snug tight joint (min. overlap not less than 3 times the inside radius ofthe end section).

(3) Arm rise is measured in the undeflected position without vertical loads on the arm.

(4) See Standard Drawing E 805-SDAC-06 for handhole B details.

5. See Standard Drawing E 805-SDAC-07 for loading diagrams.

(6) If seam welds are used, the weld location shall be along the bottom for the arms, and on the side of pole as shown. All pole and arm seam welds shall be 100% ultrasonically tested.

7. Number of cable inlets depends on arm L (see table on this sheet). The inlet diameter shall be 1 3/4" with rubber grommet (typ.).

INDIANA DEPARTMENT OF TRANSPORTATION

SIGNAL DUAL ARM CANTILEVERS
ARM DIMENSIONS AND DETAILS

SEPTEMBER 2013

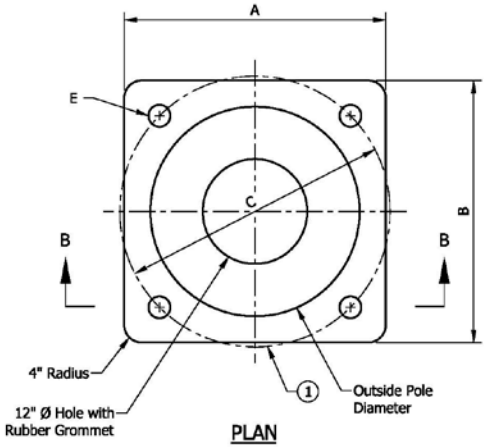
STANDARD DRAWING NO. E 805-SDAC-03

SUPERVISOR, TRAFFIC DESIGN DATE

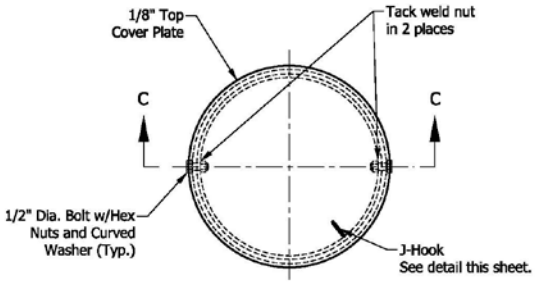
CHIEF ENGINEER DATE

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW 805-SDAC-04 SIGNAL DUAL ARM CANTILEVERS



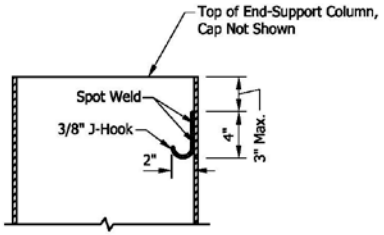
PLAN



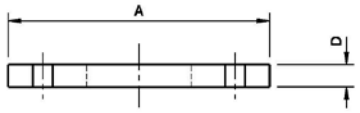
PLAN
TOP COVER - STEEL COLUMN

NOTES:

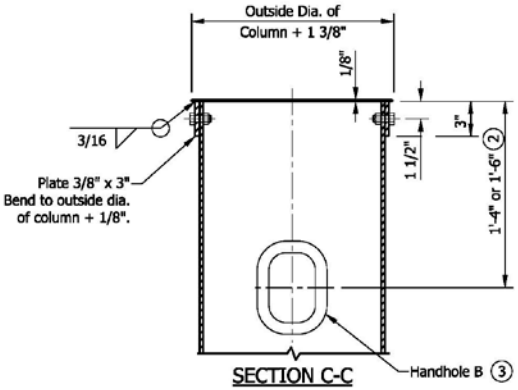
1. Anchor bolt circle shall allow clearance for the anchor bolt washers. Cutting or trimming of the washers will not be allowed.
2. See Standard Drawing E 805-SDAC-02 for handhole locations.
3. See Standard Drawing E 805-SDAC-06 for handhole details.



CABLE J-HOOK



SECTION B-B
BASE PLATE



SECTION C-C

BASE PLATE DATA				
POLE DIAMETER (IN.)	PLATE DIMENSIONS A X B (IN. X IN.)	ANCHOR BOLTS CIRCLE C (IN.)	PLATE THICKNESS D (IN.)	BOLT HOLE DIAMETER E (IN.)
18	26 x 26	25	2 1/4	2 9/16
24	30 x 30	31	2 1/2	2 13/16

INDIANA DEPARTMENT OF TRANSPORTATION

SIGNAL DUAL ARM CANTILEVERS
BASE PLATE AND POLE TOP COVER DETAILS

SEPTEMBER 2013

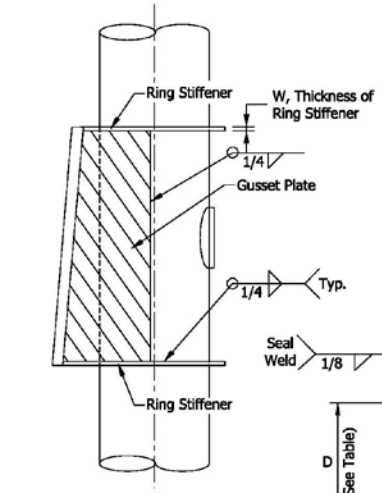
STANDARD DRAWING NO. E 805-SDAC-04

SUPERVISOR, TRAFFIC DESIGN DATE

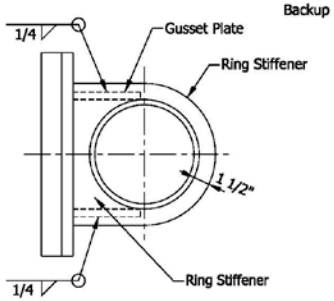
CHIEF ENGINEER DATE

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

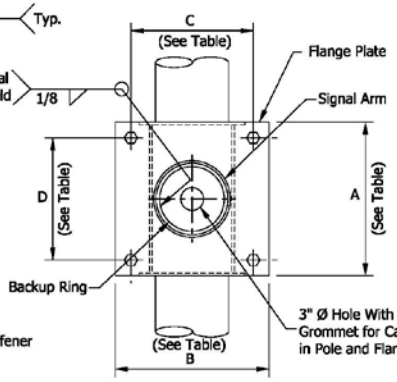
PROPOSED NEW 805-SDAC-05 SIGNAL DUAL ARM CANTILEVERS



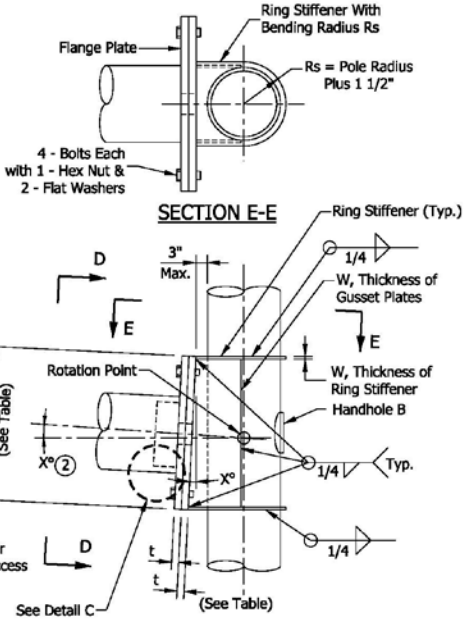
ELEVATION OF GUSSET PLATE



TOP OF GUSSET PLATE



SECTION D-D



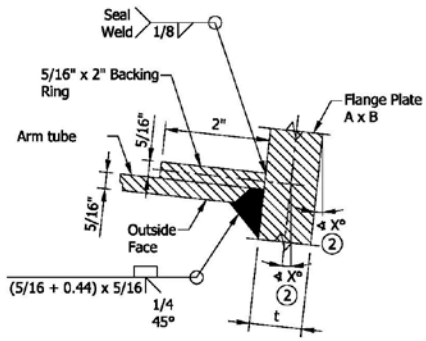
SECTION E-E

ELEVATION

SIGNAL ARM CONNECTION DETAIL

NOTES:

1. See Standard Drawing E 805-SDAC-06 for Handhole B details.
2. The required signal arm rise shall be built into the gusset plate at the angle X. The angle X is described as arc tan R/L, where R is the arm rise and L is the arm length. Both R and L vary and are listed in the Signal Dual Arm Cantilever Data table on Standard Drawing E 805-SDAC-03.



DETAIL C
ARM WELD

TABLE OF PLATES AND BOLTS FOR SIGNAL DUAL ARM CANTILEVER

ARM LENGTH (FT)	FLANGE PLATE A X B (IN.)	BOLT PATTERN C X D (IN. X IN.)	RING STIFFENER & GUSSET PLATE THICKNESS W (IN.)	FLANGE PLATE THICKNESS t (IN.)	BOLT DIAMETER (IN.)	BOLT LENGTH (IN.)
15 to 35	22 x 22	17 1/2 x 17 1/2	3/8	1 1/2	1 1/4	5
> 35 to 45	26 x 26	21 1/2 x 21 1/2	1/2	2	1 1/2	6

INDIANA DEPARTMENT OF TRANSPORTATION

SIGNAL DUAL ARM CANTILEVERS
ARM CONNECTION DETAILS

SEPTEMBER 2013

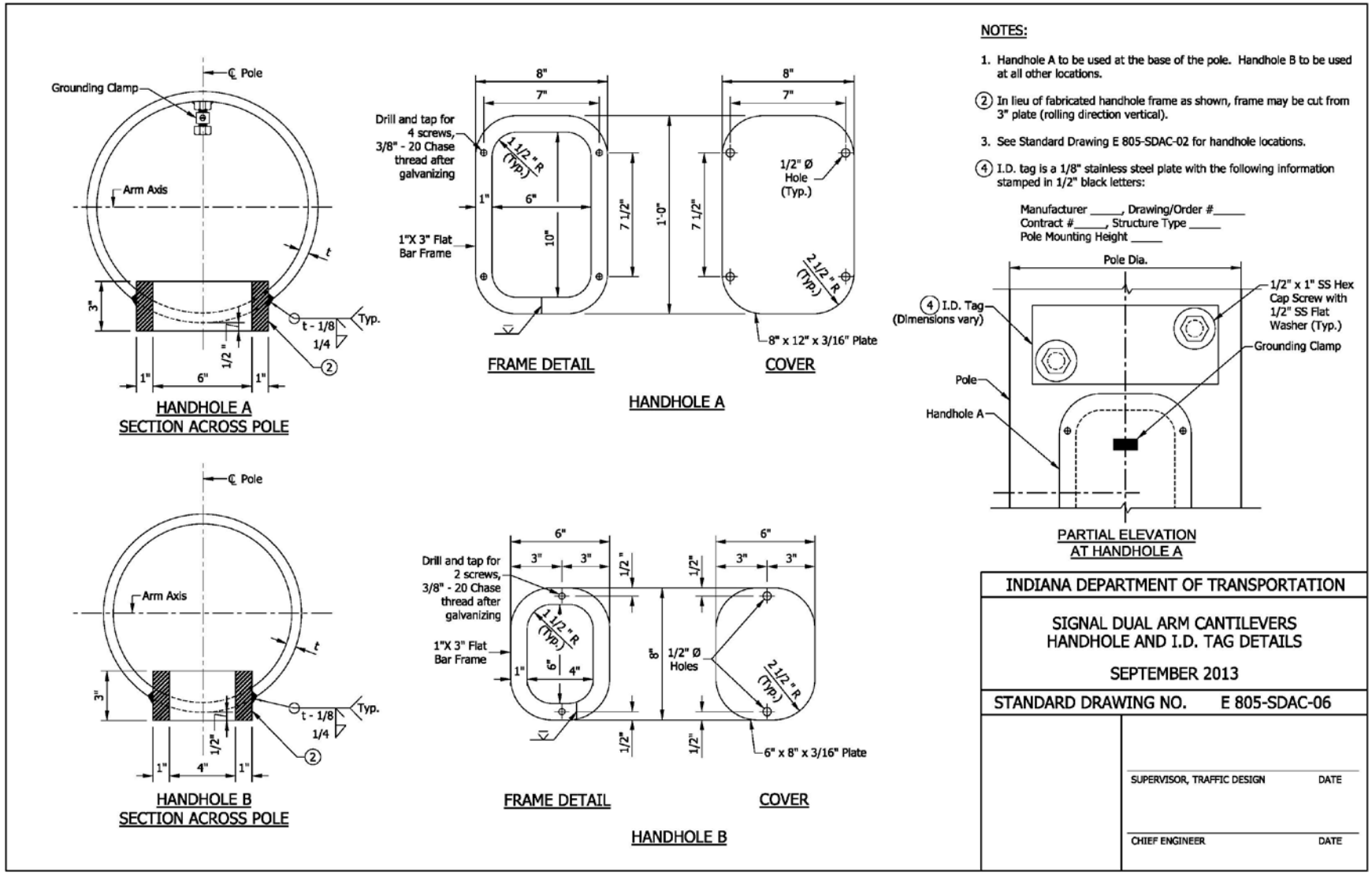
STANDARD DRAWING NO. E 805-SDAC-05

SUPERVISOR, TRAFFIC DESIGN DATE

CHIEF ENGINEER DATE

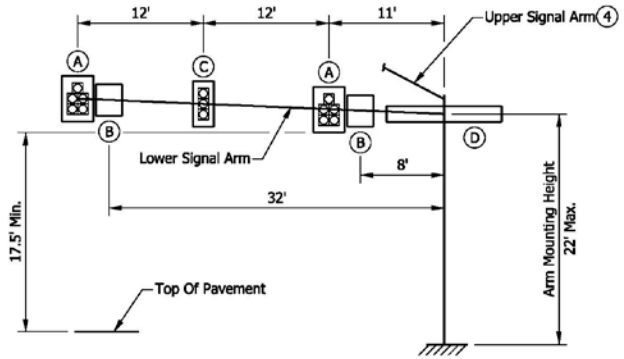
REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW 805-SDAC-06 SIGNAL DUAL ARM CANTILEVERS

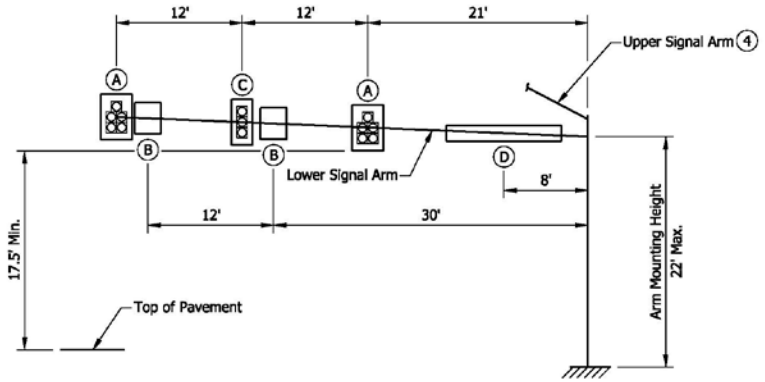


REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW 805-SDAC-07 SIGNAL DUAL ARM CANTILEVERS



35' ARMS



45' ARMS

NOTES:

1. The arms and pole are designed for the loading conditions shown. For arm lengths shorter than 35', the loading shall not exceed the loading shown for the 35' arm length.
2. Foundation Type E is designed for arm length of 35' or less. See Standard Drawing E 805-SDAC-08.
3. Foundation Type F is designed for arm length of greater than 35' to 45'. See Standard Drawing E 805-SDAC-09.

(4) Both arms can be loaded as shown in loading diagrams.

SIGNAL AND SIGN LOADING INFORMATION TABLE

DEVICE	DESCRIPTION	DEVICE AREA (SQ FT)	WEIGHT (LBS)
(A)	12" - 5 section signal head with backplates	14.5	69
(B)	36" x 30" regulatory sign	7.5	19
(C)	12" - 3 section signal head with backplates	10.1	55
(D)	18" x 11'-0" street name sign	16.5	41

INDIANA DEPARTMENT OF TRANSPORTATION

SIGNAL DUAL ARM CANTILEVERS
LOADING DIAGRAMS

SEPTEMBER 2013

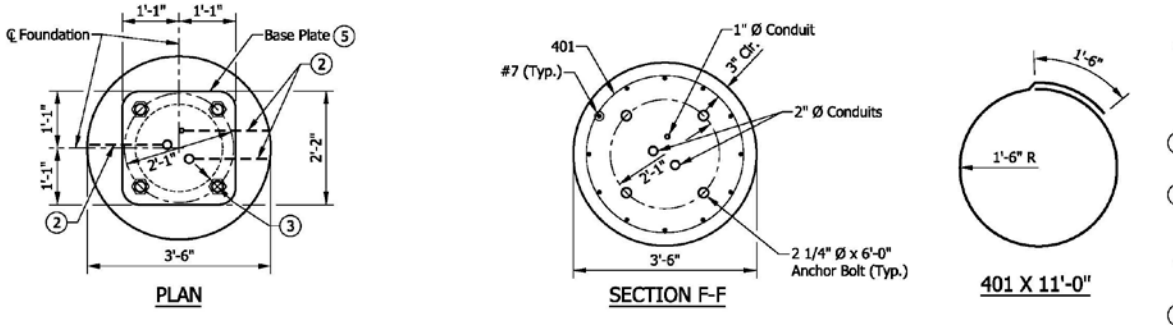
STANDARD DRAWING NO. E 805-SDAC-07

SUPERVISOR, TRAFFIC DESIGN DATE

CHIEF ENGINEER DATE

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

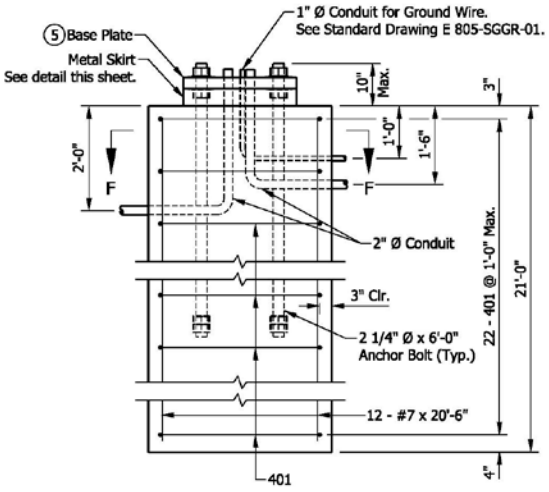
PROPOSED NEW 805-SDAC-08 SIGNAL DUAL ARM CANTILEVERS

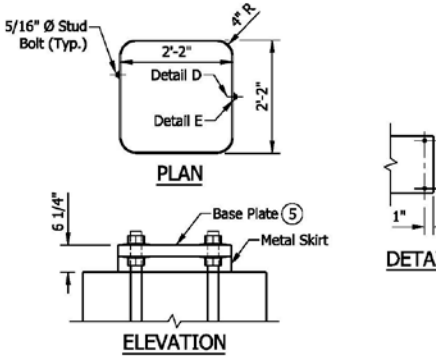


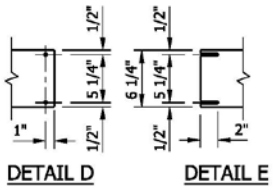
NOTES:

1. The type E foundations are to be used for 35' dual arm structures and cohesive soil with minimum Q_u = 750 lb/ft or sand with minimum friction angle 30°.
2. A tooled line or other permanent marking shall be provided on the top of the foundation to indicate the direction of the conduits' exit ends.
3. 2 1/2" minimum clearance to weld at pole. Anchor bolt circle shall allow clearance for the anchor bolt washers. Cutting or trimming of the washers will not be allowed.
4. The foundation shall be poured monolithically and shall have no construction joint.

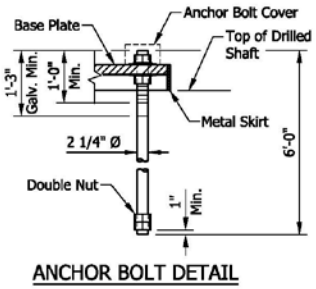
(5) See Standard Drawing E 805-SDAC-04 for base plate details.

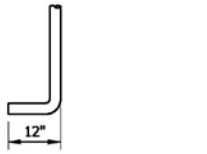






BILL OF MATERIALS			
REINFORCING BARS			
MARK OR SIZE	NO. OF BARS	LENGTH	WEIGHT
#7	12	20'-6"	
Total #7			503 LBS
401	22	11'-0"	
Total #4			162 LBS
Total Reinforcing Bars			665 LBS
CONCRETE			
Concrete, Class A			7.5 CYS





INDIANA DEPARTMENT OF TRANSPORTATION

SIGNAL DUAL ARM CANTILEVERS
FOUNDATION, DRILLED SHAFT TYPE E
FOR DUAL ARMS 35' OR LESS

SEPTEMBER 2013

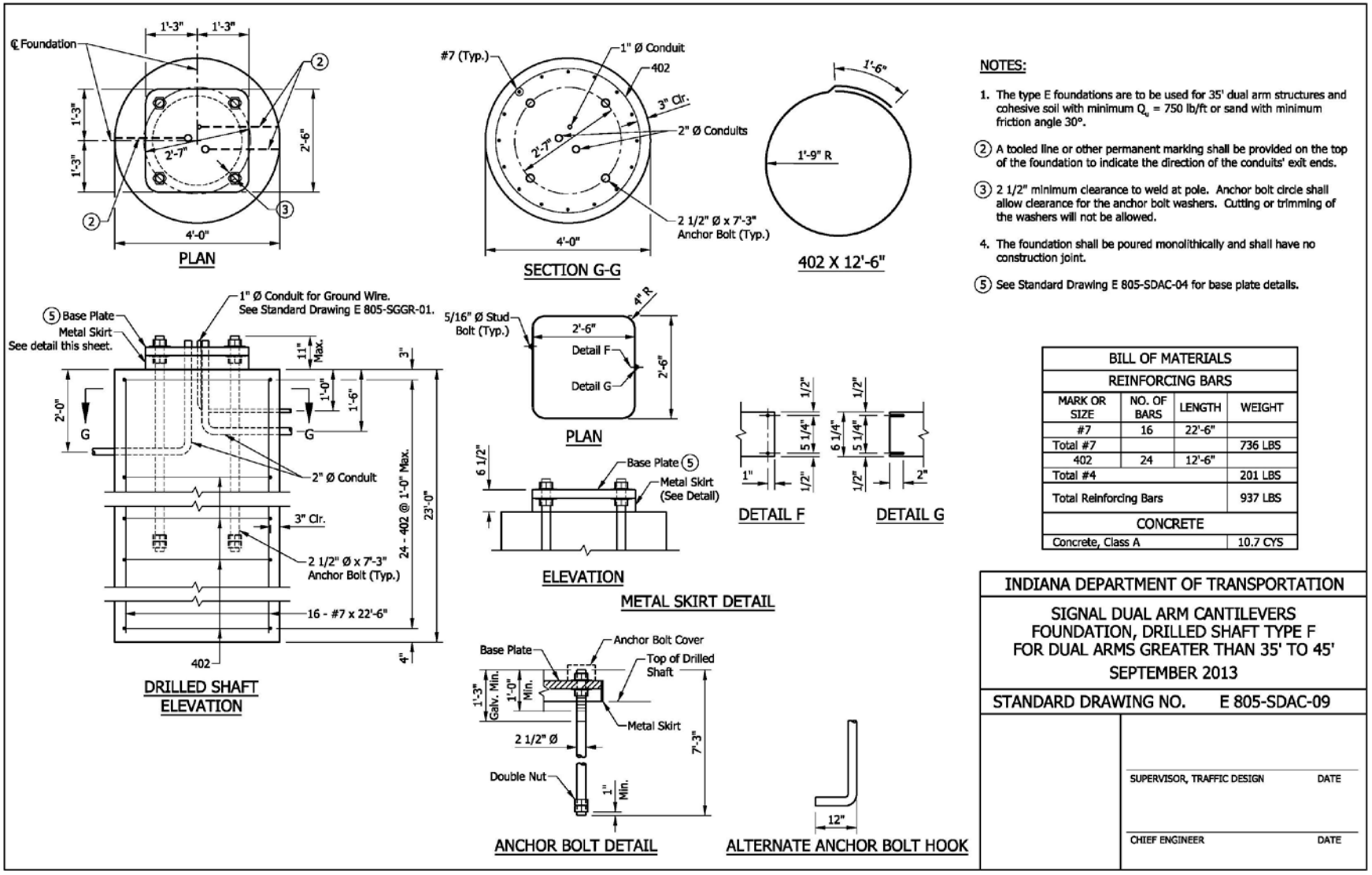
STANDARD DRAWING NO. E 805-SDAC-08

SUPERVISOR, TRAFFIC DESIGN DATE

CHIEF ENGINEER DATE

REVISION TO SPECIAL PROVISIONS AND STANDARD DRAWINGS

PROPOSED NEW 805-SDAC-09 SIGNAL DUAL ARM CANTILEVERS



BILL OF MATERIALS			
REINFORCING BARS			
MARK OR SIZE	NO. OF BARS	LENGTH	WEIGHT
#7	16	22'-6"	
Total #7			736 LBS
402	24	12'-6"	
Total #4			201 LBS
Total Reinforcing Bars			937 LBS
CONCRETE			
Concrete, Class A			10.7 CYS

INDIANA DEPARTMENT OF TRANSPORTATION

SIGNAL DUAL ARM CANTILEVERS
FOUNDATION, DRILLED SHAFT TYPE F
FOR DUAL ARMS GREATER THAN 35' TO 45'
SEPTEMBER 2013

STANDARD DRAWING NO. E 805-SDAC-09

SUPERVISOR, TRAFFIC DESIGN DATE

CHIEF ENGINEER DATE

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

77-4.03 Signal Mounting

The Department's preferred practice is to install a traffic signal using span, catenary, and tether cables, or cantilever structures with poles on all four corners. A pedestrian signal is mounted on a pedestal or pole. A pedestal- or pole-mounted supplemental signal may be used if there is a left-turn signal in a median or on the near side of the intersection if the intersection is significantly wide. Figures 77-4D, 77-4E, and 77-4F list the advantages and disadvantages of the pole-mounted signal, cable-span signal mounting, and the cantilever signal mounting, respectively.

For spans, steel strain poles are used. Steel strain poles provide greater strength, are easier to maintain, and require less space. Wood poles require the use of down-guy cables and are limited to a temporary installation.

A signal-cantilever structure is designed to satisfy the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2009, Fifth Edition.

A standardized signal-cantilever structure and its foundations should be as shown on INDOT Standard Drawings ~~E 805-TSCS-01 through -18~~. See Section 77-4.04(01) guidance in selecting a standardized structure for use. These structures are designed for the loading and structural dimensions as shown on the standard drawings.

A standardized Dual arm signal cantilever structure and its foundations should be as shown on the INDOT standard drawings. These structures are designed for the loading and structure dimensions as shown on the standard drawings.

See Section 77-4.04(02) for design criteria for a non-standardized structure.

Overhead highway lighting may be provided, where warranted (see Section 78-2.0), at a rural signalized intersection. A traffic-signal span-support pole or a cantilever pole may be used for overhead highway lighting. Figure 77-4G provides an illustration of a combination signal-luminaire pole. INDOT does not use combination poles. Figure 77-4H provides the heads' orientation for a cable-span-mounted signal.

77-4.04 Signal-Cantilever Structure Selecction Guidance and Design Criteria

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

77-4.04(01) Selection Guidance

INDOT Standard Drawings ~~E 805-TSCS-01 through -18~~ show details for standardized signal cantilever structures, pole section 2, combination arm, and drilled-shaft and spread foundations.

~~*To determine the foundation type, soil borings will be required ? to determine if soil is cohesive or sand, the soil bearing capacity, and the friction coefficient. Once the soil properties are known, the foundation type can be determined as shown in Figure 77-4 I.*~~

To determine the foundation type, at least one soil boring per intersection is required. Contact office of Geotech engineering for availability of any existing soil boring information for the location. Once the soil properties are known, the foundation type can be determined as shown in Figure 77-4 I.

A signal-cantilever structure should be designed to provide a minimum clearance of 17.5 ft under each signal head or sign. Clearance should be the vertical distance from the lowest point of the signal head or sign to a horizontal plane to the pavement surface below the signal head or sign.

A three-section signal head may be placed where a five-section signal head is shown on the INDOT Standard Drawings.

The structure should be provided with vibration mitigation devices if either of the conditions applies as follows:

1. *structure with arm length in excess of 50 ft; or*

2. *structure is located where the speed limit exceeds 35 mph and the ADT exceeds 10,000 vpd, or the ADTT exceeds 1000. ADT and ADTT are for one direction regardless of the number of lanes.*

The foundation location and type, pole height, arm length, and sign designations and messages should be shown on the plans. The true arm length should be shown from the center of the pole to the end of the arm. Such length, for pay-item-determination purposes, should be rounded to the higher 5-ft increment. The plans should show ADT and ADTT for each direction.

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

77-4.04(02) Design Criteria

If a structure shown on the INDOT Standard Drawings cannot be used, its foundation, pole, arm, and connections should be designed utilizing the design conditions as follows:

1. *90-mph wind;*
2. *50-year service life;*
3. *Category II fatigue;*
4. *galloping considered;*
5. *truck gusts considered with 60-mph truck speed;*
6. *backplates included for signal heads; and*
7. *C_d for structure members = 1.1 for fatigue and in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, Table 3-6 for working loads.*

A signal cantilever structure should be designed for weights equal to or less than those shown in Figure 77-4J. If necessary, the combination arm can be added by including pole section 2 of either 17 in. or 24 in. dia., also designed for weights equal to or less than those shown in Figure 77-4J. Where used, the combination-arm length should be equal to or less that the length of the signal-cantilever arm.

The maximum allowable horizontal deflection of the pole should be limited to 2.5% of the structure height in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, Section 10.4.2, group 1 load combination.

77-4.~~04~~ 05 Signal Display

The traffic signal display consists of many parts including the signal head, signal face, optical unit, visors, etc. The criteria set forth in the *MUTCD* Part IV, the INDOT *Standard Specifications, and* ITE's *Equipment and Material Standards of the Institute of Transportation Engineers* should be followed when determining appropriate signal display arrangements and equipment. The following provides additional guidance for the selection of the signal display equipment:

1. Signal Head Housings. Signal head housings are made from polycarbonate (plastic).

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

2. Signal Faces. Section 77-5.01 presents INDOT's preferred signal face arrangements for use on State highways. It is INDOT's practice to place the signal lenses in a vertical line rather than horizontally except where overhead obstructions may limit visibility. Where protected left turns are followed by permissive left turns, the five-section signal head is the recommended arrangement choice. The *MUTCD Part* IV provides additional information on the arrangement of signal heads.

3. Lens Sizes. INDOT's preferred practice is to use only 12-in. (300 mm) lenses. INDOT specifications require the use of plastic lenses in its signal displays.

4. Signal Illumination. For signal illumination, INDOT uses Light-Emitting Diodes (LED's) for all signal indications.

5. Visors. INDOT practice is to use a visor on all signals. These visors are typically used for two purposes -- to direct the signal indication to the appropriate approaching traffic and to reduce "sun phantom." Tunnel visors provide a complete circle around the lens. Cutaway visors are partial visors, typically with the bottom cutaway. Partial visors reduce water and snow accumulation and do not let birds build nests within the visor. The decision on which visor type should be used is determined on a site-by-site basis. For Department installations, INDOT normally uses partial visors. Visors are made of the same material as the housing.

6. Louvers. Louvers are sometimes used to direct the signal indication to a specific lane. Louvers are used where several signal heads may cause confusion for the approaching driver. One example of this problem is where an intersection has its approaches at acute angles less than 90 degrees and the signal indications can be seen from both approaches. The decision on whether to use louvers depends on site conditions and will be determined on a case by case basis.

7. Optically Programmable Signals. Like louvers, optically programmable signals are designed to direct the signal indication to specific approach lanes and for specific distances. A major advantage is that they can be narrowly aligned so that motorists from other approaches cannot see the indications. Typical applications include closely spaced intersections and intersections where the approaches have acute angles. Optically programmable signals require rigid

mountings to keep the indicator properly directed. The cost is higher than louvers but the improved visibility often makes them a better choice. The decision on whether to use an optically programmable signal depends on site conditions and will be determined on a case-by case basis.

8. Backplates. A signal indication loses some of its contrast value when viewed against a bright sky or other intensive background lighting (e.g., advertising lighting). Backplates placed around the signal assembly enhance the signal's visibility and have been shown to provide a benefit in reducing crashes. However, backplates add weight to the signal head and can increase the effect of wind loading on the signal. The decision on whether to use backplates depends on site conditions and will be determined on a case-by-case basis.

77-5.0 TRAFFIC SIGNAL DESIGN

77-5.01 Design Criteria

In general, INDOT has adopted the *MUTCD* criteria for the placement and design of traffic and pedestrian signals. This includes, but is not limited to, signal indications, color requirements, number of lenses per signal head, number and location of signal heads, height of signal heads, location of signal supports, etc. In addition to the *MUTCD*, the INDOT *Standard Drawings*, and the references in Section 77-1.01, the following sections provide further details and information on the design of traffic signals.

Once a signal is determined to be warranted, or for complete modernization projects, the following should be considered:

1. All electrical service should be metered.

2. All parking regulations should be reviewed for a distance of at least 150 ft (45 m) from the stop line or back to any detector.

3. All signal head indications should be placed within 40 to 180 ft (12 to 55 m) from the stop line.

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

4. The designer should verify the necessary signal heads for the traffic movements as shown in the phase diagram.

5. All signal equipment should satisfy the lateral clearances as specified in Chapter Forty-nine for a 4R project or Chapter Fifty-five for a 3R project.

6. Steel strain pole support heights are 30 ft (9.1 m) or 36 ft (11 m).

7. Preformed loop detection should be used where new pavement is constructed or pavement is to be replaced.

8. All existing signal components should be field verified.

9. Position and direction of aiming for all signal heads should be in accordance with Section
77-5.01(01).

10. The designer should provide a design that counts vehicles in each traveled lane approaching the signalized intersection (required for INDOT projects). The count loops shall be identified in the loop tagging table.

11. The values for detection setback distances shown in Figure 77-5W should be used.

12. Signal cantilever Structures, see section 77-4.04

77-5.01(01) Signal Displays

The *MUTCD* requires that there be at least two signal indications for each through approach to an intersection or other signalized location. A single indication is permitted for control of an exclusive turn lane, provided that this single indication is in addition to the minimum two for through movements. For multiple left turn lanes, one indication per lane shall be provided.

77-5.02 Placement of Signal Equipment

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

For the most part, the designer has limited options available in determining acceptable locations for the placement of signal pedestals, signal poles, pedestrian detectors and controller cabinets. Considering roadside safety, these elements should be placed as far back from the roadway as practical. However, due to visibility requirements, limited ~~mast arm~~ *signal cantilever structure arm* lengths, limited right-of-way, restrictive geometrics or pedestrian requirements, traffic signal equipment often must be placed relatively close to the travelway. The designer should consider the following when determining the placement of traffic signal equipment.

1. Clear Zones. If practical, the placement of traffic signal equipment on new construction and reconstruction projects should meet the clear zone criteria presented in Section 49-2.0. For 3R projects, they should be located outside of the obstruction-free zone; see Section 55-5.02. New signal installation projects on existing routes or signal modernization projects are considered to be 3R projects.

2. Controller Cabinet. In determining the location of the controller cabinet, the designer should
consider the following:

   a. The controller cabinet should be placed in a position so that it is unlikely to be struck by errant vehicles. It should be outside the obstruction-free zone.

   b. The controller cabinet should be located where it can be easily accessed by maintenance personnel.

   c. The controller cabinet should be located so that a technician working in the cabinet can see the signal indications in at least one direction.

   d. The controller cabinet should be located where the potential for water damage is minimized.

   e. The controller cabinet should not obstruct intersection visibility.

   f. The power service connect should be reasonably close to the controller cabinet.

3. Traffic Signal Supports. Traffic signal supports should be placed to provide the obstruction-free zone through the area where the traffic signal supports are located. However, the following exceptions will apply:

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

a. Channelized Islands. Installation of signal supports in channelizing islands should be avoided, if practical. However, if a signal support must be located in a channelizing island, a minimum clearance of 30 ft (9.0 m) should be provided from all travel lanes (including turn lanes) in rural areas and in urban areas where the posted speed is greater than 45 mph (70 km/h). In urban areas where the island is bordered by a barrier curb and the posted speed is 45 mph (70 km/h) or less, a minimum clearance of 10 ft (3.0 m) should be provided from all travel lanes (including turn lanes).

b. Non-Curbed Facilities (Posted Speed $\geq$ 50 mph (80 km/h) and ADT > 1500). Where conflicts exist such that the placement of the signal supports outside of the obstruction-free zone is impractical (e.g., conflicts with buried or utility cables), the signal supports should be located at least 10 ft (3.0 m) beyond the outside edge of the paved shoulder.

c. Non-Curbed Facilities (Posted Speed < 50 mph (80 km/h) or ADT $\leq$ 1500). Where conflicts exist such that the placement of the signal supports outside of the obstruction-free zone is impractical (e.g., conflicts with buried or utility cables), the signal supports should be located at least 6 ft (2.0 m) beyond the outside edge of the paved shoulder.

d. Curbed Facilities. For curbed facilities, see Section 55-5.02. For facilities with curbs less than 6 in. (150 mm) in height, see Items 3a. and 3b. above.

4. Pedestrians. If the signal pole must be located in the sidewalk, it should be placed to minimize pedestrian conflicts. In addition, the signal pole shall not be placed in a manner that will restrict a handicapped individual's access to curb ramps. Pedestrian push buttons must be conveniently located. Section 51-1.0 provides INDOT criteria for handicapped accessibility.

Foundation Type	*Soil Properties*	*Support*	*Arm Length, L, ft*
A	*Cohesive, Q_u = 750 lb/ft; or Sand, Friction Angle = 30 deg Bearing Capacity = 150 psf, and Coefficient of Friction = 0.3*	*Drilled Shaft*	*$\leq$ 35*
B		*Drilled Shaft*	*35 < L $\leq$ 60*

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

C	*Cohesive, Q_u = 750 lb/ft; or Sand, Friction Angle = 30 deg Bearing Capacity = 150 psf, and Coefficient of Friction = 0.3*	*Spread Footing*	*≤ 35*
D		*Spread Footing*	*$35 < L \leq 60$*

SIGNAL-CANTILEVER-STRUCTURE FOUNDATION-TYPE DETERMINATION

Figure 77-4 I

BACKUP 01. PROPOSED REVISION TO IDM CHAPTER 77.

Device	*Area, ft^2*	*Weight, lb*
Signal Head with Backplate, 3 Sec., Lens Dia. 12 in.	*8.7*	*35*
Signal Head with Backplate, 5 Sec., Lens Dia. 12 in.	*13.1*	*55*
Regulatory Sign, 36 in. x 30 in.	*7.5*	*19*
Street-Name Sign, 18 in. x 96 in.	*12*	*30*
Street-Name Sign, 18 in. x 132 in.	*16.5*	*41*
Mounted Camera	*1*	*20*
Top-Pole Luminaire	*2.4*	*53*

AREA AND WEIGHT OF DEVICE
TO BE MOUNTED ON SIGNAL CANTILEVER

Figure 77-4J

COMMENTS AND ACTION

SECTION 805 TRAFFIC SIGNALS
805-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS
805-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT
805-T-123 VIDEO VEHICLE DETECTOR SYSTEM
805-T-173 WIRELESS VEHICLE DETECTION SYSTEM
SECTION 922 TRAFFIC SIGNAL MATERIALS
922-T-XXX ANCILLARY TRAFFIC SIGNAL EQUIPMENT
922-T-XXX ALTERNATIVE VEHICLE DETECTION METHODS
805-SGLT-01 LOOP TAGGING SYSTEM
805-SDAC-01 THRUE 09

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: SECTIONS 805; 922 Recurring Special Provision affected: 805-T-123;805-T-173; 805-T-169; 922-T-168; Standard Sheets affected: 805-SGLT-01; PROPOSED NEW: 805-SDAC-01 THRU 09 Design Manual Sections affected: CHAPTER 77-04 AND 77-05 GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book ____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ ____ Revise RSP (No.____) Effective ____ Letting RSP Sunset Date: ____ Standard Drawing Effective ____ ____ Create RPD (No. ____) Effective ____ Letting ____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By ____ Addition or ____ Revision Frequency Manual Update Req'd? Y__N__ By ____ Addition or ____ Revision Received FHWA Approval? _____

Mr. Walker
Date: 12/20/12

SPECIFICATIONS, SPECIAL PROVISIONS AND DRAWINGS

REVISION TO STANDARD SPECIFICATIONS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: Research study SPR 3225 has made several recommendations concerning the depth of treatment and type of geogrid required for subgrade treatments. The depth of treatment for Type IV subgrade treatments and requirements for the geogrid need revision.

PROPOSED SOLUTION: Revise sections 207.04, 214, and 918.05 to specify the requirements of the use of geogrid materials for subgrade treatments.

APPLICABLE STANDARD SPECIFICATIONS: None

APPLICABLE STANDARD DRAWINGS: None

APPLICABLE DESIGN MANUAL SECTION: None

APPLICABLE SECTION OF GIFE: None

APPLICABLE RECURRING SPECIAL PROVISIONS:

PAY ITEMS AFFECTED: None

Submitted By: Ron Walker for Office of Geotechnical Services

Title: Manager, Office of Materials Management

Organization: INDOT

Phone Number: 317-610-7251 x 204

Date: 12-5-12

APPLICABLE SUB-COMMITTEE ENDORSEMENT: None

REVISION TO STANDARD SPECIFICATIONS

SECTION 207 - SUBGRADE
207.04 SUBGRADE TREATMENTS
SECTION 214 - GEOGRID
SECTION 918 - SOIL FABRICS
918.05 GEOGRID

The Standard Specifications are revised as follows:

SECTION 207, BEGIN LINE 114, DELETE AND INSERT AS FOLLOWS:

Type IV. ~~9~~*12* in. ~~(225 mm)~~ of the subgrade excavated and replaced with coarse aggregate No. 53 on geogrid.

SECTION 214, BEGIN LINE 3, DELETE AND INSERT AS FOLLOWS:

214.01 Description

This work shall consist of furnishing and installing geogrid as shown on the plans *or as directed by the Engineer* and in accordance with 105.03.

MATERIALS

214.02 Materials

Materials shall be in accordance with 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 surface soils. Construction activities using equipment which cause pumping and rutting of the embankment foundation soils shall be prevented whenever possible ~~or~~ *and shall* otherwise *be* 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 *or root mat*. The embankment foundation shall be subject to approval prior to placement of geogrid. Proofrolling of the embankment foundation will not be required *when geogrid is used in construction of embankment foundation treatment*.

214.04 Geogrid Placement

The geogrid shall be installed in accordance with the *Engineer's designs and/or* 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~~*shall* require the use of stakes, *staples, sandbags, pile of granular fill, or other approved means* to hold the geogrid in place *during fill placement operations. Type IA geogrid shall be used for embankment foundation treatment. Type IB geogrid shall be used for subgrade construction. When placing Type IA geogrid, any rutting in the granular material shall not exceed 3 in. The Engineer may increase the lift thickness to obtain stability of the granular material.*

REVISION TO STANDARD SPECIFICATIONS

SECTION 207 - SUBGRADE
207.04 SUBGRADE TREATMENTS
SECTION 214 - GEOGRID
SECTION 918 - SOIL FABRICS
918.05 GEOGRID

If required by the Engineer, T~~t~~he 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.~~

When Type IB geogrid is used, proofrolling shall be performed prior to placing the Type IB geogrid. The first 6 in. of coarse aggregate No. 53 shall be spread and compacted with a 10 T roller in static mode. The spreading and compaction of the aggregate shall be performed so that adequate interlocking of the aggregate and geogrid is obtained. The second 6 in. of coarse aggregate No. 53 shall be constructed in accordance with 301.

The ~~G~~*g*eogrid shall be overlapped a minimum of 2 ft ~~(0.6m)~~ side to side and end to end for ~~T~~*t*ype 1*B*, ~~and only end to end for type II~~. The *Type IA* geogrids shall be overlapped 3 ft ~~(0.9 m)~~ in areas where foundation conditions cannot support foot traffic or where 2 ft ~~(0.6m)~~ is found to be inadequate during fill placement. Overlaps shall be oriented *in the direction of fill placement*, or shingled, to prevent advancing fill from lifting *any* ~~the~~ geogrid *roll edges*. Overlaps shall be further secured to prevent separation during fill placement. Damaged geogrid shall be patched. Patching shall include placement of a minimum of 3 ft ~~(0.9m)~~ 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 3 calendar days after placement. Only the amount of geogrid required for pending work shall be placed to minimize exposure of the geogrid.

When the geogrid reinforced subgrade is constructed next to an existing road, the geogrid shall be placed at least 12 in. into the existing pavement.

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 1st lift *of embankment foundation treatment* if the fill is determined to be too ~~soft~~*weak* 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 aggregate used for the embankment*

REVISION TO STANDARD SPECIFICATIONS

SECTION 207 - SUBGRADE
207.04 SUBGRADE TREATMENTS
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918.05 GEOGRID

foundation improvement will be measured in accordance with 301. ~~The portion of geogrid out off or turned up into backfill layer will not be measured for payment.~~ *The geogrid reinforced subgrade shall be measured in accordance with 207.*

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. *The aggregates will be paid for in accordance with 301. The geogrid reinforced subgrade shall be paid for in accordance with 207.*

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 918, BEGIN LINE 81, DELETE AND INSERT AS FOLLOWS:

918.05 Geogrid

Geogrid shall be ~~on~~*biaxial or multi axial of* a regular network of ~~in integrally~~ connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding material. *The material shall be polypropylene, ASTM D 4101 (97% Min) and Carbon Black, ASTM D 1603 (0.5% Min).* 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, *GRI,* Standard Test Methods GG1, GG3, GG4, ~~and~~ ASTM D 5262, *and ASTM D 6637*.

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,

REVISION TO STANDARD SPECIFICATIONS

SECTION 207 - SUBGRADE
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deterioration, or damage incurred during manufacture, transportation, or storage. All damaged portions of geogrid *shall be replaced* for the entire width *of the roll* ~~shall be replaced~~. *All the geogrid shall meet the requirements of ASTM D 4873. The Contractor shall furnish the product labels that clearly show the manufacturer's or supplier name, product identification, lot number, manufactured date, roll dimension and provide a document that the material is in accordance with manufacturer's or supplier's certificate.*

Only geogrids selected from the 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 C. ~~No relabeled materials will be considered for approval. A specified material shown on the approved list will not be listed under more than 1 name~~.

The geogrid shall be in accordance with the property requirements for the type specified as follows.

(a) Type I

PROPERTY	TEST METHOD	UNIT	*Type 1A* VALUE Min.	*Type 1B VALUE, Min.*
Aperture *Area*	Calibered	*Sq* in. ~~(mm)~~	~~0.5 by 0.5~~ *1.4* ~~(13 by 13)~~	*1.4*
Open Area	COE, CW~~O~~*02*215	percent	> 50.0, ≤ 80.0	*>50.0, ≤ 80.0*
Junction Strength	*ASTM D 7737*	*lbs/ft*	-----	*788*
Tensile Modulus, machine direction cross machine direction	 ASTM D 6637[1,2,3]	 lb/ft ~~(N/m)~~ lb/ft ~~(N/m)~~	 10,000 ~~(146,000)~~ 10,000 ~~(146,000)~~	 *10,000* *10,000*
Ultimate Strength, machine direction cross machine direction	 ASTM D 6637[2,3]	 lb/ft ~~(N/m)~~ lb/ft ~~(N/m)~~	 800 ~~(11,670)~~ 800 ~~(11,670)~~	 *800* *800*
Ultra Violet Stability	*ASTM D 4355*	-----	-----	*70% at 500 hrs*

1. Secant modulus at 5% elongation.
2. Results for machine direction, MD, and cross machine direction, CMD, are required.
3. Minimum average roll values shall be in accordance with ASTM D 4759.
4. *GRI –Geosynthetic Research Institute*

(b) Type II

PROPERTY	TEST METHOD	UNIT	VALUE, Min.
Open Area	COE, CW~~O~~*02*215	percent	> 50.0, ≤ 80.0
Tensile Modulus,			

REVISION TO STANDARD SPECIFICATIONS

SECTION 207 - SUBGRADE
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machine direction	ASTM D 6637[1,2]	lb/ft ~~(N/m)~~	49,300 ~~(720,000)~~
Ultra Violet Stability	*ASTM D 4355*	*70% at 500 hrs*	
Creep Limited Strength, machine direction at 5% strain	ASTM D 5262	lb/ft ~~(N/m)~~	1,090 ~~(16,000)~~

1. Secant modulus at 2% elongation.
2. Minimum average roll values shall be in accordance with ASTM D 4759.

(c) Type III

Geogrid material shall be of high-density polyethylene, HDPE; polypropylene, PP; or polyester, PET, polymers and have the following properties.

PROPERTY	*TEST METHOD*	*UNIT*	*VALUE, Min.*
Open Area	*COE CW 02215*	*percent*	*>50.0, ≤ 80.0*
Ultra Violet Stability	*ASTM D 4355*	*70% at 500 hrs*	
Ultimate Strength ,machine direction	*ASTM D 6637*	*lb/ft*	*1,500*[2]
Long-Term Design Strength, Allowable, LTDS, machine direction	*GRI-GG4*	*lb/ft*	*1,000*[2]

1. *Geogrid shall have an adequate open aperture to establish proper interlock between geogrid and backfill material.*
2. *Minimum Average Roll Value, MARV: Property value calculated as average minus two standard deviations.*

$$LTDS = \frac{T_{ult}}{(RF_{CR})(RF_{IR})(RF_D)}$$

Where:

T_{ult} = *Ultimate strength*
RF_{CR} = *Reduction factor for creep*
RF_{IR} = *Reduction factor for installation damage*
RF_D = *Reduction factor for durability*

3. *The minimum reduction factors are as follows:*
   RF_{CR} = *2.6 for HDPE, 4.0 for PP, 1.6 for PET*
   RF_{IR} = *1.10*
   RF_D = *1.10*
4. *Independent laboratory test results for creep test in accordance with ASTM D 5262 shall be submitted.*

COMMENTS AND ACTION

SECTION 207 - SUBGRADE
207.04 SUBGRADE TREATMENTS
SECTION 214 - GEOGRID
SECTION 918 - SOIL FABRICS
918.05 GEOGRID

Motion: Mr. Second: Mr. Ayes: Nays:	Action: _____ Passed as Submitted _____ Passed as Revised _____ Withdrawn
Standard Specifications Sections affected: SECTION 207.04 pg 188; SECTION 214 pg 205 thru 207; section 918.05 pg 957 thru 958. Recurring Special Provision affected: NONE Standard Sheets affected: NONE Design Manual Sections affected: NONE GIFE Sections cross-references: NONE	_____ 2014 Standard Specifications Book ____ Revise Pay Items List _____ Create RSP (No._____) Effective _____ Letting RSP Sunset Date: _____ ____ Revise RSP (No.____) Effective ____ Letting RSP Sunset Date: ____ Standard Drawing Effective ____ ____ Create RPD (No. ____) Effective ____ Letting ____ Technical Advisory GIFE Update Req'd.? Y ___ N ___ By ____ Addition or ____ Revision Frequency Manual Update Req'd? Y__N__ By ____ Addition or ____ Revision Received FHWA Approval? _____