



INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

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

APPROVED MINUTES

August 18, 2011 Standards Committee Meeting

MEMORANDUM

September 19, 2011

TO: Standards Committee

FROM: Scott Trammell, Secretary

RE: Minutes from the August 18, 2011 Standards Committee Meeting

A Standards Committee meeting was called to order by Mr. Miller at 9:04 a.m. on August 18, 2011 in the N955 Bay Window Conference Room. The meeting was adjourned at 10:40 a.m.

The following committee members were in attendance:

Mark Miller, Chairman
Jim Keefer, Fort Wayne District
Prakash Patel*, Roadway Services
Greg Pankow, Const. Mgmt.
Bob Cales, Contr. Admin.

Dave Boruff, Traffic Admin.
Ron Walker, Materials Mgmt.
Randy Strain, Str. Services
Dave Andrews, Pvmt. Eng.

**Proxy for John Wright*

Also in attendance were the following:

Scott Trammell, Secretary
Mohammad Hajeer, FHWA
Steve Fisher, INDOT SiteMgr.
Paul Berebitsky, ICA

Bren George, FHWA
Sharig Husain, INDOT
Tony Uremovich, INDOT
Lana Podorvanova, INDOT

The following agenda items were listed for consideration

Page No.

A. GENERAL BUSINESS ITEMS

OLD BUSINESS

(No items were considered)

NEW BUSINESS

1. Approval of minutes from July 21, 2011 meeting

Note: Mr. Miller asked everyone to respond electronically with their comments or approval for the July meeting minutes.

2. Establish section 800 and 900 committees to identify target areas and clean up design information in those sections of the standard specifications

DISCUSSION: This item was introduced by Mr. Miller who expressed the need for cleaning up the design information in those sections. Mr. Miller stated that this will be a big task, which is worthwhile and will rely on the design people quite a bit. Mr. Miller will be in contact with Mr. Wright in order to form these committees.

B. CONCEPTUAL PROPOSAL ITEMS1. Implementation of seismic research and seismic guide specification pg 05C. STANDARD SPECIFICATIONS, SPECIAL PROVISIONS AND STANDARD DRAWINGS PROPOSED ITEMSOLD BUSINESSItem No. 01 07/21/11 (2012 SS) Mr. Wright pg 07

805.03	General Requirements
805.04	Pole Installation
805.05	Placing Signal Heads
805.13	Foundations
805.15	Method of Measurement
805.16	Basis of Payment

Recurring Special Provision
922-T-168

TRAFFIC SIGNAL MATERIALS AND EQUIPMENT

Standard Drawings

805-TSCS-01	TRAFFIC SIGNAL CANTILEVER STRUCTURE SIGNAL ARM DIMENSIONS & DETAILS
805-TSCS-02	TRAFFIC SIGNAL CANTILEVER STRUCTURE POLE DIMENSIONS AND DETAILS ELEVATION
805-TSCS-03	TRAFFIC SIGNAL CANTILEVER STRUCTURE BASE PLATE, BOTTOM SPLICE PLATE DETAILS
805-TSCS-04	TRAFFIC SIGNAL CANTILEVER STRUCTURE SIGNAL ARM CONNECTION DETAILS
805-TSCS-05	TRAFFIC SIGNAL CANTILEVER STRUCTURE HANDHOLE DETAILS
805-TSCS-06	TRAFFIC SIGNAL CANTILEVER STRUCTURE PLACEMENT OF SIGNALS AND SIGNS LOADING FOR ARM 35' OR LESS
805-TSCS-07	TRAFFIC SIGNAL CANTILEVER STRUCTURE PLACEMENT OF SIGNALS AND SIGNS LOADING FOR ARMS > 35' TO 60'
805-TSCS-08	TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM DIMENSIONS & DETAILS

805-TSCS-09	TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION POLE DIMENSIONS AND DETAILS ELEVATION
805-TSCS-10	TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM CONNECTION DETAILS
805-TSCS-11	TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION POLE SPLICE DETAILS FOR ARMS 35' OR LESS
805-TSCS-12	TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION POLE SPLICE DETAILS FOR ARMS > 35' TO 60'
805-TSCS-13	TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM LOADING FOR 35' ARM OR LESS
805-TSCS-14	TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM LOADING FOR ARMS > 35' TO 60'
805-TSCS-15	TRAFFIC SIGNAL CANTILEVER STRUCTURE DRILLED SHAFT FOR ARMS 35' OR LESS TYPE A
805-TSCS-16	TRAFFIC SIGNAL CANTILEVER STRUCTURE DRILLED SHAFT FOR ARMS > 35' TO 60' TYPE B
805-TSCS-17	TRAFFIC SIGNAL CANTILEVER STRUCTURE SPREAD FOUNDATION FOR ARMS 35' OR LESS TYPE C
805-TSCS-18	TRAFFIC SIGNAL CANTILEVER STRUCTURE SPREAD FOUNDATION FOR ARMS > 35' TO 60' TYPE D
Indiana Design Manual	
77-4.03	Signal Mounting
77-4.04	Signal Cantilever Structure Selection Guidance and Design Criteria
77-4.04 (1)	Selection Guidance
77-4.04 (2)	Design Criteria
77-4.045	Signal Display
77-5.01	Design Criteria
77-5.02	Placement of Signal Equipment
Figure 77-4I	SIGNAL-CANTILEVER STRUCTURE FOUNDATION-TYPE DETERMINATION
Figure 77-4J	AREA AND WEIGHT OF DEVICE TO BE MOUNTED ON SIGNAL CANTILEVER

ACTION:

PASSED AS REVISED

NEW BUSINESS

<u>Item No. 01</u>	<u>08/18/11 (2012 SS)</u>	<u>Mr. Wright</u>	<u>pg 79</u>
Indiana Design Manual			
17-1.05		Proprietary Material	
Figure 17-1A		Proprietary-Material Transmittal Memorandum	
Figure 17-1B		APPROVED PROPRIETARY MATERIALS	
Figure 17-1C		CERTIFICATION FOR PROPRIETARY-MATERIAL USE, NO SUITABLE EQUAL EXISTS	
Figure 17-1D		CERTIFICATION FOR PROPRIETARY-MATERIAL USE, ESSENTIAL FOR SYNCHRONIZATION	
Figure 17-1E		PUBLIC-INTEREST FINDING FOR PROPRIETARY- MATERIAL USE	
Figure 17-1F		PROGRAMMATIC CERTIFICATION FOR	

(CONTINUED)

PROPRIETARY-MATERIAL USE, NO SUITABLE
EQUAL EXIST

Note:

This item did not require a committee
action.

cc: Committee Members (11)
FHWA (3)
ICA (1)

CONCEPTUAL PROPOSAL

1. IMPLEMENTATION OF SEISMIC RESEARCH AND SEISMIC GUIDE SPECIFICATION

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: The Joint Transportation Research Program has completed two research projects. The first research project is "Long-Term Behavior of Integral Abutment Bridges" and the second research project is "Earthquake Resistance of Integral Bridges". It is of great advantage for the Department to implement the findings of these research projects into our design policy. In addition to the implementation of these research findings, the Department would like to formally adopt the "AASHTO Guide Specifications for LRFD Seismic Bridge Design" as the design policy for seismic design.

PROPOSED SOLUTION: The two research projects and the guide specification are all related to seismic design. The research project investigating the long term behavior of integral abutments recommends the extension of the maximum length allowed and contains recommendations for skew. The seismic research of the integral abutments contains recommendations for integral abutments in higher seismic vulnerable areas. An ad-hoc committee is needed to implement these changes. The integral abutment details will have some additional detailing requirements. The design manual will have to be revised to reflect the new limits and approval from Federal Highway will be required.

APPLICABLE STANDARD SPECIFICATIONS: None

APPLICABLE STANDARD DRAWINGS: 609-RCBA-02

APPLICABLE DESIGN MANUAL SECTION: 409-2.0 and figures 409-2A, 409-2B, and 409-2C

APPLICABLE SECTION OF GIFE: None

APPLICABLE RECURRING SPECIAL PROVISIONS: None

PAY ITEMS AFFECTED: None

Submitted By: Randy Strain

Title: Implementation of seismic research and seismic guide spec.

Organization: Engineering Services & Design Support

Phone Number: 317-232-3339

Date: 08-01-11

APPLICABLE SUB-COMMITTEE ENDORSEMENT: ASCE Structural Subcommittee

CONCEPTUAL PROPOSAL

1. IMPLEMENTATION OF SEISMIC RESEARCH AND SEISMIC GUIDE SPECIFICATION

DISCUSSION: This item was introduced by Mr. Strain, who explained that the intent is to adopt the AASHTO design spec for this subject matter. Mr. Strain also mentioned that we will need FHWA to be on board with this, and further stated that there has been more liquefaction than had been previously anticipated, creating a need for an integral abutment to be utilized.

Mr. Strain said he will contact the Geotechnical Division internally to get their input and will also gather input from FHWA. Mr. George (FHWA) concurred.

Mr. Strain mentioned that longer integral abutments will require more work. Mr. Strain also commented that it may take a few months to put all of the information together and that he will present it to the group at a later date.

SPECIFICATION REVISIONS

(OLD BUSINESS ITEM)

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

PROPOSAL TO STANDARDS COMMITTEE

PROBLEM(S) ENCOUNTERED: Existing Signal Mast Arm standard drawings doesn't meet the latest "AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals" requirements.
Noticed Unit conversion and decimal point discrepancies.

PROPOSED SOLUTION: New Signal Cantilever Structures and foundation standard drawings were developed meeting the latest AASHTO code (2009 fifth edition) requirements.
Corrected discrepancies.

APPLICABLE STANDARD SPECIFICATIONS: 805, 922

APPLICABLE STANDARD DRAWINGS: New Standard Drawings 805-TSCS-01 thru 18

APPLICABLE DESIGN MANUAL SECTION: 77-4.03, 77-4.04, 77-4.05, 77-5.01, 77-5.02

APPLICABLE SECTION OF GIFE: N.A.

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

PAY ITEMS AFFECTED: Revision to the related pay items is in the attached RSP 805-T-169.

Submitted By: John Wright

Title: Director of Highway and Tech Support

Organization: INDOT

Phone Number: 317-232-5147

Date: 6/22/2011

APPLICABLE SUB-COMMITTEE ENDORSEMENT: Ad hoc review by industry, subcommittee from INDOT traffic section, Traffic System Division.

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

SECTION 805 - TRAFFIC SIGNALS

805.03 GENERAL REQUIREMENTS

805.04 POLE INSTALLATION

805.05 PLACING SIGNAL HEADS

805.13 FOUNDATIONS

805.15 METHOD OF MEASUREMENT

805.16 BASIS OF PAYMENT

(Underlined changes have been approved on May 05, 2008.)

The Standard Specifications are revised as follows:

SECTION 805, BEGIN LINE 79, DELETE AND INSERT AS FOLLOWS:

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 2 coats of highway yellow enamel. Aluminum poles and ~~mast arms~~ *signal support structures* shall not be painted.

SECTION 805, BEGIN LINE 146, DELETE AND INSERT AS FOLLOWS:

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 *a 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.*

SECTION 805, BEGIN LINE 162, DELETE AND INSERT AS FOLLOWS:

805.05 Placing Signal Heads

~~Mast~~ *Signal cantilever* arm and span mounted signal heads shall have 17.5 ft (5.23 m) minimum and 19 ft (5.8 m) maximum clearance over the roadway unless there are visual obstructions which require lowering the signal head. A signal head over the roadway shall not have a clearance of less than 15 ft (4.6 m). Such signal heads shall be located over the intersection as shown on the plans. Such signal heads shall have a

SECTION 805, BEGIN LINE 436, DELETE AND INSERT AS FOLLOWS:

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.

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

SECTION 805 - TRAFFIC SIGNALS

805.03 GENERAL REQUIREMENTS

805.04 POLE INSTALLATION

805.05 PLACING SIGNAL HEADS

805.13 FOUNDATIONS

805.15 METHOD OF MEASUREMENT

805.16 BASIS OF PAYMENT

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

SECTION 805, BEGIN LINE 458, DELETE AND INSERT AS FOLLOWS:

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 arm; signal cantilever structure, combination arm; signal cantilever structure, pole section 2, pole diameter 17 in. (432 mm); signal cantilever structure, pole section 2, pole diameter 24 in. (610 mm); 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; loop detector delay amplifier; loop detector delay counting amplifier; loop detector rack; auxiliary BIU panel; 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.

SECTION 805, BEGIN LINE 493, DELETE AND INSERT AS FOLLOWS:

If specified as pay items, traffic signal controller and cabinet; traffic signal head; pedestrian signal head; pedestrian push button; controller cabinet foundation; M foundation modified to P-1 foundation; signal steel strain pole; signal wood pole; ~~signal cantilever structure~~; *signal cantilever structure, signal arm; signal cantilever structure, combination arm; signal cantilever structure, pole section 2, pole diameter 17 in. (432 mm); signal cantilever structure, pole section 2, pole diameter 24 in. (610 mm); 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 handhole; signal detector housing; span catenary and tether; and span catenary for flasher will be paid for at the contract unit price per each. Conduit of the type specified, signal cable, interconnect cable, electrical signal cable, loop lead-in cable, and saw cut for roadway loop detector and sealant will be paid for at the contract unit price per linear foot (meter).*

SECTION 805, AFTER LINE 540, DELETE AND INSERT AS FOLLOWS:

805.16 BASIS OF PAYMENT

Signal Cantilever Structure, Spread Footing Foundation, EACH
type

The cost of signal pole section 1 shall be included in the cost of the signal cantilever structure.

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(Underlined changes have been approved on May 19, 2011.

Basis for Use: Required for all contracts with 805 pay items).

922-T-168 TRAFFIC SIGNAL MATERIALS AND EQUIPMENT

(Revised 05-23-11)

The Standard Specifications are revised as follows:

SECTION 922, DELETE LINES 1 THROUGH 1850.

SECTION 922, AFTER LINE 1850, INSERT AS FOLLOWS:

SECTION 922 – TRAFFIC SIGNAL MATERIALS

922.01 Description

All traffic signal materials and equipment shall be in ~~strict~~ accordance with the NEMA TS 2-2003 Standards Publication, and be ~~fully~~ compatible with the Department's current inventory of signal equipment, unless specifically outlined in the following specification.

922.02 Traffic Signal Control Equipment

10 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 ~~C~~ontroller ~~U~~nit, CU; ~~M~~alfunction ~~M~~anagement ~~U~~nit, MMU; ~~B~~us ~~I~~nterface ~~U~~nit(s), BIU; ~~C~~abinet ~~P~~ower ~~S~~upply; ~~L~~oad ~~S~~witches; ~~V~~ehicle ~~D~~etector equipment; ~~C~~ellular ~~M~~odems; ~~R~~adio ~~M~~odems, and ~~F~~lasher. The evaluation of a product will be considered
20 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(s), the operational manual(s) containing procedures for all features incorporated in the CU's design, and the maintenance manual(s) 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 ~~P~~rotocol ~~A~~nalyzer shall accompany the initial documentation as well. When accuracy of documentation is validated, the evaluation period may commence. In
30 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

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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.

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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.

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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.

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Each CA shall be supplied with ~~three~~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:

70

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 Pparts Llist indicating Ccontract Nnumber, Vvendor, Ccategory, Mmanufacturer, Mmodel, Sserial number, Ssoftware/Efirmware version as applicable, and Iinventory 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 in. x 17 in. intersection design plan; the electronic document shall be Adobe (.pdf).

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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(s) 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 five-year manufacturer's or vendor's warranty shall be provided for all major units operating in a TS2 environment. Light 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. 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 I.C. 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 five years from the date of approval or unless a significant change is made in the CU. If a significant change is made, a new certification shall be submitted. A significant change shall be the addition or deletion of any function or feature in the control unit, or any other change as defined in 922.02(a) to the circuitry in the product.

2. Certification of Environmental Testing

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

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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.

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(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.

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1. General Requirements

The CU shall be microprocessor based and both versions shall contain a ~~three~~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.

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A removable nonvolatile EEPROM module shall be utilized in each CU to maintain all programmed data. A real-time clock shall be battery-backed 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.

160

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.

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

170 *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 Pport 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.*

180 *The CU shall be capable of all inputs and outputs listed by controller type in NEMA TS2-~~Section 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.*

190 *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~~ ~~version~~ 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.

3. Internal Modules

200 *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.

210 *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

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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

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

1. Controller Cabinet Requirements

230 *The NEMA TS2 Ttype A1 controller cabinet shall be in accordance with the following requirements.*

a. General

The cabinet and the ~~shelf~~ or shelves shall be fabricated of aluminum. The cabinet shall be ~~0.125~~ 1/8 in. (3.1758 mm) minimum thickness sheet aluminum or ~~0.25~~ 1/4 in. (6.35 mm) minimum thickness die-cast aluminum. The cabinet exterior and interior including shelves shall have a sandblasted, roughened, or chemically etched finish that reduces gloss, reflection, and glare.

240 *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.*

250 *A rain channel shall be incorporated into the design of the main door panel to prevent liquids from entering the enclosure. A ~~4.5~~ 1 1/2 in. (38 mm) 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 (23 kg) 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. (610 mm) wide.*

b. Switches, Auxiliary, and Environmental Feature Requirements

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260 *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.*

270 *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 ~~A~~auto/~~F~~flash ~~S~~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 ~~S~~stop ~~T~~ime ~~S~~switch shall be installed so that when in the 'On' position the controller shall be stop-timed in the current interval. A ~~C~~ontroller ~~E~~quipment ~~P~~ower On/Off ~~S~~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.

280 **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, ~~three~~3-prong, NEMA ~~T~~ype 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-amp cartridge fuse wired ahead of the multi-breakers.

290 *Master cabinets shall have an additional duplex, ~~three~~3-prong, NEMA type 5-15R grounding outlet. This outlet shall be powered by the 10-amp 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. (25 mm) thick filter. The thermostat shall be manually adjustable from 90 to 115°F (33 to 45°C). The fan shall be mounted internally at the top and toward the front of the cabinet to exhaust out the front top lip of the cabinet. The fan shall be rated at a minimum of 100 cu ft~~3~~ (3 m³) per minute as designated by NEMA TS2, ~~Section~~ 7.9.1. The thermostat shall be located within 6 in. (150 mm) of the fan.

300 *The filter size will be according to the provisions for the type of cabinet as stated in NEMA TS2, ~~Section~~ 7.9.2.3 and shall be a replaceable pleated air filter with a ~~A~~minimum*

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Efficiency Reporting Value, (MERV), rating of 5 or higher as defined by the ASHRAE 52.2-1999 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 Standards 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 115 volts AC line input or signal buss output. Each load switch shall offer ~~three~~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 Ttype A1 CACU shall be accomplished through front panel data entry of a TS2 Ttype A1 or a TS2 Ttype 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- ~~section 5~~ standards. The model number of the main panel shall be permanently applied to the front of the panel, where it is easily readable, without removing or disconnecting the panel. Each controller input and output circuit shall terminate on the main TF panel or on a supplementary panel. The phase arrangement of the controller shall coincide with the channel arrangement of the load switches and MMU. All outputs on channels 9 through 12 field connections shall have a 1-microfarad μ F 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 24 ~~volt~~V 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,

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350 *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. RS-485 Pport 1 communications cable shall also be of sufficient length to allow any Pport 1 cable to be utilized with any TS2 unit within the CA. The RS-485 harness shall be constructed of a high quality shielded communications cable. The TF panel shall contain a Rresistor/Ccapacitor Nnetwork Ccircuit which will provide an external restart pulse to initiate the startup sequence upon initialization from flash.

360 *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

370 *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-ampere circuit breaker to provide overload protection to the CU, MMU, BIU, +12/24 V DC cabinet power supply, and detection devices. It shall also contain 1 main circuit breaker of 35 or 40 ampere, 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.*

380 *With the CA 10-ampere and Mmain 35 or-40 ampere circuit breakers off (tripped), all units inside the cabinet and the intersection display shall be 'øOff'. With the 10-ampere breaker 'øOn' and main 35-or 40 ampere circuit breaker 'øOff', the signal output shall be 'øOff' and the major units within the cabinet shall function. With the 10-ampere breaker 'øOff' and main 35-or 40 ampere circuit breaker 'øOn', the intersection shall be in flash mode and all units within the cabinet will be 'øOff'.*

390 *The cabinet shall contain a 50 kA 8 x 20 µs surge suppressor. The surge suppressor shall be a 120 ~~v~~æV AC, 15 ~~amp~~æA, minimum 2-stage parallel/series type device and protect lines: Lline-Nneutral, Lline-Gground and Nneutral-Gground, have a maximum continuous operating voltage of 140 V AC, maximum clamp voltage of 350 volts and device status indicators of green/good and red/failed. The device shall plug into a NemaEMA 12 position terminal base wired before and in parallel with the 35—or 40 ampere main signal buss circuit breaker and in series with the 10-ampere circuit breaker for the solid state equipment and provide for a tool-*

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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 (-34 to 74°C). The dimensions of the unit shall not exceed 4-5 1/5 in. (114 mm) wide by 7 in. (178 mm) long by 3-5 1/2 in. (89 mm) deep.

All equipment capable of operating at 12 or 24 ~~vol~~V 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-~~Section 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, 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-~~Section 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 RS-232 serial data connection and software interface capable of displaying loop status including but not limited to operating frequency and $-\Delta L/L$, diagnostics, and all amplifier settings and operating parameters. Edge mounted printed circuit boards and rack cards shall not have jumper wire modifications unless the jumper wires are permanently bonded to the PCB over its entire length.

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 & 2 count pulses on the edge connection assigned to channels 3 & 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

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accurate status data at all times. All detector input data to the CU shall remain accurate at all times.

- 440 *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.

- 450 *All detection shall be labeled in such a way that the numbering for any \pm loop is consistent throughout the cabinet; the ~~L~~ 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.

- 460 ***c. Detector Rack***

Each detector rack shall be labeled at the bottom of the rack with ~~1~~a continuous label. The label shall be ~~one~~ 1 in. wide, thermal printed black on clear, white or matte polyester tape with permanent adhesive, water, chemical and scratch resistant printed with ~~four~~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 ~~be~~ contain the ~~I~~ntersection 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.

470

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

- 480 *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.*

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b. Modem Hardware

Cell modems shall be Airlink Raven CDMA C3211 or similar modem with the following specifications: The ~~C~~ellular ~~M~~odem shall be capable operating in CDMA dual mode (both 800 MHz cellular and 1.9 GHz PCS bands), supporting both circuit switched and IXRTT packet switched services. The operating voltage range shall include 12~~V~~ and 24~~V~~ DC and shall draw less than 250 ~~m~~A while transmitting and receiving at 12~~V~~ DC. The modem shall have LED indications for power, signal status/strength, and TX/ RX either separately or combined. The serial interface shall be RS-232 with a DB-9 (male or female) connector.

c. Modem Antenna

The RF ~~A~~ntenna connection shall be a 50 ~~ohm~~Ω TNC connector. The antenna shall be a low profile, puck style, flat mount ~~D~~dual ~~B~~band, (800 and 1900 MHz) with ~~L~~ow ~~L~~oss RG-58 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 RG-58 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 TS-2 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 ~~FHSS~~ (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

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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 RS-232, or RS422/RS485, or FSK 1200 Bbaud 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 120~~V~~ AC operation. The modems shall be rack or shelf mounted in standard NEMA TS-2 type 1 or type 2 cabinets. The modems shall have an operation temperature of -40 to +176°F (-40 to 80°C), have a maximum current draw of 500 mA for the transmission of 1 watt of RF output power, while operating on 12~~V~~ 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 ~~GUI~~, 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~~(s)~~ 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 μ s pulse, an insertion loss or ≤ 0.1 dB, have an operating frequency in the 900 MHz range, allow throughput energy to be ≤ 220 μ J for 6 kV /3 kA @ 8/20 μ s 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 ~~V~~oltage ~~S~~tanding ~~W~~ave ~~R~~atio, (VSWR,) of the omni antenna shall be 1.5:1 or less when the antenna coax feed impedance is 50 ~~ohms~~ 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

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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

580 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 ~~V~~oltage ~~S~~tanding ~~W~~ave ~~R~~atio, ~~(VSWR)~~ of the omni antenna shall be 1.5:1 or less when the antenna coax feed impedance is 50 ~~ohms~~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

590 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.

600 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.

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

(g) Cabinets

1. Size 3 (G) Cabinet

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The size 3 (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. (305 mm) 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. (635 mm) wide, 38 in. (965 mm) high, 18 in. (460 mm) deep with a tolerance of ± 4 in. (100 mm) 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. (114 mm) outside diameter pipe and shall have a minimum of ~~three~~ 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) Cabinet

As per NEMA TS2-5.3, the TS2 type ~~1-size 5~~ (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. (380 mm) below the top of the cabinet and the second located 7 in. (180 mm) 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. (760 mm) wide, 48 in. (1220 mm) high, and 16 in. (410 mm) deep with a tolerance of ± 2 in. (± 50 mm) in any or all dimensions.

Anchor bolts shall be steel in accordance with ASTM A 36 (~~ASTM A 36M~~). Diameter of the bolt shall be 1/2 in. (13 mm) or 5/8 in. (16 mm) and the minimum length shall be 15 in. (380 mm) plus a 3 in. (75 mm) right angle hook on the unthreaded end.

The top 6 in. (150 mm) of the bolt shall be threaded with 13 NC threads on 1/2 in. (13 mm) bolts and 11 NC threads on 5/8 in. (16 mm) bolts. The hexagon nut, the flat washer, and the threaded end of the bolt shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

3. Size 6 (P-1) Cabinet

The size 6 (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. (510 mm) below the top of the cabinet and the second located 7 in. (178 mm) below the first shelf a minimum of 30 in. (762 mm) above the bottom of the cabinet, the second located 12 in. (305 mm) above the first shelf.

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The cabinet shall be 44 in. (1,120 mm) wide, 52 in. (1,320 mm) high, and 24 in. (610 mm) deep with a tolerance of ± 3 in. (± 75 mm) in any or all dimensions. Maximum exterior dimensions shall be 47 in. (1,195 mm) wide, 63 in. (1,600 mm) high, and 34 in. (860 mm) deep.

4. Size 7 (R) Cabinet

670 *The Size 7 (R) cabinet shall be ground mounted on a concrete foundation at locations and dimensions as shown on the plans with anchor bolts in accordance with 922.02(g)2. As per NEMA TS2-5.3, the TS2 type 1 R cabinet, at minimum, shall house a 16-load switch bay (configuration 3) terminal and facilities panel and shall have ~~three~~3 adjustable shelves with the first shelf located a minimum of 30 in. (762 mm) above the bottom of the cabinet, the second located 12 in. (305 mm) 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. (1,600 mm ± 75 mm) above the top of the concrete footpad.*

The cabinet shall be 44 in. (1,120 mm) wide, 72 in. (1,830 mm) high, and 24 in. (610 mm) deep with a tolerance of ± 3 in. (± 75 mm) in any or all dimensions. Maximum exterior dimensions shall be 47 in. (1,195 mm) wide, 83 in. (2,110 mm) high, and 34 in. (860 mm) deep.

5. Flasher- Two Circuit Alternating Flasher

680 *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.

690 *The flasher shall be a type 3 solid state flasher conforming to Section 8 of the NEMA Standards Publication TS 1-1983. The flasher output circuit carrying the signal load shall consist of opto or photo isolated solid state power relays and shall be hard wired to the flasher connector.*

Three schematic diagrams and 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.

700 *The flasher shall operate between 95 ~~volts~~V and 135 ~~volts~~V AC 60 Hertz. No degradation of performance shall be experienced in environmental changes from -20°F to 165°F (-29°C to 74°C) and 0 to 90% relative humidity.*

b. Cabinet Requirements

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The cabinet shall be weatherproof and fabricated from cast aluminum or aluminum sheeting with a minimum thickness of ~~0.125~~ 1/8 in. (3.18 mm). The cabinet door shall be the entire front of the cabinet and shall be hinged on the right or left side of the cabinet. A Corbin No. 2 lock and 2 No. 2 keys shall be furnished. The lock shall be located near the center of the door on the side opposite the hinge.

710

Minimum dimensions for the cabinet shall be 12 in. (305 mm) deep, 12 in. (305 mm) wide, and 12 in. (305 mm) high. The maximum dimensions shall be 18 in. (460 mm) deep, 15 in. (380 mm) wide, and 18 in. (460 mm) high.

The cabinet shall have 2 pole plates for stainless steel band mounting of the cabinet on a pole with a minimum diameter of 4 in. (100 mm) and a maximum diameter of 18 in. (460 mm). Two blank cover plates shall be provided. Two hub plates for 1 in. (25 mm) diameter conduit shall be provided with gaskets, 8 bolts at four bolts per plate, nuts, and washers for attaching the hub plates to the cabinet. The cabinet shall be drilled for the mounting of the pole plates or hub plates as shown on the plans.

720

It shall have a screened vent in the bottom with a minimum size of 1 3/4 sq in. (1,129 mm²), 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.

730

*Circuit 1 - for connection of field signals (~~E~~flash circuit 1)
Circuit 2 - for connection of field signals (~~E~~flash circuit 2)
Circuit 3 - for connection of field signals (~~E~~field ~~N~~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 (~~Light Emitting Diode~~) modules. All LED indications shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.

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(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. (305 mm). Each section of a face shall have a rectangular silhouette when viewed from the front or the rear.

(b) Housing, Door, and Visor

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750 *The top and bottom of each housing shall have an integral locking ring with 72 serrations to permit rotation of the signal housing in 5 degree increments. Hub openings in the top and bottom of the signal housing shall accommodate standard 1 1/2 in. (38 mm) bracket arms. The thickness of the hub at the top and bottom of the housing shall be a maximum of 1 in. (25 mm) and a minimum of 3/8 in. (10 mm). The 12 in. (305 mm) door shall have 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

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

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

All LED ~~indications~~ indicators provided shall be individually listed on a ~~P~~parts-~~L~~list indicating the ~~C~~contract ~~N~~umber, ~~V~~endor, ~~C~~ategory, ~~M~~anufacturer, ~~M~~odel, ~~S~~erial ~~N~~umber and ~~I~~nventory ~~N~~umber. Hard-copy and electronic copies shall be provided. The
770 *electronic document shall be MS Excel (.xls) format and the blank worksheet shall be obtained from the Department's Logistical Support Center.*

(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

780 *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 ~~to~~in accordance with Institute of Transportation Engineers Standards.*
- 2. The opening between joined sections shall accommodate two 1/2 in. (13 mm) cables.*
- 3. The maximum length of bolts used to connect sections together shall be 4 in. (100 mm).*

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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.

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(f) Terminal Block

800 The yellow 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. (13 mm). The height of the insulating ridge between screw connections shall be a minimum of 19/32 in. (15 mm) from the base of the terminal blocks.

(g) Material Requirements

1. Polycarbonate Signal Head

810 The housing, door, and visor of the section shall be made of ultraviolet and heat stabilized polycarbonate. The color shall be permanently molded into the components except the inside surface of the visor shall be painted non-reflecting flat black. The color shall be yellow in accordance with 909.02(b)4.

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

820 **(h) 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

830 A pedestrian signal shall be 1 section and rectangular in shape. The dimensions of each side may vary from 18 to 19 in. (460 to 485 mm), including the visor and the hinges. The signal shall contain 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. 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) 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

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840 the 1 1/2 in. (38 mm) 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.

850 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) Message

860 The upraised hand and walking person symbols shall each be a minimum of 11 in. (280 mm) in height. The width of the upraised hand symbol shall be a minimum of 7 in. (178 mm). The width of the walking person symbol shall be a minimum of 6 in. (150 mm). Message configuration, color, and size shall be in accordance with the standard of the Institute of Traffic Engineers for Pedestrian Traffic Control 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.

870 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.

922.05 Signal Bulbs

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

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

INDICATION WATTAGE

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	9 in. (230 mm) pedestrian	67
	12 in. (305 mm) pedestrian	116
	18 in. (455 mm) pedestrian	116
	12 in. (305 mm) red	150
	12 in. (305 mm) yellow and green	116
890	12 in. (305 mm) 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. (62 mm) for 67 watt bulbs and 3 in. (75 mm) 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. (110 mm) and for 150 watt bulbs shall be 4 3/4 in. (120 mm).*
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 6000 h minimum burning life.*

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. (1.6 mm). The span

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930 *hanger bolt where the eye-bolt or the balance adjuster is attached shall be 5/8 in. (16 mm) diameter.*

940 *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. (4.8 mm) and a maximum thickness of 1/4 in. (6.4 mm) from the base of the ring to the serration peaks. The inside diameter shall be 2 in. (50 mm) and the outside diameter shall be 2 7/8 in. (73 mm).*

The terminal block shall have an 18-point terminal block permanently engraved or etched with sequential numbers indicating the circuits. The terminal block shall not have a method of connection which allows a screw point to damage wires when the wires are securely connected. Each point of connection shall accommodate a minimum of four No. 14 gauge (2-# mm) wires.

950 *The disconnect hanger shall have 2 side entrance holes on opposite sides capable of receiving a 1 1/2 in. (38 mm) plastic or rubber insert to reduce water infiltration. It shall be capable of supporting signal faces in the ambient temperature range of -35 to 120°F (-35 to 49°C) without failure.*

The balance adjuster shall have hex head bolts, lock washers, and nuts for securing the main body of the balance adjuster firmly onto and around the eye-bolt to prevent any twisting or turning of the head suspended below it. The span hanger shall have 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. (13 mm) in diameter.

960 *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. (1.6 mm). No bushings or shims will be allowed in this assembly.

(b) Balance Adjuster

970 *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

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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. (64 mm) 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 slipin connection, the locking device shall be a double nut assembly. If the weatherhead and threaded pipe has a screw-in connection, the locking device shall be a double set screw assembly.

The span hanger shall be furnished with 2 each of J-bolts, lock washers, and hex head nuts. The J-bolt shall be a minimum of 1/4 in. (6.4 mm) diameter and shall have sufficient threads to be able to secure the hanger to a 1/4 in. (6.4 mm) or to a 1/2 in. (13 mm) 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

The multiple pipe arm assembly shall consist of a span hanger assembly, a balance adjuster, a signal weatherhead, a 2, 3, or 4 way pipe arm, 1 1/2 in. (38 mm) pipe, a lower arm assembly, and all related hardware necessary for a complete assembly.

The 2, 3, or 4 way pipe arms shall have a minimum of 2 in. (50 mm) of exposed thread. Each arm of the pipe arm shall be furnished with two 72 serration locking rings. One locking ring shall have a 3 in. (75 mm) outside diameter and one locking ring shall have a 2 3/8 in. (60 mm) outside diameter.

ASSEMBLY	MAXIMUM ALLOWABLE WEIGHT
2 Way	19 lbs (8.6 kg)
3 Way	25 lbs (11.3 kg)
4 Way	28 lbs (12.7 kg)

922.08 Mid-Mast 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 mast signal cantilever arm; and

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1020 (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.

1030 All electrical wiring shall be concealed within the bracket, except that which runs from the bracket to the ~~mast~~ signal cantilever arm.

Upper and lower arms shall be cast from aluminum in accordance with ASTM B 26 (~~ASTM B 26M~~), alloy 713.0-T5 or 356.0-T6. The vertical support tube shall be extruded from aluminum in accordance with to ASTM B 241 (~~ASTM B 241M~~), alloy 6063-T6 or 6061-T6, and the strapping to attach the bracket to the arm shall be stainless steel. All steel or malleable iron parts shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

1040 **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.

1050 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 (~~ASTM B 26M~~), alloy ANSI 356.0-T6. The square base shall include an access door and anchor bolts with nuts and washers. The base shall be 13 3/8 in. (8,630 mm) square and 15 in. (380 mm) in height $\pm 1/4$ in. (± 6 mm). The weight shall be 22 lbs $\pm 5\%$ (~~10.0 kg~~ ± 2.2 kg).

1060 The base shall be designed to support a 150 lbs (68 kg) axial load and 11 sq ft \pm (~~1.0 m²~~) of signal head area rigidly mounted. For design purposes, the distance from the bottom of the base to the center of the signal head area is 18 ft (5.5 m). In addition to the dead load, the base shall be designed to withstand wind 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 in. by 8 1/4 in. $\pm 1/4$ in. (200 mm by 210 mm ± 6 mm) with a stainless steel hex head bolt for attaching the door.

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1070 *The base shall be attached to a foundation by ~~four~~ 4 anchor bolts, with an anchor bolt circle of 12 3/4 in. (324 mm). Slotted lugs shall be integrally cast into the ~~four~~ 4 corners of the base for attachment of the anchor bolts. The anchor bolts shall be steel in accordance to ASTM A 36 (~~ASTM A 36M~~). The diameter of the anchor bolt shall be 3/4 in. (19 mm) with a minimum length of 18 in. \pm 1/2 in. (460 mm \pm 13 mm), plus 2 1/2 to 3 in. (64 to 75 mm) right angle hook on the unthreaded end. The top 4 in. (100 mm) of the bolt shall be threaded with 10 NC threads. The threads, plus 3 in. (75 mm), shall be coated after fabrication in accordance with ASTM A 153 or be mechanically galvanized and in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C. Each anchor bolt shall be provided with 2 hex head nuts in accordance with ASTM A 325 (~~ASTM A 325M~~) and 3 washers. Two of the washers shall have a minimum 2 in. (50 mm) and maximum 2 1/8 in. (54 mm) outside diameter and be in accordance to ANSI B 27, ~~F~~type B regular series and ~~one~~ shall be a nominal 3/4 in. (19 mm) series W washer, in accordance with ASTM F 436 (~~ASTM F 436M~~).*

1080 *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

1090 *The top of the base shall accommodate a pole having a 4 1/2 in. (114 mm) outside diameter. The threads inside the top of the base shall be 4 in. (100 mm) national standard pipe threads. The pole shall be either a steel pedestal pole or an aluminum pedestal pole.*

1100 *A steel pedestal pole shall be a seamless schedule 40 carbon steel pipe in accordance with ASTM A 53, grade B. The pole shall have an outside diameter of 4 1/2 in. (114 mm). The pole shall weigh approximately 10.8 lbs/ft (16 kg/m). The length of the pole shall be as shown on the plans. The pole shall have full depth national standard pipe threads on ~~one~~ end of the pole. The length of threads shall be 2 1/2 in. (64 mm). The pole shall be galvanized, after threading, in accordance with ASTM A 123. The threads shall be cleaned of all excess galvanizing and protected by a suitable shield.*

An aluminum pedestal pole shall be in accordance with ASTM B 241 (~~ASTM B 241M~~) for seamless aluminum alloy, schedule 40, 6061-T6. The outside diameter of the pole shall be 4 1/2 in. (114 mm). The length of the pole shall be as shown on the plans. The pole shall weigh approximately 3.7 lbs/ft (5.5 kg/m). The pole shall have full depth national standard pipe threads on ~~one~~ end of the pole. The length of threads shall be 2 1/2 in. (64 mm) and protected by a suitable shield. The pole shall have a spun finish.

(c) Pole Cap

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1110 *A pole cap shall be supplied for the top of the pole if the pole is used for the mounting of pedestrian signal faces or side mounted signal control cabinets. The pole cap shall be either a cast pole cap of aluminum or a pole cap of spun aluminum.*

A cast pole cap shall be made of aluminum, in accordance with ASTM B 179, alloy ANSI 319.1 or 319.2. The cap shall fit freely on the 4 1/2 in. (114 mm) outside diameter pole. A set screw using a 3/4 in. (19 mm) No. 12 hex head machine screw shall be supplied to hold the cap on the pole. A standard foundry draft will be allowed on the casting.

1120 *A pole cap made from spun aluminum shall be in accordance with ASTM B 209 (ASTM B 209M), alloy 1100-0. The cap shall fit tightly when placed on the end of the pole.*

922.10 Signal Supports

(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.

1130 *The pole shall have a reinforced handhole within 18 in. (460 mm) of the base. The handhole minimum size shall be 5 in. (130 mm) by 8 in. (130 by 200 mm) with a cover and latching device. The pole shall have a top or cap with a set screw that can be removed with small hand tools.*

The pole material shall be in accordance with ASTM A 595 or A 572 with a minimum yield strength of 50,000 psi (345 kPa ~~m~~MPa). The pole shall be galvanized after fabrication in accordance with ASTM A 123.

1140 *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 (0.610 kg/m²).*

1150 *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 572M, grade 345); ASTM A 606; or ASTM A 36 (ASTM A 36M) with minimum yield of 50,000 psi (345 kPa ~~m~~MPa). The minimum width of the bands shall be 3 in. (75 mm) and the bands shall be capable of supporting the pole design load. Each half of the band shall be stamped with the corresponding size number.*

All welding shall be in accordance with 711.32. Welds shall generate the full strength of the shaft. Only longitudinal continuous welding shall be permitted on the pole shaft. Contacting joint surfaces shall be thoroughly cleaned before fabrication then completely sealed by means of welding. Working drawings shall be submitted in accordance with 105.02.

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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.

- 1160 *The steel strain pole shall be capable of supporting a 8,000 lb (35.6 kN) load applied horizontally 18 in. (460 mm) below the top of the pole with a maximum allowable deflection of 0.16 in. (4.1 mm) per 100 lb (445 N) of load. The pole shall be tapered 0.14 in./ft ~~per foot~~ (12 mm/m ~~per meter~~) of length.*

A ~~one~~ piece base plate shall be secured to the base of the pole and shall develop the full strength of the pole. The base plate material shall be in accordance with ASTM A 36 (~~ASTM A 36M~~), A 572 (A 572M), or A 588 (A 588M). The base plate shall have ~~four~~ 4 holes of adequate size to accommodate 2 1/4 in. (57 mm) anchor bolts. The bolt circle shall have a 22 in. (560 mm) diameter and bolt square of 15 1/2 in. (394 mm).

- 1170 *Four high strength steel anchor bolts, 2 1/4 in. (57 mm) diameter and 96 in. (2,400 mm) 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 (~~ASTM A 675M~~) with a minimum yield strength of 55,000 psi (379 ~~kPa~~ ~~m~~MPa) or ASTM A 36 (~~ASTM A 36M~~), special quality, modified to 55,000 psi (379 ~~kPa~~ ~~m~~MPa) or approved equal. The threaded end of the anchor bolt shall have 12 in. (305 mm) of 4 1/2 NC threads and shall be galvanized the length of the threads, plus 3 in. (75 mm). The threaded end shall be coated after fabrication in accordance with ASTM A 153 or be mechanically galvanized and be in accordance with the coating thickness, adherence, and quality requirements of ASTM A 153, class C. The unthreaded end of the anchor bolt shall have a standard L bend for a distance of 9 in. (230 mm) from the centerline of the anchor bolt to the end of the L. In lieu of the standard bend a steel plate 4 1/2 sq in. (2,900 mm²) and 1 1/4 in. (32 mm) thick may be welded to the embedded end of the anchor bolt.*
- 1180

(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.

- 1190 *All poles shall be full length pressure treated by the full cell process in accordance with current specifications as set forth in the AWPAs Standards C1 and C4, using preservative as outlined in standard P5 and set forth in 911.02(h).*

Treatment, handling, and storage methods shall be in accordance with the current AWPAs Standards.

(c) Signal Cantilever Structures

1. General

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1200 ~~A signal cantilever structure shall be designed in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, except where modified herein.~~

~~Where the manufacturer has wind tunnel test data, they may use drag coefficients based on actual tests. Otherwise, the manufacturer shall use the drag coefficients in Table 1.2.5e.~~

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

1210 **~~2. Signal Support~~**

~~The traffic signal pole and mast arm shall be designed to support the loads in accordance with the plans in a 80 mph (129 km/h) wind with gusts to 104 mph (167 km/h). Loading shall assume die cast aluminum heads.~~

~~The traffic signal pole and mast arm shall be designed to provide a 17 ft (5.3 m) minimum clearance at all signals. Clearance shall be the vertical distance from the lowest point of the signal combination to a horizontal plane 3 in. (75 mm) below the base of the mast arm pole or from the lowest point of the signal combination to the pavement surface below the signal combination, whichever governs. Adjustment of the clearance at the installation site shall be by raising or lowering the mast arm along the upper length of the pole. After the pole is anchored to the foundation, the pole design shall permit the mast arm to be rotated 90° in either direction and secured. The cable inlet shall not be obstructed when a field rotation or vertical adjustment of the mast arm is made.~~

1220 ~~There shall be no threads in the wearing surface plane at the point of connection between the clevis clamp and the signal face assembly. The clevis clamp shall have a 11/16 in. (18 mm) diameter bolt hole to receive the signal face assembly.~~

~~3. Combination Signal Luminaire Support~~

1230 ~~All requirements for a signal support shall apply to a combination signal luminaire support.~~

~~The minimum design load of the luminaire shall be 53 lbs (24 kg) with a projected surface area subject to wind loading of 2.4 sq ft (0.223 m²). If heavier or larger luminaires are used, their actual values shall be used. The required luminaire mounting height shall be in accordance with the plans. Mounting height shall be defined as the vertical distance from the lowest point of the luminaire to the horizontal plane that passes through the base of the pole.~~

1240 ~~The maximum percentage of allowable stress shall be 80% of the AASHTO Standard Specifications for Group I loads. Vibration dampers shall be furnished as recommended by the manufacturer.~~

~~4. Pole Requirements~~

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a. General

1250 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 (1.2 to 1.8 m) of a signal support pole may be non-tapered. The pole and arms taper rate shall be 0.14 in./ft (12 mm/m). The signal support pole cantilever structure poles shall have a reinforced handhole as shown on the plans 4 in. (100 mm) by 6 in. (150 mm) minimum complete with cover and latching device located 18 in. (460 mm) above the base. A 1/2 in. (13 mm) 13 NC threaded grounding nut or approved equivalent shall be provided and be accessible through the handhole. The pole cap shall be secured in place with setscrews. The combination signal luminaire pole shall have a reinforced handhole 4 in. (100 mm) by 8 in. (200 mm) minimum complete with cover and latching device, located 18 in. (460 mm) above the base. The combination signal luminaire pole shall be provided with a removable pole cap and integral wire support hook for the luminaire electrical cable. The cable shall be attached to the hook by a service drop clamp. A wiring hole with a 1 in. (25 mm) to 1 1/2 in. (38 mm) inside diameter grommet shall be provided where the luminaire mast arm attaches to the pole.

1260

b. Deflection

The maximum allowable horizontal deflection of the pole under maximum loading conditions shall not exceed a deflection angle of 1° 10" from the vertical axis of the pole for any 1 ft (305 mm) section of the pole along the entire length of the pole.

1270 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.

c. Materials

1280 The signal pole and the combination signal luminaire pole shall be steel or aluminum. Steel poles shall be in accordance with ASTM A 595 or A 572 with a minimum yield strength of 50,000 lbs (345 kPa) and shall be galvanized in accordance with ASTM A 123. Aluminum poles shall be in accordance with ASTM B 221 (ASTM B 221M) alloy 6063 T6 or 6005 T5, or ASTM B 241 (ASTM B 241M), alloy 6063 T6.

d. Hardware

All hardware for steel poles except bolts for the mast arm clamps and anchor bolts shall be in accordance with ASTM A 307 and shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to 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 (0.610 kg/m²).

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1290 ~~All hardware for aluminum poles shall be stainless steel in accordance with ASTM A 276, type 304 or type 305.~~

E2. Anchor Base Plate

1300 ~~A 1 piece anchor base shall be supplied as shown on the plans. secured to the lower end of the pole and shall develop the full strength of the pole. The base shall be provided with 4 holes of adequate size to accommodate 1 1/4 in. (32 mm) anchor bolts equally spaced on a bolt circle of 15 in. (380 mm) diameter and shall have 4 tapped holes for attaching the bolt covers. Four removable bolt covers shall be provided with each base and each cover shall attach to the upright portion of the body of the base by means of 1 hex head cap screw. The steel for the anchor base shall be in accordance with ASTM A 36 (ASTM A 36M), A 572 (A 572M), or A 588 (ASTM A 588M). Aluminum for the anchor base shall be in accordance with ASTM B 26, alloy 356.0 T6 or 356.0 T7 or ASTM B 209, alloy 6061 T6.~~

f. Arm Requirements

(1) Signal Cantilever Arm

1310 ~~A signal cantilever arm shall be attached to the pole by circular clamps. One half of the clamp shall be welded to the cantilever arm. The single member arm or the upper tapered member of the truss style arm shall have a cable inlet adjacent to the clamp complete with grommet. The cable inlet shall be a 1 3/4 in. (44 mm) diameter hole with a 1 1/2 in. (38 mm) inside diameter rubber grommet. The 20, 25, and 30 ft (6.1, 7.6 and 9.2 m) cantilever arms shall have 1 intermediate cable inlet with grommet located 12 ft (3.7 m) from the free end of the arm. The 35 and 40 ft (10.7 and 12.2 m) cantilever arm shall have 2 intermediate cable inlets with grommets located 12 ft (3.6 m) and 24 ft (7.3 m) respectively from the free end of the arm. The intermediate cable inlet shall be 1 in. (25 mm) diameter hole with 3/4 in. (19 mm) inside diameter rubber grommet.~~

1320 ~~The maximum rise of the single member arm shall be 1/2 in. (13 mm) per 1 ft (305 mm) of arm after loading. The maximum rise of the truss style arm shall be as set out in the table. The rise shall be measured vertically from the centerline of the free end of the truss to a plane through the centerline of the upper arm bracket after loading.~~

Mast Arm Length ft (m)	Total Rise ft-in. (m)	Tolerance in. (mm)
12-20 (3.7-6.1)	4-0 (1.2)	±1 (±25)
25 (7.6)	4-3 (1.3)	±1 (±25)
30-40 (9.2-12.2)	4-7 (1.4)	±1 (±25)

~~The end signals on the truss style arms shall be suspended and the intermediate signals shall be rigidly attached. All signals on the single member arms shall be rigidly attached as shown on the plans. The cantilever arms shall be used as an enclosed raceway for wiring and shall be free of burrs and rough edges.~~

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~~Both parts of the clamp for the single member arms shall be stamped with the arm length prior to galvanizing.~~

~~(2) Luminaire Mast Arm for Combination Support~~

~~The luminaire mast arm shall be in accordance with 922.01(a)1.~~

~~(3) 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 (345 MPa). of the same material as the pole. The luminaire mast arm shall be of the same material as the pole except that a truss type arm shall be in accordance with 922.01(a). Bolts for the mast arm clamp shall be stainless steel in accordance with ASTM A 276, type 304 or 305.~~

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 (0.610 kg/m²).

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 1-1/4 in. (32 mm) in diameter with a minimum of 15 in. (380 mm) of 7 NC threads on the upper end. The threads, nuts, and washers shall be galvanized in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C. The anchor bolt shall be 48 in. (1220 mm) long with a 4 in. (100 mm) right angle bend on the lower end or a square steel washer, 6 in. by 6 in. by 1/2 in. (150 mm by 150 mm by 13 mm), with a hex nut welded onto the lower end. The steel for the bolt shall be in accordance with ASTM F 1554, ASTM A 576 or ASTM A 675 (ASTM A 675M), with a minimum yield strength of 36,000 psi (248 MPa) or 55,000 psi (379 MPa), or ASTM A 36 (ASTM A 36M), special quality, modified to 55,000 psi (379 MPa) or approved equal.

6. Finish

All steel material shall be fully galvanized. Galvanizing shall take place after all welding is accomplished and holes cut. Aluminum poles shall be provided with a satin finish accomplished by mechanical rotary grinding and aluminum mast arms shall be provided with a satin etched finish.

7. Certification

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

j8. Working Drawings

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

~~k~~(d) Downguys, Anchors, Rods, and Guards

- 1380 *Pole anchors shall be 8 way expanding with a minimum area of 135 sq in. (87,100 mm²) when expanded or a 10 in. (250 mm) diameter screw anchor. They shall have a minimum holding strength of 10,000 lb (44.5 kN). They shall be painted and in accordance with ASTM A 569 (ASTM A 569M). Anchor rods for expanded anchors shall be 3/4 in. (19 mm) diameter steel and for screw anchors shall be 1 1/4 in. (32 mm) diameter steel, 8 ft (2.4 m) long, in accordance with ASTM A 659 (ASTM A 659M), and be galvanized in accordance with ASTM A 153.*

- 1390 *Guy guards shall be made of 18 gauge galvanized steel, polyethylene, polyvinylchloride, or melamine phenolic, and shall be 7 ft (2.1 m) long. The steel guy guard shall have a tight gripping, non-scarring hook for quick attachment to the guy wire. The bottom shall have a clamp that fits over the anchor rod and securely grips by tightening the bolt. Steel guy guards shall be in accordance with ASTM A 659 (ASTM A 659M). 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

~~1922.10.1(a)~~ 1. Messenger Cable

- 1400 *Messenger cable shall be zinc-coated steel wire strand, contain 7 wires, and have a nominal diameter of 3/8 in. (10 mm). The cable shall be in accordance with ASTM A 475, Siemens-Martin Grade.*

~~m~~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. (10 mm) nominal diameter, made of stainless steel wire, and consist of 7, 19 wire flexible steel strands. The 3/8 in. (10 mm) cable shall have a minimum breaking strength of 12,000 lb (53.4 kN). It shall be in accordance with Military Specifications MIL-W-83420D.

~~n~~3. Tether and Support Cable

- 1410 *Tether and support cable shall be aircraft cable, for non-aircraft use, and shall be 3/16 in. (5 mm) nominal diameter, made of stainless steel wire, and consist of 7, 7-wire flexible steel strands. The 3/16 in. (5 mm) cable shall have a minimum breaking strength of 3,700 lbs (16.5 kN). It shall be in accordance with Military Specifications MIL-83420D.*

~~o~~ 4. Cable Hardware

~~(4a)~~ Messenger Hangers

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1420 Messenger hangers shall be either a 3-bolt clamp or a 3/8 in. (10 mm) by 1 3/4 in. (44 mm) steel hanger with a 90° ~~degree~~ bend extending from the pole 3 3/4 in. (95 mm). The hanger shall have a curved groove and clamp capable of receiving a 5/16 ~~in.~~ to 1/2 in. (8 ~~mm~~ to 13 mm) cable.

The messenger shall be clamped by two 1/2 in. (13 mm) high carbon steel bolts. The angle hanger shall be mounted with a 5/8 in. (16 mm) through bolt and a 1/2 in. (13 mm) lag screw. The 3-bolt clamp shall be mounted with a 5/8 in. (16 mm) through bolt. The angle hanger shall be in accordance with ASTM A 575. The bolts shall be in accordance with NEMA PH 23.

(2b) Cable Ring

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

1430 **(3c) Clamps**

Clamps shall be made of 3/8 in. (10 mm) steel and in accordance with ASTM A 575.

Two bolt clamps shall be a minimum of 3 3/4 in. (95 mm) long and 1 1/4 in. (32 mm) wide with two 1/2 in. (13 mm) bolts which shall clamp cable of 1/8 to 1/2 in. (3 to 13 mm) diameter.

Three bolt clamps shall be a minimum of 6 in. (150 mm) long and 1 5/8 in. (42 mm) wide with three 5/8 in. (16 mm) bolts which shall clamp cable of 5/16 to 1/2 in. (8 ~~mm~~ to 13 mm) diameter.

1440 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.

(4d) Servi-Sleeves

Servi-sleeves shall be 1 1/4 to 2 1/4 in. (32 mm to 57 mm) in length and shall hold the size of the cable specified. The sleeves shall be in accordance with ASTM A 659 (~~ASTM A 659M~~).

(5e) Straight Eye-Bolts

1450 Straight eye-bolts shall be 19 mm (3/4 in.) diameter drop forged steel, a minimum of 14 in. (356 mm) long, and have 6 in. (150 mm) of thread. The steel washers shall be 2 1/4 ~~in.~~ by 2 1/4 ~~in.~~ by 3/16 in. (57 ~~mm~~ by 57 ~~mm~~ by 5 mm) in size with a 13/16 in. (21 mm) hole in the center. All parts shall be in accordance with ASTM A 575 and shall be galvanized in accordance with ASTM A 123.

(6f) Hub-Eyes

1460 Hub-eyes shall be made of drop forged steel and in accordance with ASTM A 575. They shall receive a 3/4 in. (19 mm) mounting bolt and have a full rounded thimble eye for protection of the guy cable.

922.11 Signal Cable

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(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. (1.19 mm) thick and a 600 volt rating. Insulation shall be color coded, as required, and labeled with gauge, voltage rating, and insulation type.

(b) Signal Control Cable

1470 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

1480 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

1490 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.

1500

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

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applied to the outer jacket using permanent ink and shall be permanently engraved into the jacket to provide long lasting readability.

1510 **922.13 Detection Wire and Sealant**

(a) Loop Detector Lead-in Cable

Runs 700 ft (213 m) 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 (213 m) shall use 14 AWG wire.

The nominal capacitance between conductors shall be 57 pF/ft (187 pF/m) and 98 pF/ft (322 pF/m) between one conductor and the other conductor connected to the shield.

1520 **(b) Roadway Loop Wire**

Roadway loop wire shall be 14 AWG gauge IMSA 51-7 duct-loop wire with polyvinyl chloride or polyethylene outer jacket of 1/4 in. (6.3 mm) diameter.

(c) Preformed Pavement Loops

All components of preformed pavement loops designed for HMA paved-over application shall have a minimum temperature rating exceeding the maximum temperature range for class B HMA mixtures in accordance with 402.07 (300 ~~degrees Fahrenheit~~°F (150 ~~degrees Celsius~~°C). Preformed pavement loops shall be selected from the Department's list of approved Traffic Signal and ITS Control Equipment.

1530 *The size of a preformed pavement loop shall be 6 ft (1.83 m) diameter, 18.9 ft (5.75 m) circumference round or 6 ft (1.83 m) octagonal, 20-0 ft (6.1 m) perimeter. The loops placed in the same lane shall be spaced 15 ft (4.57 m) from the center of one loop to the center of the next loop.*

Preformed pavement 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.

1540 **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

1550 *Ground rods shall be 1/2 in. (13 mm) in diameter by 8 ft (2.4 m) long with a machined point and chamfered top. They shall be made of steel with a molecularly bonded outer layer of*

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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.

1560 *The finished rod shall be cold-drawn and shall have the following minimum physical properties:*

PHYSICAL PROPERTY	MINIMUM
Tensile strength	97,000 psi (668 MPa)
Yield strength, 0.2% offset	85,000 psi (58.64 586 MPa)
% of elongation	13 psi (90 kPa)

The ground rod and wire connection shall be made by a thermo weld process or approved equal. The welding material shall cover and secure the conductor to the rod and shall be porous free.

1570 *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

The ring and cover for handholes shall be in accordance with 910.05(b).

922.18 Entrance Switch

1580 *The entrance switch shall be a double pole, 50 ~~amp~~A, 120 V ~~volt~~ circuit breaker in a NEMA type 3R enclosure. The minimum dimensions of the enclosure shall be: 5 in. (127 mm) wide, 3 3/4 in. (95 mm) deep and 9 1/4 in. (235 mm) height. A 1 in. (25 mm) rain-tight detachable hub shall be supplied in the top of the enclosure. The enclosure shall have knockouts on the sides, bottom and back with diameters of 7/8 in. (22 mm) to 1 3/4 in. (44 mm). The enclosure shall contain the circuit breaker, an insulated solid bar for connection of AC Nneutral, 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.

1590

922.19 Conduit and Fittings

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(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.

- 1600 *The various conduit fittings such as bands, bodies, straps, lock nuts, and threadless connectors, shall be in accordance with Federal Specifications A-A-50553 and shall be galvanized if not stainless steel. Conduit straps shall be ~~two~~ 2 hole straps with a minimum thickness of 1/8 in. (3 mm). Conduit lock nuts 3/8 ~~in.~~ to 1 1/2 in. (10 ~~mm~~ to 38 mm) in size shall be made of steel. Other sizes shall be made of either steel or malleable iron. All conduit lock nuts shall be galvanized. Other nuts shall be either stainless steel or galvanized steel.*

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

- 1610 *~~PVC conduit shall be schedule 40 in accordance with ASTM D 1785. The PVC conduit fittings shall be in accordance with ASTM D 2466. Schedule 40 polyvinyl chloride, PVC, 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 a coupling.~~*

(c) Schedule 80 PVC Conduit

~~Schedule 80 polyvinyl chloride, PVC, 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 a coupling.~~

(d) Fiberglass Conduit

- 1620 *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 °F to 230 °F (-40 °C to 110 °C). Rigid fiberglass conduit shall be pigmented with carbon black for ultraviolet protection and fire resistant per UL 94. All rigid fiberglass conduit shall be heavy walled, HW, and meet the specifications, labeling and testing of ANSI/NEMA TC14.*

922.20 Detector Housing

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

1630 **922.21 Certification**

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

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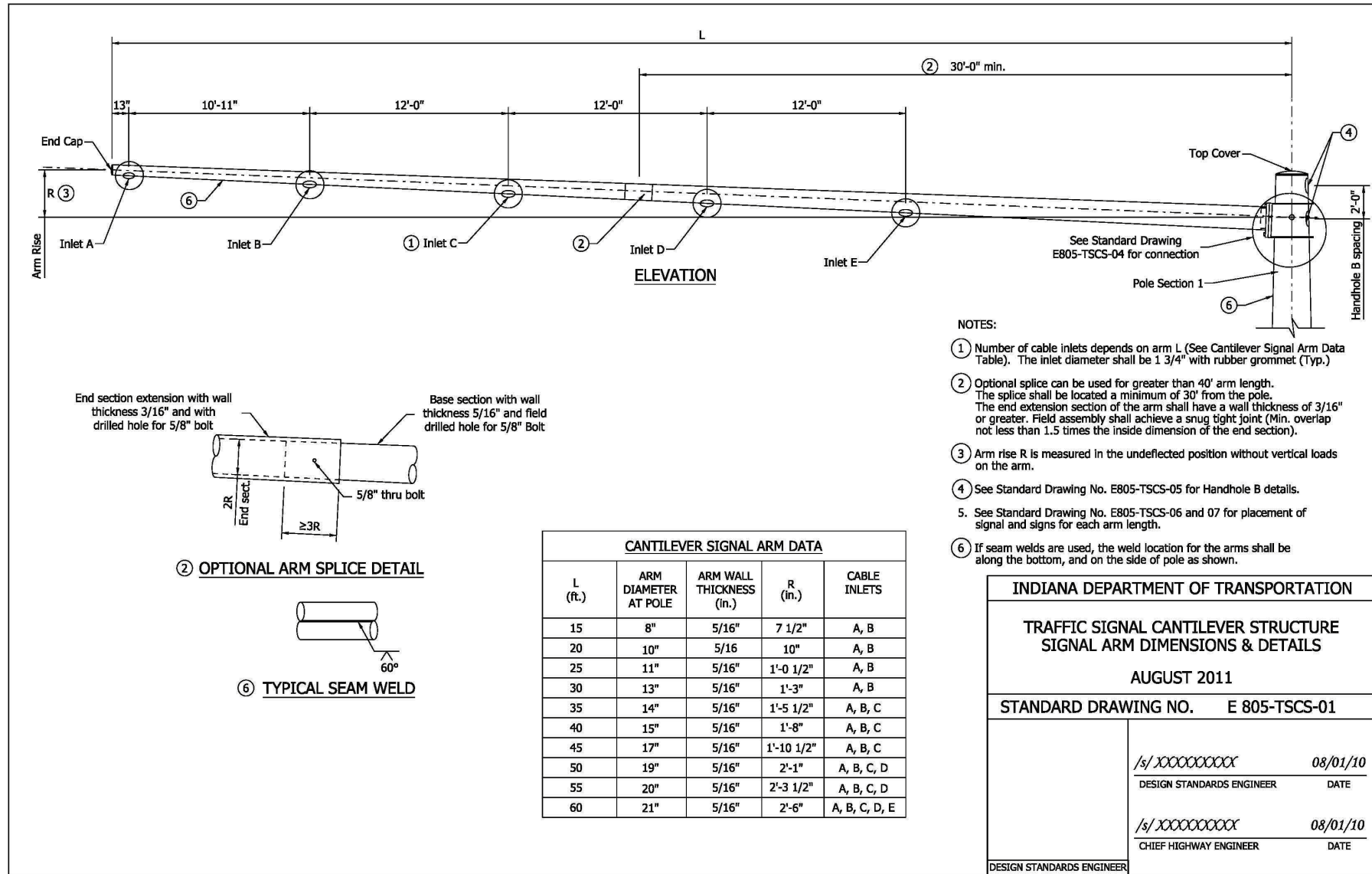
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APPROVED MINUTES

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

805-TSCS-01 TRAFFIC SIGNAL CANTILEVER STRUCTURE SIGNAL ARM DIMENSIONS & DETAILS

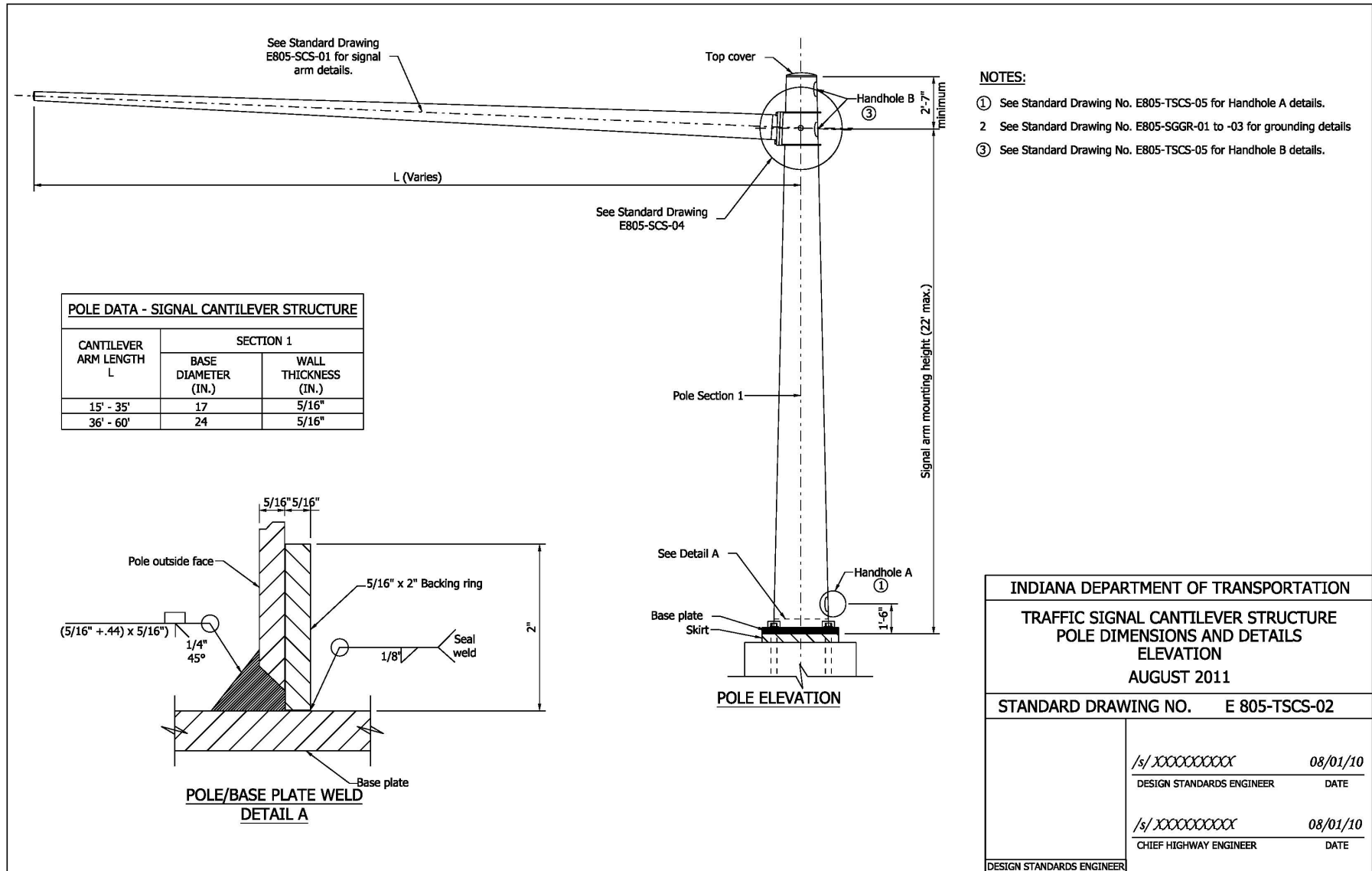


Item No. 01 07/21/11 (2012 SS) (contd.)
 Mr. Wright
 Date: 08/18/11

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(OLD BUSINESS ITEM)

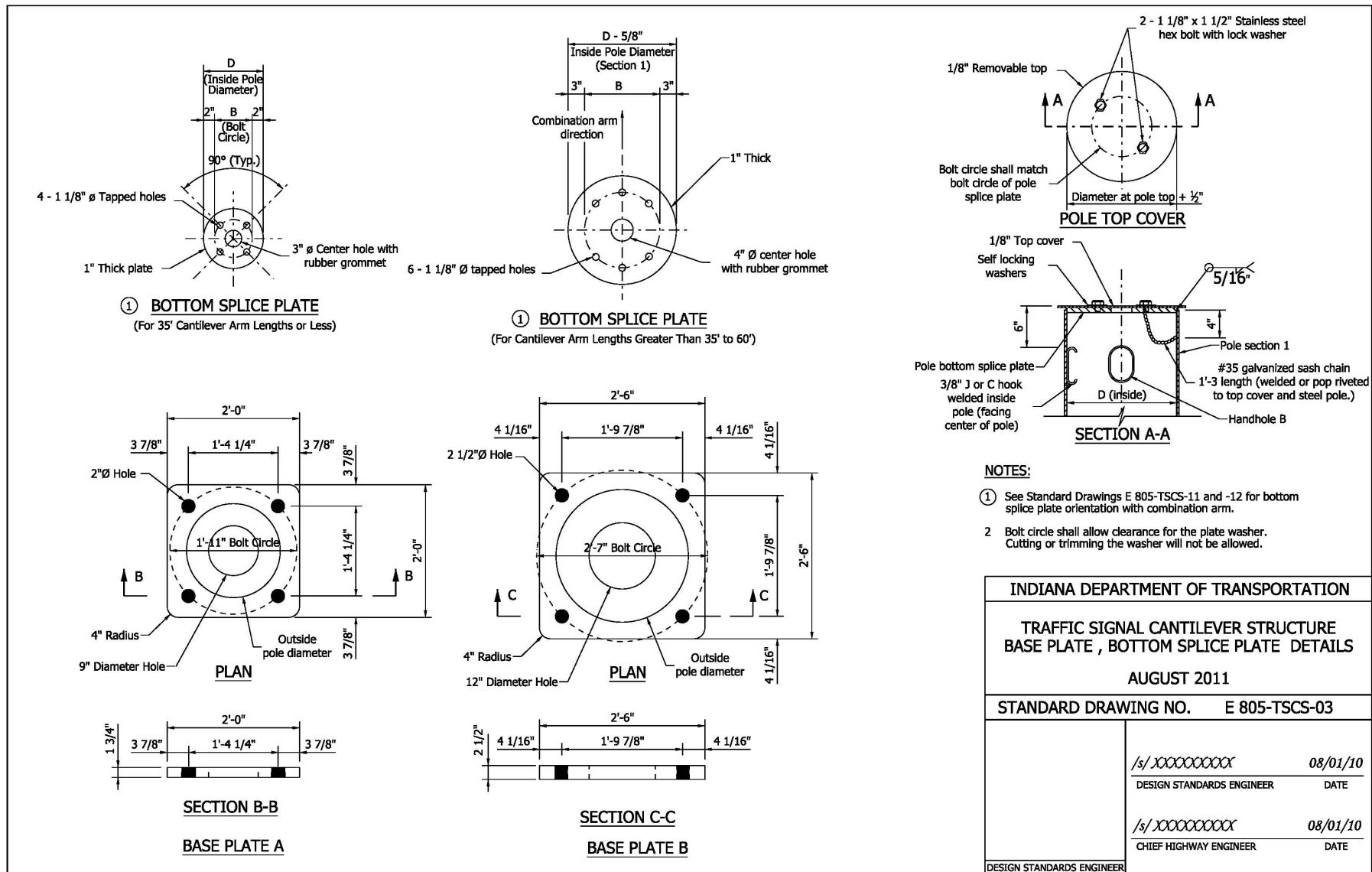
805-TSCS-02 TRAFFIC SIGNAL CANTILEVER STRUCTURE POLE DIMENSIONS AND DETAILS ELEVATION



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(OLD BUSINESS ITEM)

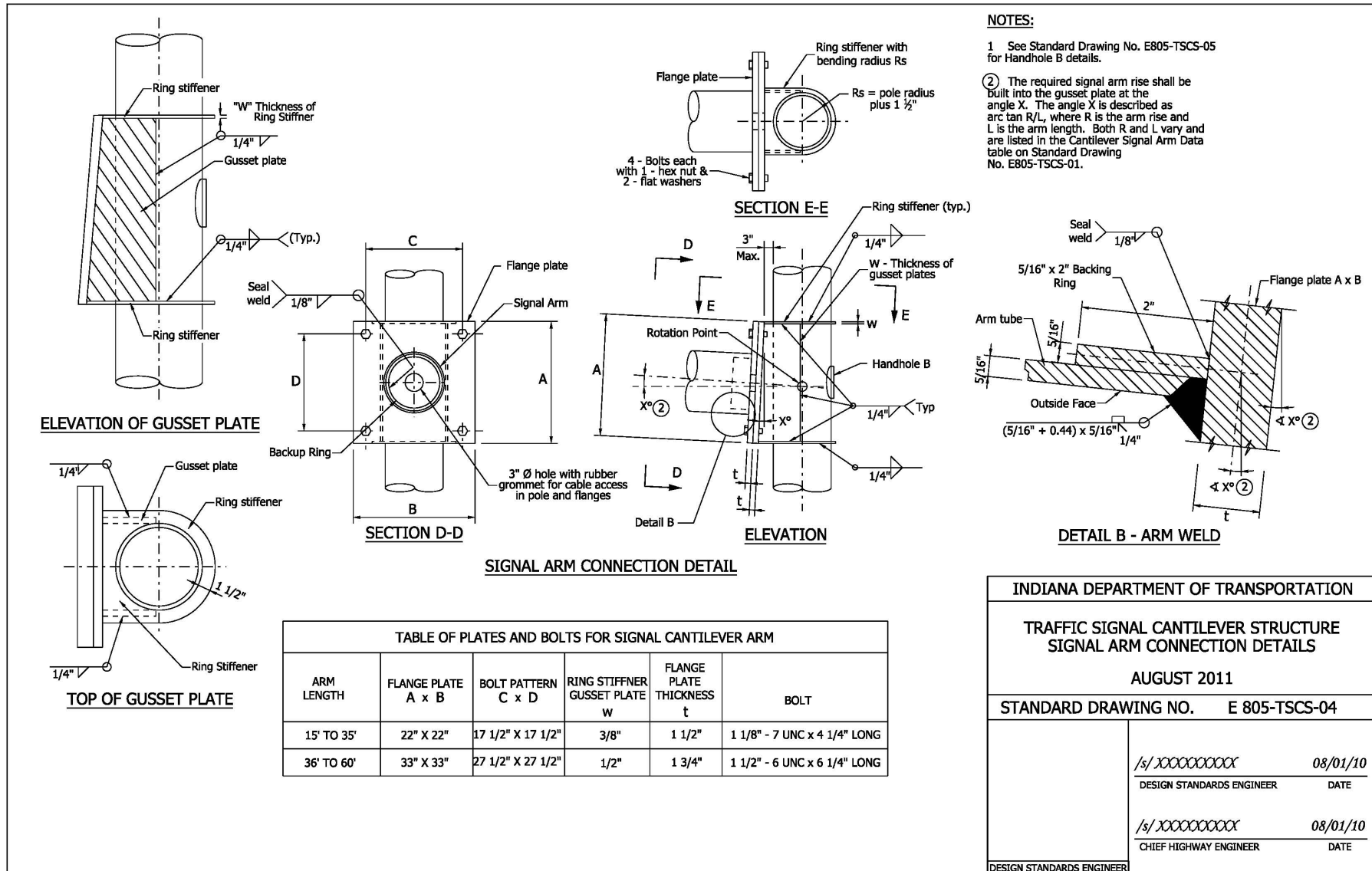
805-TSCS-03 TRAFFIC SIGNAL CANTILEVER STRUCTURE BASE PLATE, BOTTOM SPLICE PLATE DETAILS



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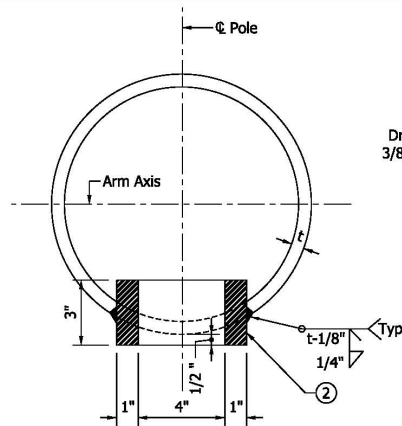
(OLD BUSINESS ITEM)

805-TSCS-04 TRAFFIC SIGNAL CANTILEVER STRUCTURE SIGNAL ARM CONNECTION DETAILS

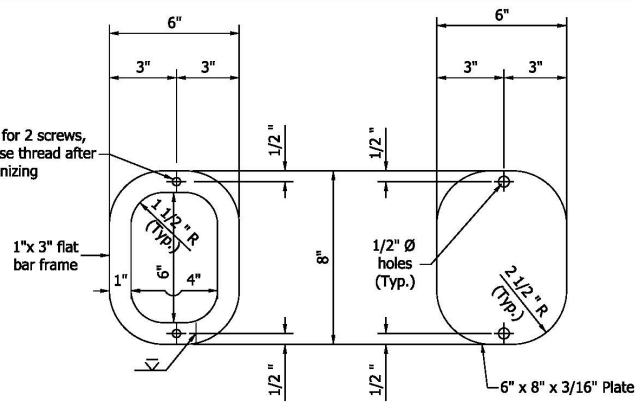


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 805-TSCS-05 TRAFFIC SIGNAL CANTILEVER STRUCTURE HANDHOLE DETAILS

(OLD BUSINESS ITEM)



HANDHOLE B
SECTION ACROSS POLE



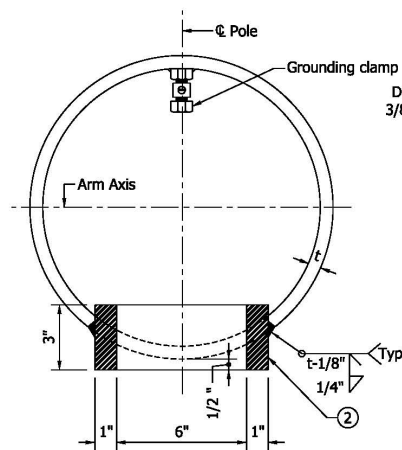
FRAME DETAIL

COVER

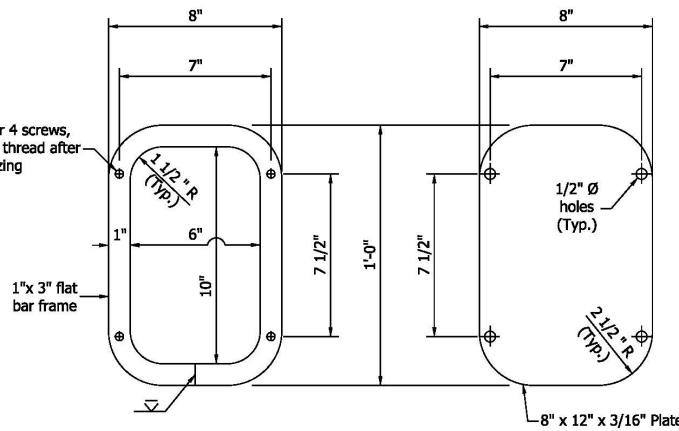
HANDHOLE B

NOTES:

- 1 Handhole A shall be used at the base of the pole. Handhole B shall be used at all other locations.
- ② In lieu of fabricated handhole frame as shown, frame may be cut from 3" plate (rolling direction vertical).
- 3 See Standard Drawing E 805-TSCS-02 for handhole locations.



HANDHOLE A
SECTION ACROSS POLE



FRAME DETAIL

COVER

HANDHOLE A

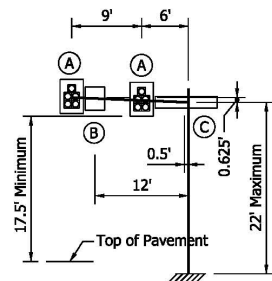
INDIANA DEPARTMENT OF TRANSPORTATION	
TRAFFIC SIGNAL CANTILEVER STRUCTURE HANDHOLE DETAILS	
AUGUST 2011	
STANDARD DRAWING NO.	E 805-TSCS-05
DESIGN STANDARDS ENGINEER	/s/XXXXXXXXXX 08/01/10 DATE
	/s/XXXXXXXXXX 08/01/10 CHIEF HIGHWAY ENGINEER DATE

Item No. 01 07/21/11 (2012 SS) (contd.)
 Mr. Wright
 Date: 08/18/11

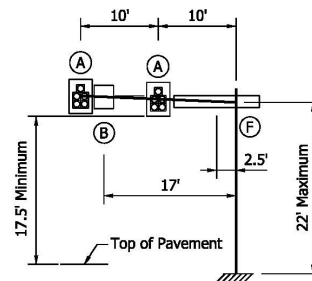
REVISION TO STANDARD SPECIFICATIONS, PROVISIONS AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

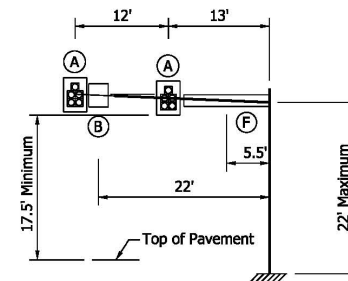
805-TSCS-06 TRAFFIC SIGNAL CANTILEVER STRUCTURE PLACEMENT OF SIGNALS AND SIGNS LOADING FOR ARM 35' OR LESS



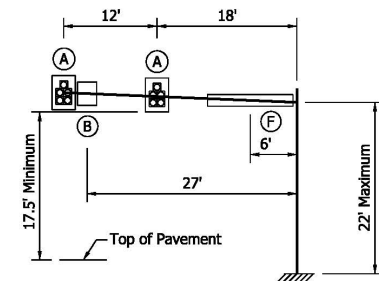
15' ARM



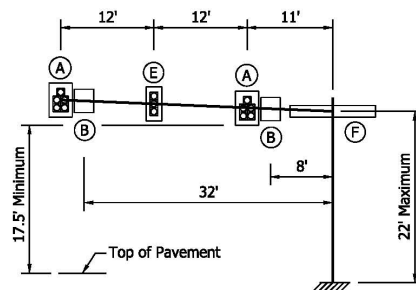
20' ARM



25' ARM



30' ARM



35' ARM

LEGEND	
Device	Description
(A)	12" - 5 Section Signal Head With Backplates
(B)	36" x 30" Regulatory Sign
(C)	18" x 96" Street Name Sign
(E)	12" - 3 Section Signal Head With Backplates
(F)	18" x 132" Street Name Sign

INDIANA DEPARTMENT OF TRANSPORTATION

TRAFFIC SIGNAL CANTILEVER STRUCTURE
 PLACEMENT OF SIGNALS AND SIGNS
 LOADING FOR ARMS 35' OR LESS
 AUGUST 2011

STANDARD DRAWING NO. E 805-TSCS-06

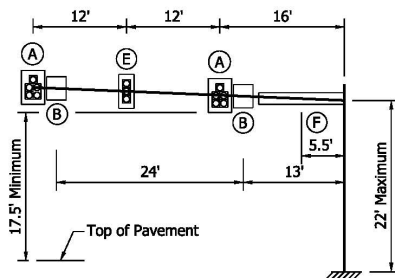
DESIGN STANDARDS ENGINEER	/s/ XXXXXXXXXXXX	08/01/10
	DESIGN STANDARDS ENGINEER	DATE
CHIEF HIGHWAY ENGINEER	/s/ XXXXXXXXXXXX	08/01/10
	CHIEF HIGHWAY ENGINEER	DATE

Item No. 01 07/21/11 (2012 SS) (contd.)
 Mr. Wright
 Date: 08/18/11

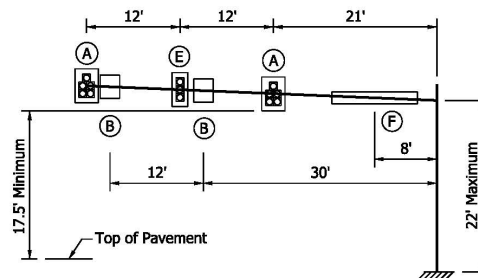
REVISION TO STANDARD SPECIFICATIONS, PROVISIONS AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

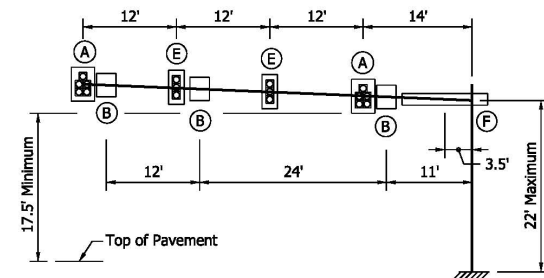
805-TSCS-07 TRAFFIC SIGNAL CANTILEVER STRUCTURE PLACEMENT OF SIGNALS AND SIGNS LOADING FOR ARMS > 35' TO 60'



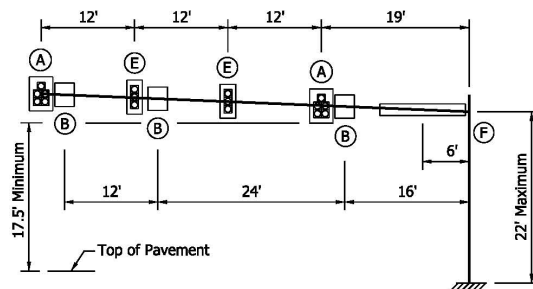
40' ARM



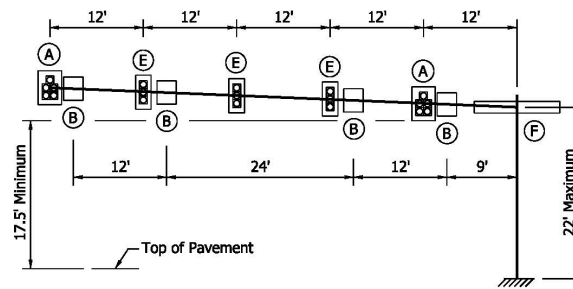
45' ARM



50' ARM



55' ARM



60' ARM

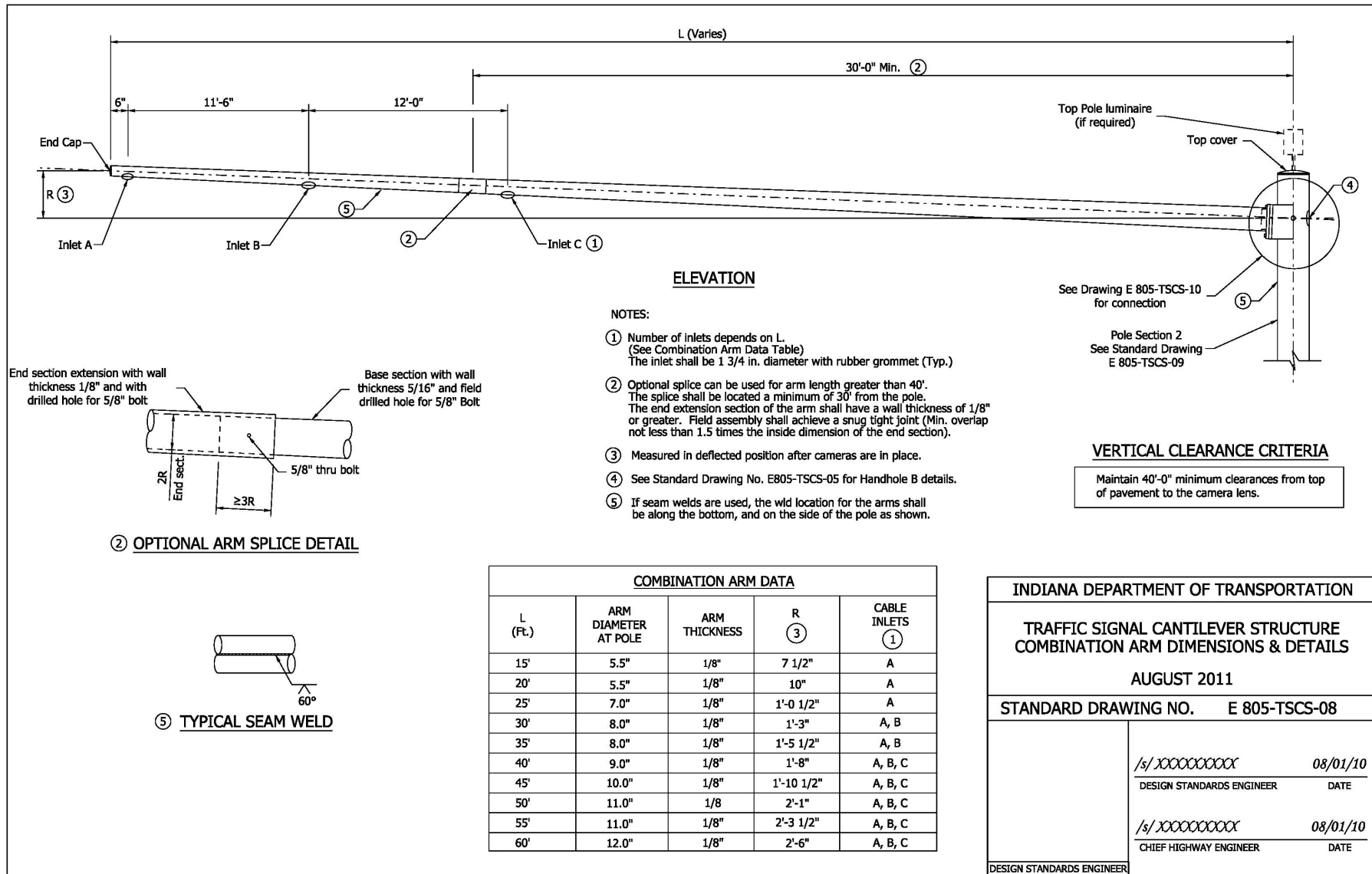
NOTE:
 See Standard Drawing No. E805-TSCS-06 for Legend.

INDIANA DEPARTMENT OF TRANSPORTATION	
TRAFFIC SIGNAL CANTILEVER STRUCTURE PLACEMENT OF SIGNALS AND SIGNS LOADING FOR ARMS > 35' TO 60'	
AUGUST 2011	
STANDARD DRAWING NO. E 805-TSCS-07	
DESIGN STANDARDS ENGINEER	/s/ XXXXXXXXXXXX 08/01/10 DATE
	/s/ XXXXXXXXXXXX 08/01/10 DATE
CHIEF HIGHWAY ENGINEER	

REVISION TO STANDARD SPECIFICATIONS, PROVISIONS AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

805-TSCS-08 TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM DIMENSIONS & DETAILS

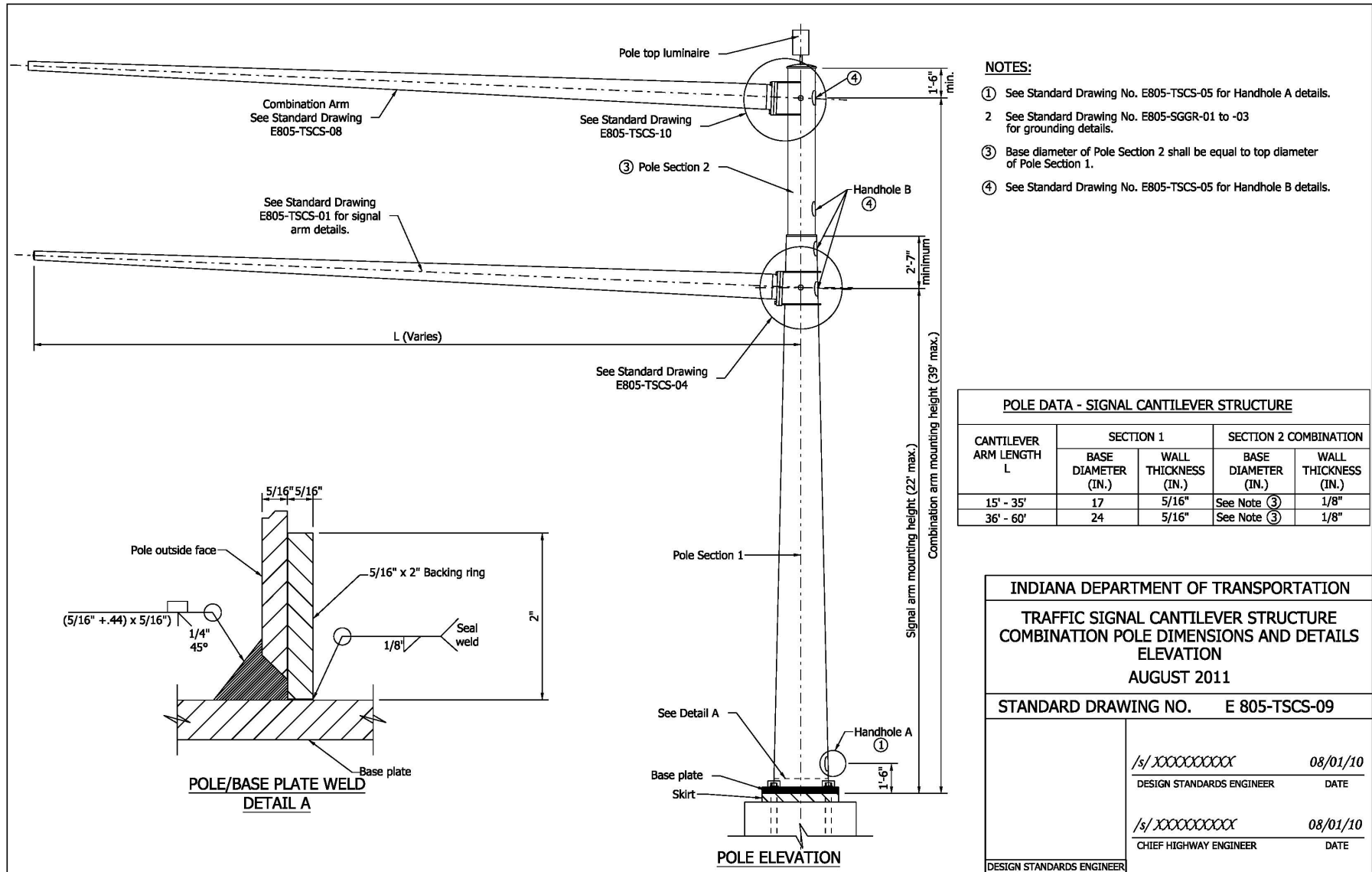


Item No. 01 07/21/11 (2012 SS) (contd.)
Mr. Wright
Date: 08/18/11

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

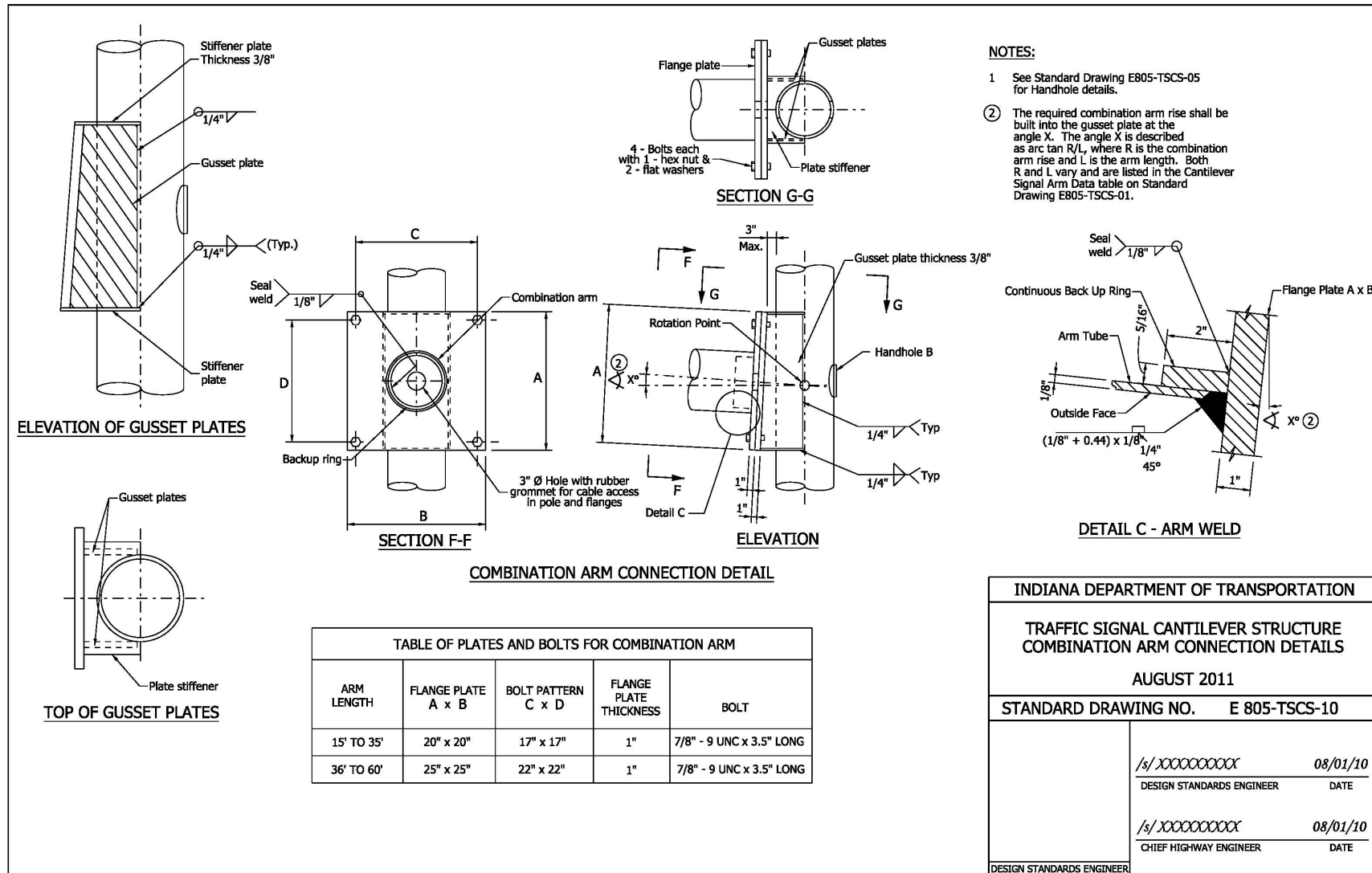
805-TSCS-09 TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION POLE DIMENSIONS AND DETAILS ELEVATION



REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

805-TSCS-10 TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM CONNECTION DETAILS

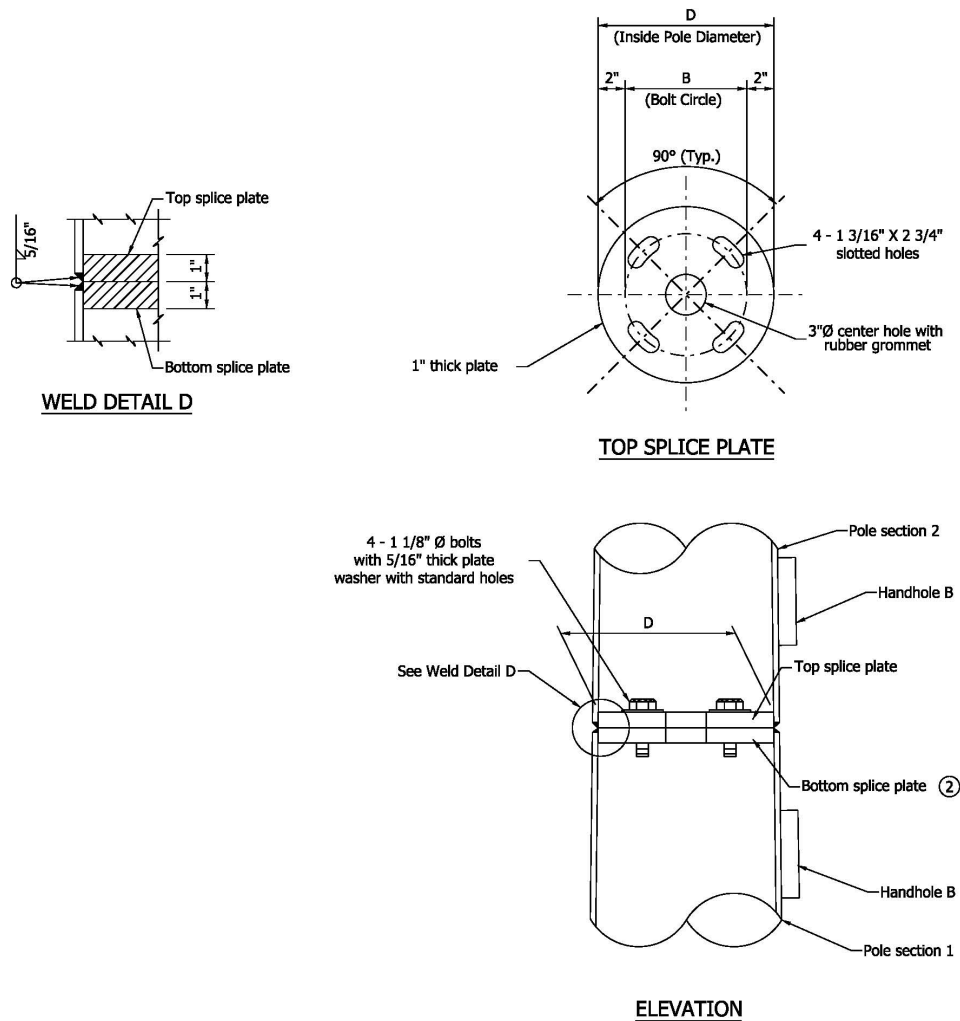


Item No. 01 07/21/11 (2012 SS) (contd.)
 Mr. Wright
 Date: 08/18/11

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

805-TSCS-11 TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION POLE SPICE DETAILS FOR ARMS 35' OR LESS



NOTES:

- 1 Diameter at the bottom of Pole section 2 shall match the diameter at the top of Pole section 1.
- ② See Standard Drawing E805-TSCS-03 for bottom splice plate details.

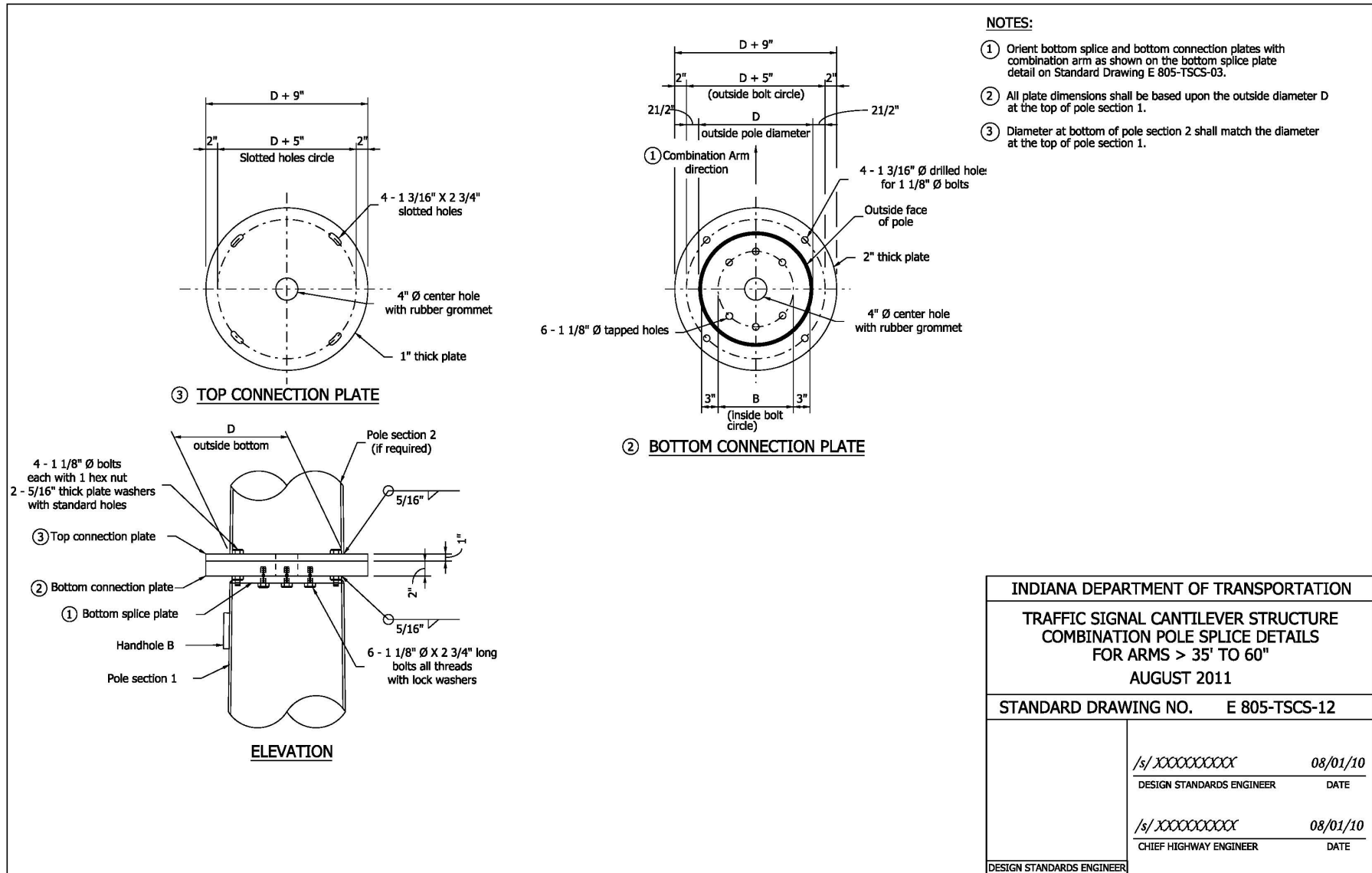
INDIANA DEPARTMENT OF TRANSPORTATION			
TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION POLE SPICE DETAILS FOR ARMS 35' OR LESS AUGUST 2011			
STANDARD DRAWING NO.		E 805-TSCS-11	
	<i>/s/XXXXXXXXXXXX</i>		<i>08/01/10</i>
	DESIGN STANDARDS ENGINEER		DATE
	<i>/s/XXXXXXXXXXXX</i>		<i>08/01/10</i>
	CHIEF HIGHWAY ENGINEER		DATE
DESIGN STANDARDS ENGINEER			

Item No. 01 07/21/11 (2012 SS) (contd.)
 Mr. Wright
 Date: 08/18/11

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

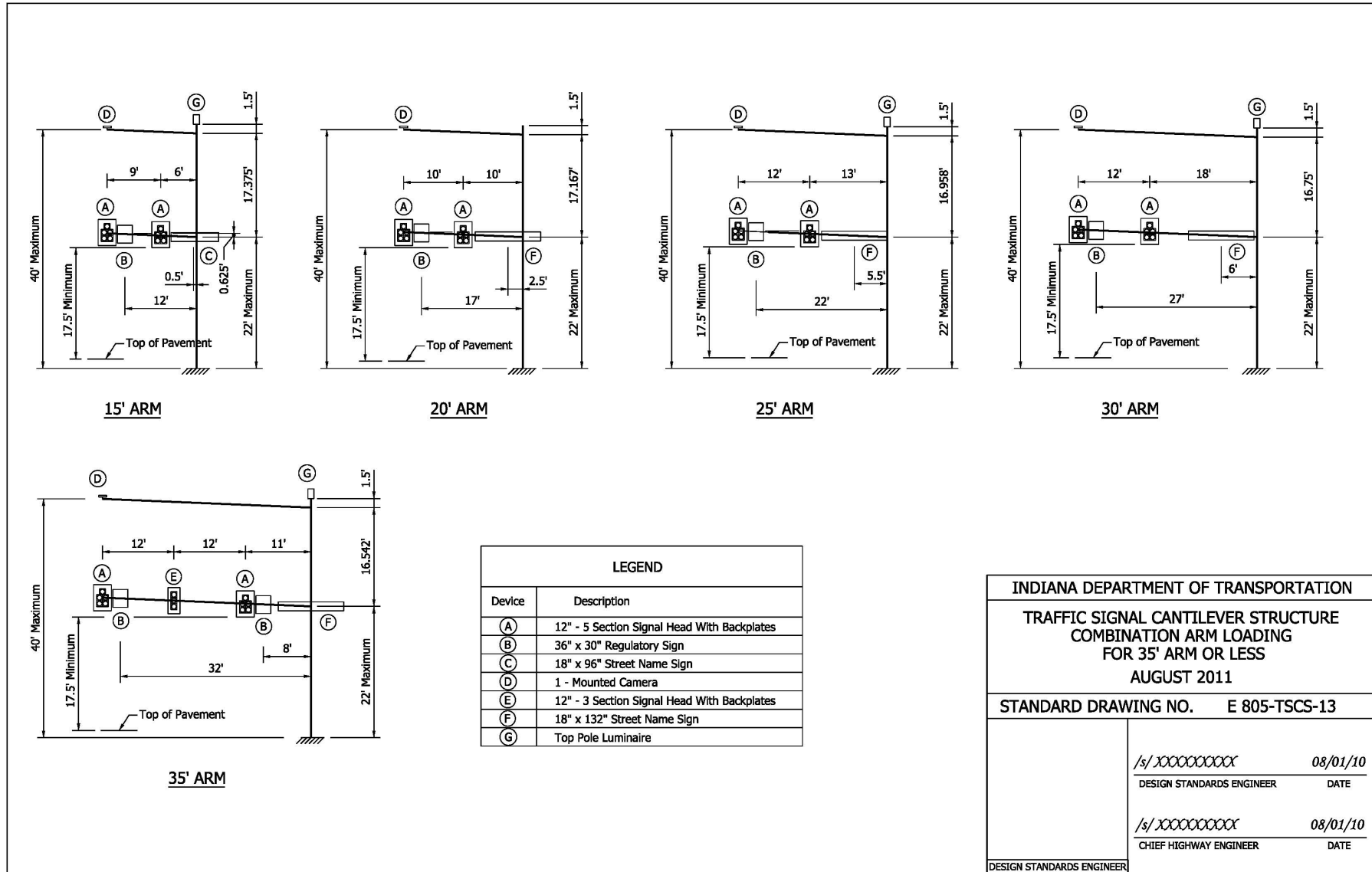
805-TSCS-12 TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION POLE SPLICE DETAILS FOR ARMS > 35' TO 60'



REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

805-TSCS-13 TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM LOADING FOR 35' ARM OR LESS

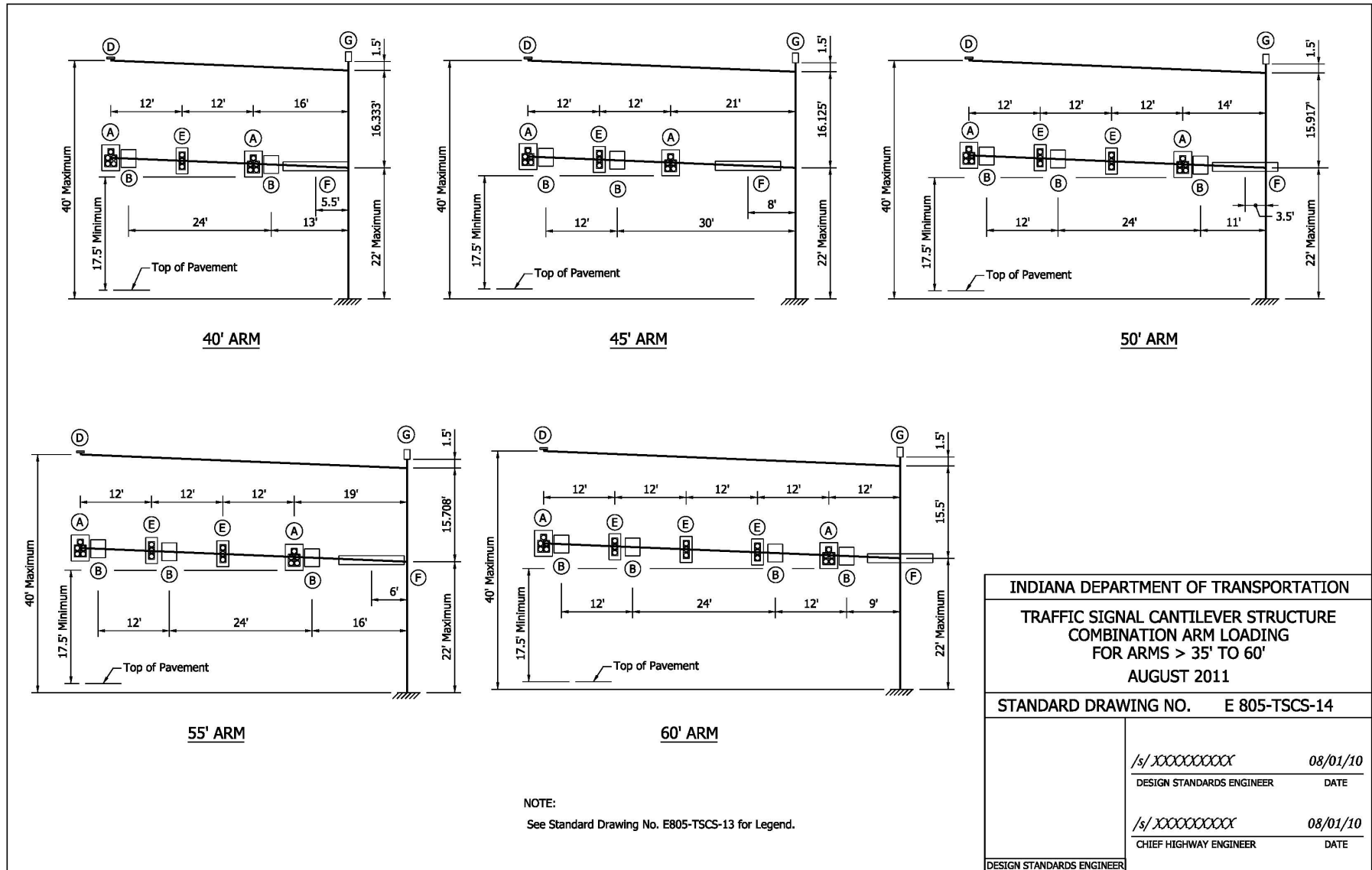


Item No. 01 07/21/11 (2012 SS) (contd.)
 Mr. Wright
 Date: 0/18/11

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

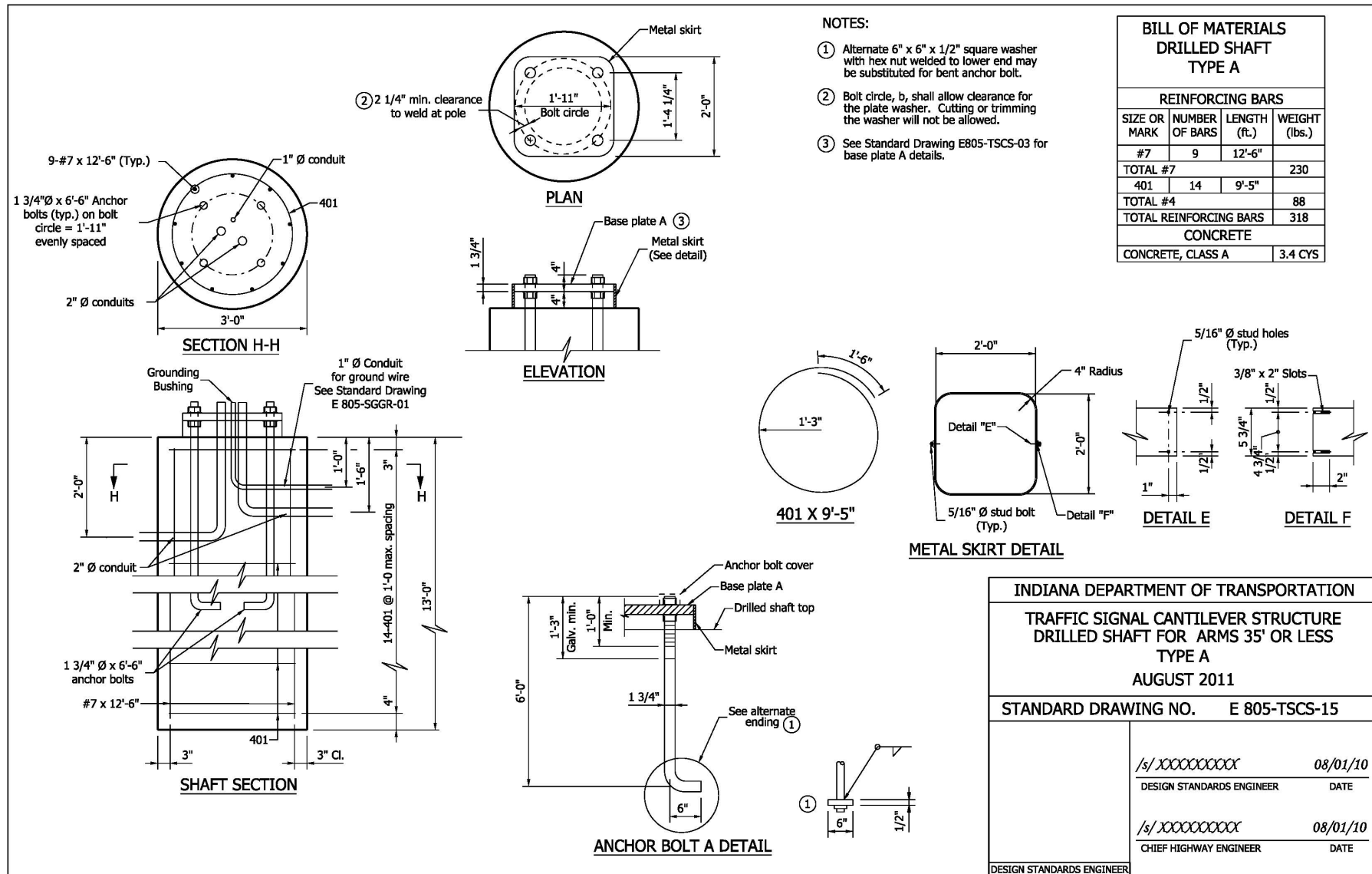
805-TSCS-14 TRAFFIC SIGNAL CANTILEVER STRUCTURE COMBINATION ARM LOADING FOR ARMS > 35' TO 60'



REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

805-TSCS-15 TRAFFIC SIGNAL CANTILEVER STRUCTURE DRILLED SHAFT FOR ARMS 35' OR LESS TYPE A



Date: 08/18/11

(OLD BUSINESS ITEM)

BILL OF MATERIALS

REINFORCING BARS			
SIZE OR MARK	NUMBER OF BARS	LENGTH (ft.)	WEIGHT (lbs.)
#7	15	15'-6"	475
401	17	12'-6"	142
TOTAL REINFORCING BARS			617
CONCRETE			
CONCRETE, CLASS A			7.5 CYS

NOTES:

- Alternate 8" x 8" x 1/2" square plate tapped and welded to the anchor bolt may be substituted for bent anchor bolt.
- Bolt circle, b, shall allow clearance for the plate washer. Cutting or trimming the washer will not be allowed.
- See Standard Drawing E805-TSCS-03 for base plate B details.

SECTION I-I

15-#7 x 15'-6" (Typ.)

2 1/4" Ø x 8'-0" Anchor bolts (typ.) on 2'-7" bolt circle evenly spaced

2" Ø conduits

4'-0"

1" Ø conduit

2 1/2" Ø Hole

2 1/2" Min. Clearance To Weld At Pole

2'-7" Bolt circle

1'-9 7/8"

2'-6"

PLAN

Base plate B (3)

Metal skirt (See detail)

2 1/2"

6 1/2"

4 1/2"

4"

ELEVATION

2'-6"

4" Radius

Detail "G"

2'-6"

5/16" Ø Stud Bolt (Typ.)

SKIRT DETAIL

Detail "H"

5/16" Ø Stud Holes (Typ.)

3/8" x 2" Slots

1 1/2"

1"

1 1/2"

6 1/2"

5 1/2"

2"

DETAIL G

DETAIL H

SHAFT SECTION

2'-0"

1'-0"

1'-6"

3"

2" Ø conduit

2 1/4" Ø anchor bolts

#7

17-401 @ 1'-0" Max. Spacing

16'-0"

4"

3"

401

3"

ANCHOR BOLT B DETAIL

Anchor bolt cover

Base plate

Metal skirt

1'-3"

Galv. min.

1'-0"

Min.

2 1/4"

See alternate ending (1)

9"

7'-3"

1'-9"

401 X 12'-6"

INDIANA DEPARTMENT OF TRANSPORTATION

TRAFFIC SIGNAL CANTILEVER STRUCTURE

DRILLED SHAFT FOUNDATION FOR ARMS >35' TO 60'

TYPE B

AUGUST 2011

STANDARD DRAWING NO. E 805-TSCS-16

DESIGN STANDARDS ENGINEER

CHIEF HIGHWAY ENGINEER

08/01/10

DATE

08/01/10

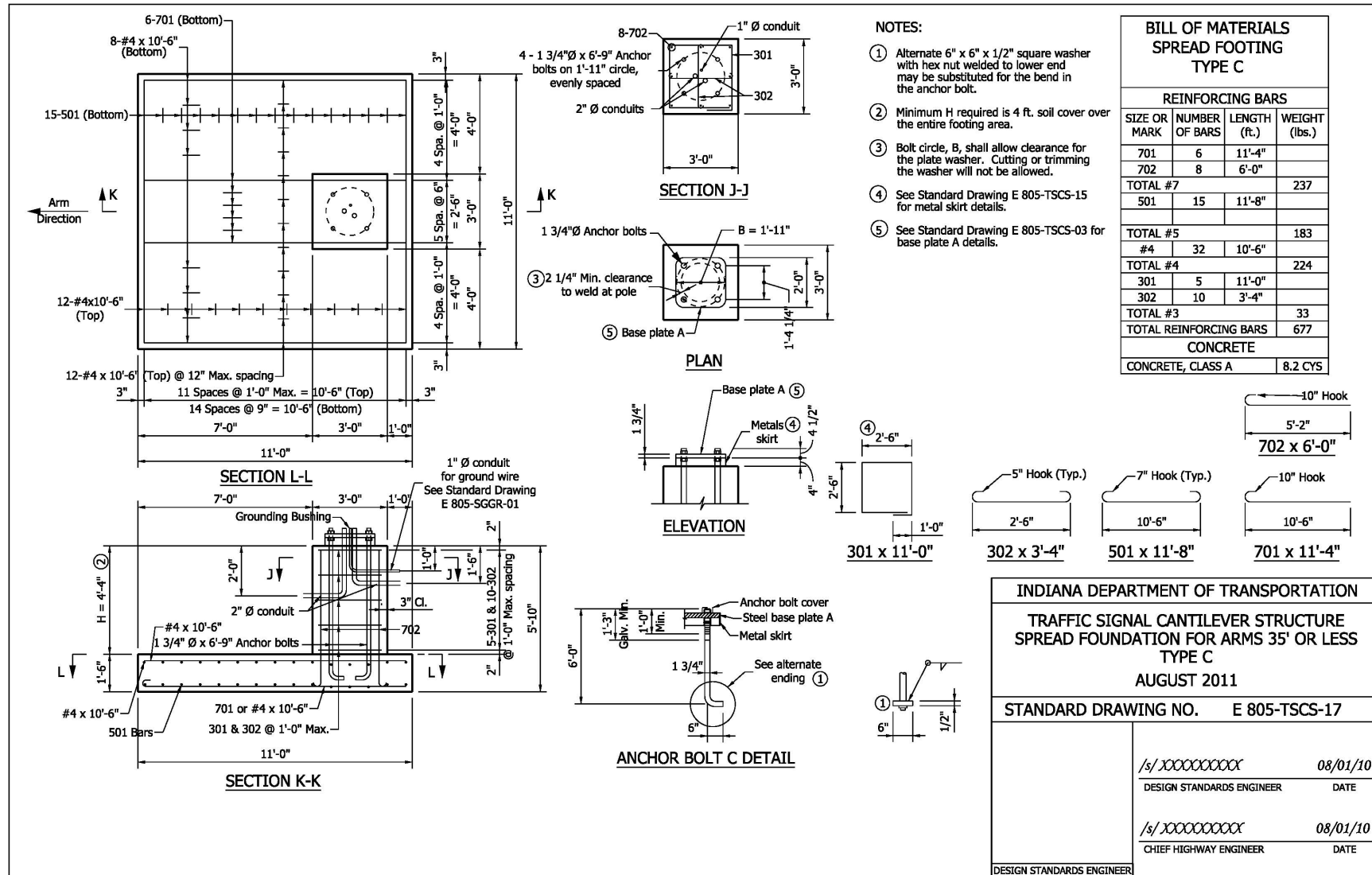
DATE

Item No. 01 07/21/11 (2012 SS) (contd.)
 Mr. Wright
 Date: 08/18/11

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS

(OLD BUSINESS ITEM)

805-TSCS-17 TRAFFIC SIGNAL CANTILEVER STRUCTURE SPREAD FOUNDATION FOR ARMS 35' OR LESS TYPE C



Date: 08/18/11

(OLD BUSINESS ITEM)

12-#4x11'-6" (Bottom)

8-801 (Bottom)

17-701 (Bottom)

13-#4x14'-6" (Top)

16-#4x11'-6" (Top) @ 12" Max. spacing

12 Spaces @ 1'-0" Max. = 11'-6" (Top)

16 Spaces @ 9" Max. = 11'-6" (Bottom)

7'-6" 3'-6" 1'-0" 12'-0"

3" 3" 3" 3" 5'-9" 3'-6" 15'-0"

6 Spa. @ 1'-0" Max. = 5'-9" 1/2" 7 Spa. @ 5" 6 Spa. @ 1'-0" Max. = 5'-9" 1/2" = 2'-11"

Bottom spacing

SECTION M-M

7'-6" 3'-6" 1'-0"

Grounding bushing

2" Ø conduit

2 1/4" Ø Anchor bolts

802

801 or #4 x 11'-6"

301 & 302 @ 1'-0" Max.

701 Bars

12'-0"

SECTION N-N

7'-6" 3'-6" 1'-0"

2'-0"

2" Ø conduit

2 1/4" Ø Anchor bolts

802

801 or #4 x 11'-6"

301 & 302 @ 1'-0" Max.

701 Bars

12'-0"

1'-6"

H = 4'-4"

1'-0"

1'-6"

2'-0"

2" 5-301 & 10-302 @ 1'-0" Max. sSpacing 5'-10"

1" Ø conduit for ground wire See Standard Drawing E 805-SGGR-01

SECTION O-O

Diagram illustrating the dimensions and components of a rectangular base plate:

- ⑤ Base plate B
- ③ 2 1/2" Min. clearance to weld at pole
- Dimensions:
 - Overall width: 2'-6"
 - Overall height: 3'-6"
 - Inner width: 1'-9 7/8"
 - Inner height: 2'-7"
 - Clearance dimension: B = 2'-7"

ELEVATION

Base plate B (5)

Metal skirt (4)

2 1/2"

34.0"

4 1/2"

4"

Diagram illustrating the Anchor Bolt D Detail. The diagram shows a cross-section of the anchor bolt assembly. Key dimensions and components are labeled:

- Overall height: 6'-0"
- Galvanized metal skirt height: 1'-3"
- Steel base plate B height: 1'-0"
- Anchor bolt cover height: 1'-0"
- Galvanized metal skirt thickness: Min.
- Anchor bolt cover thickness: Min.
- Horizontal distance from base plate to skirt: 2 1/4"
- Horizontal distance from skirt to base plate: 1'-0"
- See alternate ending ①

ANCHOR BOLT D DETAIL

- ① Alternate 8" x 8" x 1/2" square plate tapped and welded to anchor bolt may be substituted for the bent anchor bolt.
- ② Minimum H required is 4 ft. soil cover over the entire footing area.
- ③ Bolt circle, B, shall allow clearance for the plate washer. Cutting or trimming the washer will not be allowed.
- ④ See Standard Drawing E 805-TSCS-16 for metal skirt details.
- ⑤ See Standard Drawing E 805-TSCS-03 for base plate B details.

BILL OF MATERIALS SPREAD FOOTING TYPE D			
REINFORCING BARS			
SIZE OR MARK	NUMBER OF BARS	LENGTH (ft.)	WEIGHT (lbs.)
801	8	11'-5"	
802	16	6'-1"	
TOTAL #8			504
701	17	16'-2"	
TOTAL #7			562
#4	13	14'-6"	
#4	28	11'-6"	
TOTAL #4			341
301	5	13'-0"	
302	10	9'-8"	
TOTAL #3			61
TOTAL REINFORCING BARS			1468
CONCRETE			
CONCRETE, CLASS A			12.0 CYS

INDIANA DEPARTMENT OF TRANSPORTATION	
TRAFFIC SIGNAL CANTILEVER STRUCTURE SPREAD FOUNDATION FOR ARMS > 35' TO 60' TYPE D AUGUST 2011	
STANDARD DRAWING NO. E 805-TSCS-18	
	<div> <div>/s/ XXXXXXXXXXXX</div> <div>08/01/10</div> </div> <div> <div>DESIGN STANDARDS ENGINEER</div> <div>DATE</div> </div>
	<div> <div>/s/ XXXXXXXXXXXX</div> <div>08/01/10</div> </div> <div> <div>CHIEF HIGHWAY ENGINEER</div> <div>DATE</div> </div>
	DESIGN STANDARDS ENGINEER

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS
REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

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 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. 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 Selection Guidance and Design Criteria

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. If soil parameters are such

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS
REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

that the table values cannot be applied, the foundation must be designed and the details should be shown on the plans.

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.

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*

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS
REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

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 than 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).
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.

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS
REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

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

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS
REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

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.
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).

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REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

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

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.

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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:
- 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 >

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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.

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 REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

<i>Founda- tion Type</i>	<i>Soil Properties</i>	<i>Support</i>	<i>Arm Length, L, ft</i>
<i>A</i>	<i>Cohesive, $Q_u = 750$ lb/ft; or Sand, Friction Angle = 30 deg</i>	<i>Drilled Shaft</i>	≤ 35
<i>B</i>	<i>Bearing Capacity = 150 psf, and Coefficient of Friction = 0.3</i>	<i>Drilled Shaft</i>	$35 < L \leq 60$
<i>C</i>	<i>Cohesive, $Q_u = 750$ lb/ft; or Sand, Friction Angle = 30 deg</i>	<i>Spread Footing</i>	≤ 35
<i>D</i>	<i>Bearing Capacity = 150 psf, and Coefficient of Friction = 0.3</i>	<i>Spread Footing</i>	$35 < L \leq 60$

***SIGNAL-CANTILEVER-STRUCTURE
 FOUNDATION-TYPE DETERMINATION***

Figure 77-4 I

REVISION TO STANDARD SPECIFICATIONS, PROVISION AND STANDARD DRAWINGS
REVISION TO IDM CHAPTER 77-4.03 SIGNAL MOUNTING (DRAFT)

<i>Device</i>	<i>Area, ft²</i>	<i>Weight, lb</i>
<i>Signal Head with Backplate, 3 Sec., Lens Dia. 12 in.</i>	<i>8.7</i>	<i>35</i>
<i>Signal Head with Backplate, 5 Sec., Lens Dia. 12 in.</i>	<i>13.1</i>	<i>55</i>
<i>Regulatory Sign, 36 in. x 30 in.</i>	<i>7.5</i>	<i>19</i>
<i>Street-Name Sign, 18 in. x 96 in.</i>	<i>12</i>	<i>30</i>
<i>Street-Name Sign, 18 in. x 132 in.</i>	<i>16.5</i>	<i>41</i>
<i>Mounted Camera</i>	<i>1</i>	<i>20</i>
<i>Top-Pole Luminaire</i>	<i>2.4</i>	<i>53</i>

**AREA AND WEIGHT OF DEVICE
TO BE MOUNTED ON SIGNAL CANTILEVER**

Figure 77-4J

COMMENTS AND ACTION

(OLD BUSINESS ITEM)

805.03 GENERAL REQUIREMENTS
805.04 POLE INSTALLATION
805.05 PLACING SIGNAL HEADS
805.13 FOUNDATIONS
805.15 METHOD OF MEASUREMENT
805.16 BASIS OF PAYMENT
922-T-168 TRAFFIC SIGNALS MATERIALS AND EQUIPMENT
805-TSCS-01 THRU -18 SIGNAL CANTILEVER STRUCTURES

DISCUSSIONS: This item was introduced by Mr. Patel on behalf of Mr. Wright, who made the motion to approve these revisions as shown. Mr. Andrewski seconded the motion.

Mr. Patel explained each of the revisions to the standard drawings. Mr. Patel also explained in detail each of the revisions to the spec sections, as well as the proposed revisions to the design manual portions.
Revised drawings are shown in these minutes.

There was a discussion involving soil borings. Mr. Miller expressed some concern over this regarding having enough borings, but not too many. Mr. Strain offered that it be left up to the Geotechnical Engineer to determine the number and locations of those borings. Mr. Pankow mentioned that there could be other issues in determining the locations of the soil borings. Having one at each location could become tedious. With all of the other utilities involved, too many borings could create even more problems. Mr. Pankow suggested they talk to the Geotechnical soils people and coordinate with them. Mr. Patel agreed that their guidance would be good to have.

Mr. Walker also commented on the friction coefficient. Mr. Patel commented that all the information would be useful to have. Mr. Patel said that he will revisit this item under IDM 77-4.04(01) and rework that language on the soil borings.

Mr. Strain inquired as to the minimal clearance under a signal head and reference sheet E 805-TSCS-06 of the drawings. The drawing shows 17.5 ft minimum clearance, but the spec shows 17 ft. Mr. Patel agreed to revise that clearance to 17.5 feet in section 805.05 of the spec. Mr. Patel also pointed out some of the editorial changes that were made to the revised 805 section. Mr. Uremovich pointed out that the "M" should be capitalized in MPa.

Mr. Keefer pointed out that the drawings should say "Drilled Shaft **Foundations**" instead of just "drilled shaft", in the title block. Mr. Keefer also made some editorial suggestions which are shown on page 8 of these minutes, in section 805.13 Foundations. The words *concrete* and *placed* were added. Mr. Walker and Mr. Uremovich made some other editorial recommendations for section 922.01, clarifying the language, which were incorporated during the meeting.

There was a brief discussion about the ground rods and how they should be certified. Should they have a type C certification?

Mr. Pankow suggested that language be placed in page 43 pertaining to design manual issues to paving over loops and how they are installed to alleviate bumps (location and termination), giving the designers some direction. There ensued a brief discussion between Mr. Pankow and Mr. Andrewski on the location and depths of those loops.

Mr. Uremovich had some questions on the standard drawings. Beginning with drawing E 805-TSCS-04 - note 2 - the required signal arm rise..... Mr. Uremovich would like to it to say "shall" instead of "will" and have it say it shall be built "at" and angle, not "as" an angle. Mr. Patel will incorporate those revisions.

Mr. Miller pointed out that the spec already contains language requiring type C certifications. Mr. Miller asked if there is any more discussion on these items.
The revised motion passed.

COMMENTS AND ACTION

(OLD BUSINESS ITEM)

805.03 GENERAL REQUIREMENTS
 805.04 POLE INSTALLATION
 805.05 PLACING SIGNAL HEADS
 805.13 FOUNDATIONS
 805.15 METHOD OF MEASUREMENT
 805.16 BASIS OF PAYMENT
 922-T-168 TRAFFIC SIGNALS MATERIALS AND EQUIPMENT
 805-TSCS-01 THRU -18 SIGNAL CANTILEVER STRUCTURES

(Continued)

Motion: Mr. Patel Second: Mr. Andrews Ayes: 7 Nays: 0	Action: <input type="checkbox"/> Passed as Submitted <input checked="" type="checkbox"/> Passed as Revised <input type="checkbox"/> Withdrawn
Standard Specifications Sections affected: 805.16 pg 745 (2012 SS) Recurring Special Provision affected: 805-T-169 TRAFFIC SIGNALS; 922-T-168 TRAFFIC SIGNALS MATERIALS AND EQUIPMENT Standard Sheets affected: NONE Design Manual Sections affected: CHAPTER 77-4.03 CHAPTER 77-4.04 CHAPTER 77-4.05 CHAPTER 77-5.0 CHAPTER 77-5.01 Figure 77-4I Figure 77-4J GIFE Sections cross-references: NONE	<input type="checkbox"/> 20__ Standard Specifications Book <input checked="" type="checkbox"/> Revise Pay Items List <input type="checkbox"/> Create RSP (No. ____) Effective _____ Letting RSP Sunset Date: _____ <input checked="" type="checkbox"/> Revise RSPs (No. 805-T-169 and 922-T-168) Effective January 01, 2012 Letting RSP Sunset Date: 2014 Book Standard Drawing Effective Sept. 01, 2012 <input checked="" type="checkbox"/> Create RPD (No. 805-T-177d) Effective January 01, 2012 Letting <input checked="" type="checkbox"/> 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? <u>Yes</u>

REVISION TO INDIANA DESIGN MANUAL
IDM 17-1.05 PROPRIETARY MATERIAL USE
FIGURES 17-1A THROUGH 17-1F



INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 11-__ Technical Advisory

July 19, 2011 DRAFT

TO: All Design, Operations, and District Personnel, and Consultants

FROM: _____
Richard L. VanCleave
Manager, Office of Roadway Engineering Standards
Highway Design and Technical Support Division

SUBJECT: Proprietary-Material Use

SUPERSEDES: *Indiana Design Manual* Section 17-1.05

EFFECTIVE: ????????

To ensure competitive bidding, the designer should restrict the use of proprietary materials on a project. A proprietary material is defined through specifications that are so specific that only one product will satisfy the requirements, or that the name of the product is actually specified. However, if a situation occurs where the use of a proprietary material will enhance safety, control costs, or will otherwise improve the project design, the use of a proprietary material may be justifiable. The designer should submit either a certification or a public-interest finding for the use of a proprietary material at Stage 2, but not later than Stage 3. *Indiana Design Manual* Figure 17-1A, the Transmittal Memorandum, should be included with each of the requests listed below.

1. Certification for No Suitable Existing Equal Material. If no suitable equal material exists, a Certification should be prepared. *Indiana Design Manual* Figure 17-1C should be used for this request. An editable version of this form appears on the Department's website at www.in.gov/dot/div/contracts/design/dmforms/.
2. Certification for Product Essential for Synchronization. A proprietary material may be justified where it is essential for synchronization with an existing highway facility, for which there is no equally-suitable alternative. *Indiana Design Manual* Figure 17-1D should be used for this request. An editable version of this form appears on the Department's website at www.in.gov/dot/div/contracts/design/dmforms/.
3. Experimental. A proprietary material may be justified for research purposes or for a distinctive type of roadway. A justification for an experimental or research item should include a work plan which details the evaluation to be conducted. For such a material to be used on the State highway system, the procedure described in the *INDOT Guidelines for Initiating and Reporting Experimental Features Studies* should be followed. *Indiana Design Manual* Figure 17-1C should be used for this request. An editable version of this form appears on the Department's website at www.in.gov/dot/div/contracts/design/dmforms/.
4. Public-Interest Finding for Proprietary-Material Use. The designer should prepare a Public-Interest Finding (PIF) for the use of a material if suitable alternatives exist but are not the most cost-effective or in the public's best interest. This should include a description of the circumstance being addressed due to use of the proprietary material, alternative solutions that were considered, and the reasoning why the proprietary material was chosen. *Indiana Design Manual* Figure 17-1E should be used for this request. An editable version of this form appears on the Department's website at www.in.gov/dot/div/contracts/design/dmforms/.
5. Program-Wide Programmatic Approval. A PIF is required for a product approved on a program-wide basis if there are other suitable alternatives. A Programmatic Certification is required if no suitable alternatives exist. The justification should include a work plan which details the evaluation to be conducted. A PIF (See *Indiana Design Manual* Figure 17-1E) or Programmatic Certification (See *Indiana Design Manual* Figure 17-1F) should include the length of time that the approval will be in effect. A Programmatic approval should be periodically reviewed to assess changes in the market conditions that can make them obsolete. If a pre-approved list has fewer than three vendors, a proprietary-product

approval is required before that list can be used. The currently-approved Proprietary Materials are listed in *Indiana Design Manual* Figure 17-1B.

6. Approval Process. Each request should be submitted through ERMS to the project manager, then forwarded to either the Highway Design and Technical Support Division director, or the Bridge Design Inspection Hydraulics and Technical Support Division director for approval. Approval requirements are as follows.
 - a. INDOT approval is required for each Figure 17-1C request that no suitable equal exists, or each Figure 17-1D request for product essential for synchronization. FHWA concurrence will be required only for a project that requires FHWA oversight.
 - b. FHWA approval is required for each Figure 17-1C experimental proprietary-material request.
 - c. FHWA approval is required for each Figure 17-1E PIF request.
 - d. FHWA approval is required for each Figure 17-1E Programmatic PIF request.
 - e. FHWA approval is required for each Figure 17-1F Programmatic Certification request.

FHWA approval listed in b through e above is required without regard to FHWA oversight.

If the project is under construction and a proprietary material is added to the contract, the Certification or PIF should be prepared and approved prior to completion of the change order. If a pay item is changed to proprietary during construction, federal participation is limited to the lower of either the contract unit price or the change-ordered unit price.

All of the *Indiana Design Manual* figures referenced herein are attached herewith.

RVC:rb

Attachments

REVISION TO INDIANA DESIGN MANUAL
IDM 17-1.05 PROPRIETARY MATERIAL USE
FIGURES 17-1A THROUGH 17-1F

(CONTINUED)

Figure 17-1A

Proprietary-Material Transmittal Memorandum

, 20

TO:

THRU:

FROM:

ROUTE:

DES. NO.:

PROPRIETARY MATERIAL:

The attached documentation is for your consideration in approving use of the proprietary material shown above. Pursuant to 23 CFR 635.411, the material satisfies the requirement checked below.

- ☐ Certification that no suitable equal exists
- ☐ Certification that product is essential for synchronization
- ☐ Approval for experimental purposes, Work Plan included
- ☐ Public-Interest Finding (PIF); suitable alternatives exist but they are not the most cost-effective or in the public's best interest
- ☐ Programmatic Approval for PIF / certification, Work Plan included

Additional comments:

THERE ARE NO APPROVED PROPRIETARY
MATERIALS AT THIS TIME.

APPROVED PROPRIETARY MATERIALS

Figure 17-1B

APPROVED MINUTES

REVISION TO INDIANA DESIGN MANUAL
IDM 17-1.05 PROPRIETARY MATERIAL USE
FIGURES 17-1A THROUGH 17-1F

(CONTINUED)

Figure 17-1C

**CERTIFICATION FOR PROPRIETARY-MATERIAL USE,
NO SUITABLE EQUAL EXISTS**

ROUTE: DES. NO:
PROJECT NO.: COUNTY:
PROJECT DESCRIPTION:
FHWA OVERSIGHT: ☐ YES ☐ NO
PROPRIETARY MATERIAL:

1. Description of Need: [Provide a discussion as to why the product was selected, including limitations and conditions for its use. Delete all instructions once fields are completed.]

2. Product History: [Indicate if the product has been used successfully in Indiana or elsewhere.]

3. Product Availability: [Indicate if there are other similar products that can be used, and which other similar products were considered. Indicate that there are not at least two other similar products for Certification. A minimum of 3 vendors' products are necessary to negate the need for a proprietary-material approval. Provide discussion or comparison matrix.]

4. Product Cost: [Provide the difference in the cost of the proposed item to other non-proprietary items. Indicate the additional cost or cost savings for the use of the proposed item. Include an estimate of additional cost incurred as a result of this proprietary-product requirement.]

☐ This certification is for an experimental or research item. The Work Plan is attached.

Prepared By: Date:

APPROVED: _____ Date: _____
INDOT Deputy Commissioner
Engineering Services and Design Support

CONCURRED: _____ Date: _____
Federal Highway Administration

REVISION TO INDIANA DESIGN MANUAL
IDM 17-1.05 PROPRIETARY MATERIAL USE
FIGURES 17-1A THROUGH 17-1F

(CONTINUED)

Figure 17-1D

**CERTIFICATION FOR PROPRIETARY-MATERIAL USE,
ESSENTIAL FOR SYNCHRONIZATION**

ROUTE: DES NO:
PROJECT NO: COUNTY:
PROJECT DESCRIPTION:
FHWA OVERSIGHT: ☐ YES ☐ NO
PROPRIETARY MATERIAL:

- 1. Description of Need:** [Provide a discussion as to why the product was selected, including limitations and conditions for its use. Delete all instructions once fields are completed.]
- 2. Product History:** [Indicate if the product has been used successfully in Indiana or elsewhere.]
- 3. Product Availability:** [Indicate if there are other similar products that can be used, and which other similar products were considered. Indicate that there are not at least two other similar products for Certification. A minimum of 3 vendors' products are necessary to negate the need for a proprietary-material approval. Provide discussion or comparison matrix.]
- 4. Product Cost:** [Provide the difference in the cost of the proposed item to other non-proprietary items. Indicate the additional cost or cost savings for the use of the proposed item. Include an estimate of additional cost incurred as a result of this proprietary-product requirement.]
- 5. Project Compatibility:** [Indicate if this is the only product that is compatible due to function, logistics, or aesthetics. Discuss and document compatibility requirements evaluated. Provide comparisons to other products and their relationship to the product requirements.]
- 6. Maintenance:** [Discuss maintenance issues such as training or storage. Provide discussion as to why other products cannot be used due to maintenance concerns.]

Prepared By: . Date:

APPROVED: _____ Date: _____
INDOT Deputy Commissioner

REVISION TO INDIANA DESIGN MANUAL

(CONTINUED)

IDM 17-1.05 PROPRIETARY MATERIAL USE
FIGURES 17-1A THROUGH 17-1F

Engineering Services and Design Support

CONCURRED: _____ Date: _____
Federal Highway Administration

APPROVED MINUTES

Figure 17-1E

PUBLIC-INTEREST FINDING FOR PROPRIETARY-MATERIAL USE

ROUTE: DES NO:
PROJECT NO: COUNTY:
PROJECT DESCRIPTION:
FHWA OVERSIGHT: ☐ YES ☐ NO
PROPRIETARY MATERIAL:

- 1. Description of Need:** [Provide a discussion as to why the product was selected, including limitations and conditions for its use. Delete all instructions once fields are completed.]
- 2. Product History:** [Indicate if the product has been used successfully in Indiana or elsewhere.]
- 3. Product Availability:** [Indicate if there are other similar products that can be used, and which other similar products were considered. Indicate that there are not at least two other similar products for Certification. A minimum of 3 vendors' products are necessary to negate the need for a proprietary-material approval. Provide discussion or comparison matrix.]
- 4. Product Cost:** [Provide the difference in the cost of the proposed item to other non-proprietary items. Indicate the additional cost or cost savings for the use of the proposed item. Include an estimate of additional cost incurred as a result of this proprietary-product requirement.]
- 5. Project Compatibility:** [Indicate if this is the only product that is compatible due to function, logistics, or aesthetics. Discuss and document compatibility requirements evaluated. Provide comparisons to other products and their relationship to the product requirements.]
- 6. Maintenance:** [Discuss maintenance issues such as training or storage. Provide discussion as to why other products cannot be used due to maintenance concerns.]
- 7. Engineering Analysis:** [Compare the project requirements to similar project types and discuss the reasonableness of the requirements. Discuss unique project factors.]
- 8. Expanded Economic Analysis:** [Include life-cycle cost analysis.]

REVISION TO INDIANA DESIGN MANUAL

(CONTINUED)

IDM 17-1.05 PROPRIETARY MATERIAL USE
FIGURES 17-1A THROUGH 17-1F

9. Contractual or Performance Implications: [Discuss whether use of this item will impose restrictions on the use of other items specified in the contract or in future contracts.]

10. Attach Supplemental Documentation: [Outline assumptions, product research, and quantifiable benefits.]

11. Length of Time that Approval is Effective:

Prepared By: . Date:

APPROVED: _____ Date: _____
INDOT Deputy Commissioner
Engineering Services and Design Support

APPROVED: _____ Date: _____
Federal Highway Administration

REVISION TO INDIANA DESIGN MANUAL
IDM 17-1.05 PROPRIETARY MATERIAL USE
FIGURES 17-1A THROUGH 17-1F

(CONTINUED)

Figure 17-1F

**PROGRAMMATIC CERTIFICATION FOR PROPRIETARY-MATERIAL USE,
NO SUITABLE EQUAL EXISTS**

ROUTE: DES NO:
PROJECT NO.: COUNTY:
PROJECT DESCRIPTION:
FHWA OVERSIGHT: ☐ YES ☐ NO
PROPRIETARY MATERIAL:

1. Description of Need: [Provide a discussion as to why the product was selected, including limitations and conditions for its use. Delete all instructions once fields are completed.]

2. Product History: [Indicate if the product has been used successfully in Indiana or elsewhere.]

3. Product Availability: [Indicate if there are other similar products that can be used, and which other similar products were considered. Indicate that there are not at least two other similar products for Certification. A minimum of 3 vendors' products are necessary to negate the need for a proprietary-material approval. Provide discussion or comparison matrix.]

4. Product Cost: [Provide the difference in the cost of the proposed item to other non-proprietary items. Indicate the additional cost or cost savings for the use of the proposed item. Include an estimate of additional cost incurred as a result of this proprietary-product requirement.]

5. Length of Time that Approval is Effective:

The Work Plan is attached.

Prepared By: . Date:

APPROVED: _____ Date: _____
INDOT Deputy Commissioner
Engineering Services and Design Support

REVISION TO INDIANA DESIGN MANUAL

(CONTINUED)

IDM 17-1.05 PROPRIETARY MATERIAL USE

FIGURES 17-1A THROUGH 17-1F

APPROVED: _____ Date: _____

Federal Highway Administration

APPROVED MINUTES

DISCUSSION

IDM 17-1.05 PROPRIETARY MATERIAL USE FIGURES 17-1A THROUGH 17-1F

DISCUSSION: Mr. Husain introduced this item on behalf of Mr. Wright. The attached forms are such that only one form needs to be used, depending on the application, in regards to proprietary items. Mr. Strain asked if this had been coordinated with FHWA, and Mr. Husain responded that yes, they have. Mr. Walker explained that they have a system in place for proprietary items used in synchronization. Mr. Husain also said that there is a form for experimental items, in response to Mr. Pankow's inquiry.

Mr. Strain expressed concern as to how this overlaps with the new products committee. Mr. Miller asked if they have an example for an approval. Mr. Husain said that they do, and mentioned the micro loops process.

Mr. Strain commented that this only mentions one material, and Mr. George (FHWA) offered that if the Contractor has a choice of more than one source for the material, then that item is not proprietary. Mr. Patel and Mr. Husain offered that the requirement in the CFR is three or more. There ensued discussion on proprietary materials, how they are determined, how many suppliers are needed and what is meant by "or approved equal".

Mr. Walker mentioned that on the approved list of materials, a material can be added. But there needs to be an evaluation.

Mr. Miller asked if we need to add additional language to direct the bidder anywhere else to make sure they are using an approved material. Mr. Keefer mentioned that on LPA projects, often a proprietary material will be requested or required by local officials.

Mr. Miller said that the procedure for the evaluation of the material in regards to proprietary products (new or existing) needs to be in the GIFE so our reviewers in the field can properly handle potential change orders.

Mr. Walker mentioned that some products are so specific that a USP is needed to describe exactly what is needed. He again mentioned that what is important is the synchronization of materials and products with our existing system.

Further discussion by Mr. Walker and Mr. Patel revealed that it is critical to define the specific design criteria. It is also important to maintain a generic design criteria to prevent only one vendor from being able to supply the product.

Mr. Pankow said that he will look into the GIFE.

Mr. Miller asked if they have an effective date, and when they plan to officially issue this. The response was that it will be effective and issued as soon as it is ready and all are in agreement.