



INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 09-29 Technical Advisory

December 16, 2009

DESIGN MEMORANDUM No. 09-29 TECHNICAL ADVISORY

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

FROM: /s/ Richard L. VanCleave
Richard L. VanCleave
Design Policy Engineer
Office of Roadway Engineering Services

SUBJECT: Use of Flashing Beacons with Signs

REVISES: *Indiana Design Manual* Sections 77-3.02 and 77-3.04

EFFECTIVE: Lettings on or after January 2, 2010

One or more flashing beacons should be included with a sign if requested by the district traffic engineer or upon receipt of a signed Official Action authorizing the installation of such beacon.

A hazard-identification beacon or speed-limit-sign beacon can be either electrically or solar powered. Solar power should be specified except as described below.

1. If sunlight is expected to be obstructed by trees, buildings, or other obstructions in the vicinity of the beacon, electric power should be specified.
2. For an intersection-control beacon or "Stop" sign beacon, electric power should be specified.

The location of each sign that requires beacons, the number of beacons and the lens color, and the power method should be shown on the plans. The pay item names, code numbers, and pay units are unchanged.

Recurring Special Provision 805-T-169 should be called for until instructed otherwise. Recurring Plan Detail 805-T-169d should be called for in projects to be let through August 31, 2010. It will become a series of INDOT *Standard Drawings* beginning with the September 1, 2010, letting. Both documents are attached herewith.

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805-T-169 TRAFFIC SIGNALS

(Revised 08-20-09)

The Standard Specifications are revised as follows:

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

SECTION 805 – TRAFFIC SIGNALS

805.01 Description

This work shall consist of furnishing miscellaneous materials, not furnished by the Department, and installing traffic signals in accordance with these specifications and in reasonably close conformance with the lines, grades, and locations shown on the plans or as directed.

MATERIALS

805.02 Materials

Materials shall be in accordance with the following:

Castings for Handhole.....	910.05(b)
Coarse Aggregate, Class E or Higher, Size No. 8.....	904
Concrete, Class A, B, or C.....	702
Loop Detector Sealant.....	906.02(a)
Reinforced Concrete Pipe.....	907.02
Traffic Signal Materials and Equipment.....	922
Treated Lumber.....	911.02

The proposed work shall be examined in order to determine what materials not furnished by the Department are required to complete the contract. The Department will furnish only the materials specified on the Department Furnished Materials special provision. If materials to be furnished by the Contractor are listed, the list is only a guide for estimating purposes. All additional materials required to complete an operating installation as specified shall be furnished.

Signal handholes shall be class III reinforced concrete pipe as shown on the plans.

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

Preformed pave-over loops shall be designed for use with HMA, SMA or PCCP as applicable.

Wood poles to be furnished shall be in accordance with the current ANSI specifications and dimensions. They shall be of the length and class specified, be fully treated in accordance with 922.05(b), and dry. Minimum circumference at the top and at a point 6 ft (1.8 m) from the butt shall be in accordance with ANSI specifications.

Steel strain poles greater than 24 ft (7.3 m) in length shall be in accordance with 922.05(a).

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

CONSTRUCTION REQUIREMENTS

805.03 General Requirements

The Contractor shall maintain existing traffic signals in operation until the Engineer determines that the progress of the work necessitates their removal. The new installation shall not interfere with the operation of the existing signal. The work shall proceed in such a manner that the signals are not out of service at any two adjacent intersections at any time. When the operation of an existing traffic signal must be interrupted before the new signal is placed in operation, the traffic shall be controlled at all times. The work shall be scheduled so that the interruption is limited to a minimum amount of time and at off peak hours. When a new span, catenary, and tether are to be installed on an existing structure, the work shall be done so as not to damage the structure. ~~Tether cable will not be required on a flasher installation.~~ If an existing structure is damaged, it shall be repaired or replaced as directed with no additional payment. The new span and catenary installation shall not interfere with the operation of the existing traffic signal. Traffic shall be controlled at all times during the changeover when the existing traffic signal is turned off and the new signal is turned on. This changeover shall take place such that the interruption is limited to a minimum amount of time.

When directed, temporary stop signs shall be erected at the intersection. When no work is in progress, the intersection shall have at least two operating signal faces for each approach. When the new installations are completed, all existing signal equipment and materials including wood poles, steel poles, and cast-iron handhole rings and covers which have not been used in the new installation shall be carefully removed. Regardless of the right to materials found on the project, as set out in other sections of these specifications, items designated in the contract documents, and field identified by the Department, as traffic signal equipment to be salvaged by the Department or local unit of government shall be stored at a secure site until such time as it is transported to the District Office, when designated as a pay item, or salvaged by the Department or local unit of government. The Contractor shall verify that the field identification placed by the Department has not been removed by vandalism or natural causes. If the Contractor has reason to believe field identifications have been removed, it shall contact the Department. The Contractor shall be responsible for all damage or loss of this equipment and shall repair or replace the damaged or lost equipment as directed. All signal equipment removed and not designated to be salvaged shall become the property of the Contractor and shall be disposed of in accordance with 202.

All existing painted signal equipment to be reused, such as pedestals, bases, controller cabinets, signal heads, signal weatherheads, pipe arms, shall be cleaned and

painted with two coats of highway yellow enamel. Aluminum poles and mast arms shall not be painted.

Existing concrete foundations, which have not been used in the new installation, shall be removed to a minimum of 4 in. (100 mm) below the adjacent grade. The openings shall be filled with concrete and the surface finished and broomed, if they are located in sidewalk areas. Otherwise, they shall be filled with acceptable material conforming with the surrounding area. Existing signal handholes to be removed, shall be filled after removing rings and covers, with B borrow with a minimum of 4 in. (100 mm) of concrete on top to bring it up to grade in a sidewalk area. Surfaces shall be finished and broomed. Otherwise, they shall be filled with acceptable material conforming with the surrounding area.

The signal controller timings will be provided and the Engineer shall be present when the signal intersection is to be placed in operation.

All electrical wiring terminations and splices; controller and cabinet set-up; and testing, review, and turn-on of all operational apparatus at each location shall be done by or in the presence of and under the responsible charge of an employee of the Contractor who holds a Level II Traffic Signal Electrician certification which has been granted by the International Municipal Signal Association. Supervision of non-electrical, traffic signal related construction work and traffic control shall be done by a person holding a Level I Work Zone Traffic Safety Specialist certification which has been granted by the International Municipal Signal Association, or an equivalent certification approved by the Department.

Before starting work, the Contractor shall provide the names of the Level II Traffic Signal Electricians and Level I Work Zone Traffic Safety Specialists who have been assigned to perform signal related work, and a photocopy of each such person's certification card. If the Level II Traffic Signal Electricians or Level I Work Zone Traffic Safety Specialists are dismissed from the work, all signal related work requiring such certified personnel on the project site shall cease until the names and photocopies of certification cards for replacement personnel are provided to the Engineer.

Electrical work shall be executed in accordance with the requirements of the National Board of Fire Underwriters, the State Fire Marshal, and the power company which will furnish the electric service. The work shall be in accordance with any local regulations that may apply. The Department will arrange and provide for power service which the power company will bring to the point designated on the plans. Prior to the start of construction, the schedule of activities shall be coordinated with the power company and they shall be contacted again at least 14 days prior to the time the service work is to be completed.

The Department will obtain permits from local officials, companies, or individuals for the use of poles, right-of-way, or other property incidental to the installation of traffic signal. Although entering into the contract implies permission and authority to cut into and push under pavement, sidewalks, and alleys, any damage to underground utilities or interruption of such service shall be the responsibility of the

Contractor. The Contractor shall be in accordance with local regulations as well as 107.08. Protective devices shall be in accordance with 107.12 and 801.

The location of signal heads, controllers, signal poles, signal cantilever structures, detector housing, disconnect hangers, and other installation items will be shown on the plans. However, a change in the location of an item may be ordered during the progress of the work. The work shall be completed as shown on the plans except for those changes specifically authorized in writing.

Flashing beacons shall flash at a rate for each beacon of 50 to 60 times per minute with the illuminated period from 1/2 to 2/3 of the total cycle. If a second beacon is specified, the 2 beacons shall flash alternately.

805.04 Pole Installation

Metal poles shall be erected on concrete foundations and shall be reasonably plumb after installation of signal heads. The handhole side of the pole shall be at right angles to the direction of the mast arm or span, catenary, and tether. Signal cables shall be brought up inside the poles. Any steel pole, mast arm, or hardware not galvanized or painted with baked enamel shall be painted with two coats of rust inhibiting aluminum paint. Paint shall be applied in accordance with 619 with the exception that commercial blast cleaning of the steel will not be required. All rust, scale, and dirt shall be cleaned from the metal surface so that paint adheres to the surface.

The construction of concrete foundations shall be in accordance with 805.13. Wood poles shall be set a minimum of 7 ft (2.1 m) in the ground and raked 12 in. (300 mm).

805.05 Placing Signal Heads

Mast arm and span mounted signal heads shall have 17 ft (5.2 m) minimum and 19 ft (5.8 m) maximum clearance over the roadway unless there are visual obstructions which require lowering the signal head. A signal head over the roadway shall not have a clearance of less than 15 ft (4.6 m). Such signal heads shall be located over the intersection as shown on the plans. Such signal heads shall have a uniform clearance, which will be determined. Signal heads not mounted over a paved roadway, on the top or side of a pole, shall not be less than 10 ft (3 m) nor more than 15 ft (4.6 m) above the sidewalk or, if none, above the pavement grade at the center of the roadway. Signal faces shall be directed to the proper approach lane in each direction. *Flasher signal faces that supplement signs shall be mounted with the bottom of the housing at not less than 3 ft (0.9 m) nor more than 13 ft (3.9 m) above the edge of pavement. Flasher signal faces that supplement signs shall be directed towards oncoming traffic.* Pedestrian signal faces shall be mounted with the bottom of the housing at not less than 7 ft (2.1 m) nor more than 10 ft (3 m) above the sidewalk. The pedestrian signal shall be in line with the pedestrian's vision at the appropriate crosswalk being used. Pedestrian push-buttons shall be mounted at a height of 3 1/2 to 4 ft (1.1 to 1.2 m) above the sidewalk as shown on the plans. A pedestrian actuated signal sign shall be mounted immediately above the push-button.

Signal heads shall be assembled and wired with one conductor, THW, stranded wire. Where splices are made, a 2 ft (0.6 m) minimum length of cable or wire in excess of

that required for a continuous run shall be provided. Splices shall be twisted together and soldered or approved type connectors used. Each splice shall be completely insulated by wrapping with an approved tape and sealed with an approved electrical coating material. Splices shall be made in such manner that the connections are moisture proof. The cables coming out of the signal weatherhead shall be looped to form a drip loop. The drip loop shall be made so that the cables coming out of the weatherhead loop down below the elevation of the weatherhead to prevent water from following the cable into the weatherhead. If used, the splice indicated above shall be located in the top of the coils of cable forming the drip loop.

Signal heads shall not be installed until all other work has been completed. If it becomes necessary to mount signal heads for more than 2 h before the lights are to be turned on, the signal heads shall be hooded by placing sacks or similar cover over them so as to conceal them from traffic. Hooded signal heads are not permitted to be in place for more than five days. No signal head shall be left over night with the lights out unless it is hooded. Signal heads shall be securely mounted. The polycarbonate signal face shall be used only when securely supported on both ends of the assembly. In a span cable installation, a tether cable would satisfy this requirement.

805.06 Grounding

All signal supports, signal controller supports, and entrance switches shall be grounded in accordance with the applicable requirements of 807.12.

805.07 Wire and Cable Installations

All cable runs attached to utility poles shall have code clearance relative to utility cables. They shall be no less than 18 ft (5.5 m) above the ground level except over railroad tracks when a minimum of 27 ft (8.2 m) clearance shall be maintained. All cable runs shall be installed in continuous lengths without splices between terminals except when necessary at handholes, junction boxes, pole signal bases, and pedestal bases. The type of cable and the number of conductors as well as the gage shall be as shown on plans unless otherwise specified.

Cable rings shall be used to support the signal cable on the signal span cable. They shall be spaced 12 in. (300 mm) on center. Cable shall be pulled through the conduit to the terminal panel in the controller cabinet. Caution shall be used to prevent damage to the cable when it is being pulled through conduit.

Coded cable conductors shall be used throughout the installation. Cable conductors shall be tagged at all detector housings, handholes, pole signal pole bases, and controller cabinets. *At the ends of each cable, the tag shall be placed between 4 in. (100 mm) and 8 in. (200 mm) from the end of the wire and on the outer jacket. At all other locations, the tag shall be placed in the middle of the length of cable stored at the location. The tag shall be one-half inch wide, thermal printed black on yellow or black on white, polyester or nylon tape with permanent adhesive and shall be water, chemical and scratch resistant. The font shall be arial, size 10. Tags shall be installed flag style around the cable with the backs of the tag ends placed together. Tags shall consist of an aluminum blank of sufficient size to be stamped with not less than 3/16 in. (5 mm) high*

~~all upper case letters which~~ shall identify the cables by their use ~~and phase~~. The following are the uses which shall be indicated by the tags:

- (a) Power
- (b) Pedestrian Signal
- (c) Pedestrian Actuation
- (d) Signal-~~Phase Identification~~
- (e) Detection Loop Identification
- (f) *Interconnect*

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

~~Loop identification shall consist of the following:~~

~~Inside of the Detector Housing, the loop wires of each loop shall be tagged with, in _____, out _____, as shown on the plans.
Loop Number — Loop Number~~

~~Inside of the Controller Cabinet, each lead-in cable shall be tagged within 6 in. (150 mm) of the terminal strip connection with: Lane designation, Phase Number, Loop Number, and when applicable with loop system number, and speed trap according with the plans.~~

~~Phase identification shall consist of the single number "1", "2", "3", etc., which corresponds to the phase diagram for the respective intersection. Tags shall be securely fastened to the cable with a non-corroding material. The tagging material and fastening shall be approved prior to proceeding with this work. The color coded wires shall be connected properly. The white wire shall be the common or ground. Wire used for all identical indications of any individual phase shall be color coded and, where possible, shall use red wire to connect red lenses, orange wire to connect yellow lenses, and green wire to connect green lenses. Signal heads shall be assembled and wired before being installed. The testing of the loops shall be documented in the Loop Testing Table provided by the State.~~

805.08 Controller Cabinet, Signal Service, and Detector Housing Installation

Three document packets shall be prepared in accordance with 922.02(b) for each cabinet. Each packet shall be labeled with the name of the contract number, the intersection, the commission number of the signal and the date of installation. One packet shall be placed in the cabinet and the remaining two packets shall be submitted to the Engineer within 2 days after the signal is turned on. Information in the packets shall

include all approved changes to the signal installation. All detector loop lead-in tags and detector rack labels shall reflect all approved changes to the signal installation.

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

For signal cabinets installed by the Contractor, where no detector loop or lead-in work is included in the contract, the Contractor shall perform detector loop tagging, testing and vehicle simulator testing in accordance with 805.09, only to the extent of documenting the test readings and confirming that all existing detector loops are connected correctly and all detector related equipment in the cabinet is operating correctly.

The controller cabinet shall be mounted securely on a pole, pedestal, or concrete foundation. All cabinets on concrete foundations shall be installed with the anchor bolts inside. Controller cabinets on poles or pedestals shall be mounted at a height of 38 in. \pm 2 in. (970 mm \pm 50 mm). Pole mounted controller cabinets shall be fastened with two stainless steel bands as shown in the plans. Signal cables and lead-in cable shall be run in conduit from the controller cabinet to the signal support base and to detector housing as indicated on the plans. Galvanized steel elbows shall be used on the detector housing as shown on the plans.

The Contractor shall wire the entrance switch and bring service cable up the riser and out the weatherhead and leave 4 ft (1.2 m) of cable outside the weatherhead. The utility company, at their option, may bring the service cables to the load side of the entrance switch. Meter bases, if required, shall be obtained from the power company ~~and any service connection or miscellaneous charges shall be assumed by the Contractor.~~

A minimum of 12 in. (300 mm) and a maximum of 18 in. (450 mm) of loop wire duct will be permitted in the detector housing for each loop lead. Concrete used in the installation of detector housings shall be in accordance with 506, except 506.05 will not apply. A CMDS in accordance with 502.03 shall be submitted, however, utilization of the Department provided spreadsheet is not required. Where a portion of the road is closed or where there is no vehicular traffic, then class A concrete in accordance with 702 may be used. The concrete shall be placed flush with existing surface and shall be covered with a steel plate during the setting time.

805.09 Loop Wire Detector Installation

This work shall consist of placement and testing of loop wire detectors in accordance with the installation details shown on the plans.

MATERIALS

~~Loop wire shall be in accordance with 922.06(e)7b. Loop detector sealant shall be in accordance with 922.06(e)7e.~~

(a) Layout

The number, size, arrangement, and locations of loops shall be as shown on the plans except that loop spacing shall be adjusted to avoid PCCP joints. Loops shall be of a regular octagon shape with sides of 2.5 ft (0.75 m) in length or a circular shape with a diameter of 6 ft (1.8 m). Loops placed longitudinally adjacent 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. Loops shall be arranged so that no loop wire will be bent at an angle less than 120°. Regardless of configuration, the loop installation shall match the intention of the loop tagging table.

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

(b) Installation

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

1. Saw-cut Loops

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

control and a mechanical agitator. A backer rod shall be used for both cold applied sealants and hot poured sealants. The sealant material shall fill the saw cut as shown on the plans. All excess joint sealant on the pavement surfaces shall be promptly removed.

~~The specified number of turns shall be placed in the slot and gently tamped with a blunt non-metallic tool. A sash cord or backer rod shall be placed above the wire after tamping. The number, size, arrangement, and locations of loops shall be as shown on the plans. Loop spacing shall be adjusted to avoid pavement joints. Loop wire shall be pressed into the saw slot with a blunt non-metallic tool. Loop wire shall only be bent at angles of 120° or greater. All loops shall be wired clockwise as viewed from above. Loops shall be wired with four turns and in a series unless otherwise specified. Joints shall be overlapped such that the saw cut at the corner is full depth. The sealant shall be poured into the saw cut making a water tight seal. The splice of the loop wire and lead-in cable shall be soldered and waterproofed at the detector housing. Waterproofing shall consist of the use of heat shrink tubing which has an internal coating sealant material. The heat shrink tubing shall not be heated by means of a direct flame tool. Loop wire and lead-in cable shall be tagged according to the plans and 805.07. The black lead-in wire shall be spliced to the loop wire which goes back to the field. Such wire shall be tagged as "Out/Loop (No.)". The white lead-in wire shall be spliced to the loop wire which comes in from the field. Such wire shall be tagged as "In/Loop (No.)".~~

2. Preformed Pavement-over Loops

Preformed pavement-over loops may be installed as a 1, 2, 3 or 4 loop configuration. Pavement-over loops shall be secured in place prior to paving.

(c) Splices

For each loop cable and lead-in cable entering a handhole, there shall be 6 ft (1.8 m) of cable jacket remaining on each wire after the splice is complete. For each loop cable and lead-in cable entering a detector housing, there shall be 2 ft (0.60 m) of cable jacket remaining on each wire after the splice is complete. For all loop splices, there shall be a maximum of 0.5 in. (12 mm) of non-jacketed wire measured from the end of each cable jacket to the edge of the splice waterproofing material. The splice of the loop wire and lead-in cable shall be soldered and waterproofed at the detector housing or handhole. Waterproofing shall consist of the use of heat shrink tubing which has an internal coating sealant material. The heat shrink tubing shall not be heated by means of a direct flame tool.

(d) Testing and Acceptance

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

TESTING

The Contractor shall meter all new loop wire detectors or a new bank of loop wire detectors by means of instruments capable of measuring electrical values for installed loop wires and lead-in cables. The instruments shall measure inductance in microhenries,

resistance in ohms, induced A.C. voltage in volts, and leakage resistance in megohms. All measuring tests shall be performed at the detector housing before the loop wire is spliced to the lead-in cable, and at the cabinet after the loop wire is spliced to the lead-in cable.

1. Electrical Testing

(a) a. Megohm Test Before Splice is Made at Detector Housing for Loop Wire

One of the megohm probes shall be connected to ground and the other probe shall be connected to the “in” or “out” loop wire. The remaining loop wire shall be isolated. The test shall then be performed.

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

~~The two wires of the lead-in cable at the cabinet shall be twisted together and taped. The shield of the lead-in cable shall be grounded in the cabinet. At the detector housing, one megohm probe shall be connected to ground and the other probe shall be connected to one of the lead-in wires. The remaining lead-in wire shall be isolated. The test shall then be performed.~~

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

- (1) Connect the first megohm probe to ground and the second probe to the shield. Record the reading.*
- (2) Connect the first megohm probe to the first lead-in wire and the second probe to the shield. Record the reading.*
- (3) Connect the first megohm probe to the second lead-in wire and the second probe to the shield. Record the reading.*
- (4) Connect the first megohm probe to the first lead-in wire and the second probe to the second lead-in wire. Record the reading.*

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

(c) c. Megohm Test After Splice is Completed at Cabinet

This test shall be performed after the splice at the detector housing is completed. A water solution of one tablespoon (15 ml) of baking soda per pint (0.5 L) of water shall be placed in a metal container. The metal container shall be grounded and the splice shall be fully submerged in the solution for 2 min. With the splice submerged, the *shield of the lead-in shall be connected to ground at the cabinet. One megohm probe shall then be connected to ground and the other probe connected to one of the lead-in wires* ~~test shall be performed at the cabinet on the end of the lead-in cable and the reading recorded.~~

~~(d) Vehicle Simulator Test~~

~~This test shall be performed after all other tests are completed and after all connections have been made at the controller in the cabinet. This test shall be performed by dragging a test vehicle across the loops using a non-conducting string. The test vehicle shall be fabricated with an 8 ft (2.4 m) length of No. 6 bare copper wire formed into a circle. The two ends shall then be electrically spliced. The detector unit amplifier shall record a call as the test vehicle is dragged across the loop. It shall cancel the call as the test vehicle leaves the loop.~~

2. Delay Amplifier Settings and Vehicle Simulator Test

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

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

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

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

This test shall be performed by dragging a test vehicle across the loops using a non-conducting string. The test vehicle shall be fabricated with an 8 ft (2.4 m) length of No. 6 bare copper wire formed into a 2.5 ft (0.76 m) diameter circle. The two ends shall then be electrically spliced. The test shall be started with all detector amplifiers turned off except for one (1) approach. All amplifiers for that approach shall be turned on and adjusted to the proper settings as per 805.09(d)4. All traffic for the approach being tested shall be stopped and not allowed to cross any loops during the test procedure for that approach. The simulator shall be dragged slowly across each loop system in the same direction as to simulate a vehicle driving through the loop system. As the simulator crosses each loop an IMSA level II certified Signal Technician shall verify that a call is displayed exclusively on the corresponding loop amplifier, controller detector input and controller phase(s). After completely verifying the loops on the first approach the amplifiers shall be left on, and the amplifiers for the next approach to be tested shall be turned on and adjusted to the proper settings. The same procedure shall be followed for each remaining approach. With large intersections, as the test proceeds, it may become difficult to verify that the calls are going to the correct detector inputs. In this case, traffic control shall be used to stop vehicles before reaching the loops for as many approaches as needed to accurately complete the testing to the inspector's approval. Testing may be paused between lanes to allow traffic to clear.

(e) 3. Acceptance Criteria

The Contractor shall record all test readings, in triplicate, on tabular forms provided by the Department or by copying the one included elsewhere herein. The Contractor shall complete, sign, and date the forms before submitting them to the District Traffic Engineer. The District Traffic Engineer will use these forms for recording the Department's readings on the corresponding space provided.

In order for the loop detector installation to be accepted, the electrical values shall be as follows:

- ~~1.~~ a. Inductance shall be between 80 and 800 μ H. Inductance shall be determined by means of digital readout meter which drives the field loop system.
- ~~2.~~ b. Resistance shall be less than or equal to 8 ohms.
- ~~3.~~ c. ~~Induced AC voltage~~ Voltage shall be less than or equal to 3 V.
- ~~4.~~ d. ~~Induced A.C. voltage and leadage~~ Leakage resistance shall be greater than 100 megohms.

Loop wire and/or lead-in cable failing to meet this requirement shall be replaced at no cost to the State.

805.10 Magnetometer and Microloop Detectors

Before installation of Magnetometer or Microloop probes the Contractor shall confirm the adequacy of the magnetic field intensity, to be sure that the range is suitable for their operation. Arrangement of probes shall be located at maximum distance from steel support under bridges. Probes shall be installed with their long dimension vertical, and with the cable end at the top. Probes shall be firmly supported, so the lateral and vertical motion is restricted. Probes shall be connected in series. The splice shall be soldered by means of hot iron, or pouring or dripping without flames, with rosin core solder and shall be insulated and waterproofed in accordance with the manufacturer's specifications.

805.11 Steel Conduit

Conduit shall be installed to a depth of no less than 2 ft (0.6 m) or more than 5 ft (1.5 m) below the finished grade unless otherwise specified or approved. Pockets or traps where moisture might accumulate shall be avoided. Conduit shall be placed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without permission. If permission is granted, cuts in pavement areas shall be no greater than 24 in. (600 mm) wide. All cuts in the pavement and sidewalk areas shall be sawed. Sidewalk removal and replacement shall be to the nearest tooled joint. Jacking and drilling pits shall be kept at least 2 ft (0.6 m) clear of the edge of any type of pavement or paved shoulder. Excessive use of water that may cause undermining of the pavement shall be avoided. Continuous conduit runs shall not exceed 250 ft (76 m) in length, unless otherwise indicated on the plans.

Expansion fittings as detailed on structure plans shall be installed where conduit crosses an expansion joint in the structure. Where it is deemed inadvisable to install expansion fittings in closely confined areas, the installation of approved flexible tubing may be permitted. Such expansion joints or tubing shall be the same size as the conduit. Any existing underground conduit to be incorporated into a new signal installation shall be cleaned with a mandrel and blown out with compressed air before cable is drawn into pipe. All new conduit runs shall be cleaned and swabbed before cables are installed. All conduit ends shall be capped and shall remain capped until the Contractor is ready to pull cable into the conduit, at which time the caps shall be removed and conduit bushings placed on each end to protect the cable. The inside surface of the conduit shall be kept clean. Conduit to be installed, indicated on the plans for future use of signal cables, shall be left in place with a pull cord on its entire length.

Larger size conduit may be used with no additional payment, but when it is used, it shall be for the entire length of the run from outlet to outlet. Conduit runs as shown on the plans are for bidding purposes only and may be changed, with permission, to avoid underground obstructions. A change order may be authorized if the conduit runs can be made on the opposite side of the street to that shown on the plans in order to avoid obstruction and traffic inconvenience or to avoid unnecessary tearing up of existing pavement.

805.12 PVC Conduit

The method of installing PVC conduit underground shall be the same as for steel conduit where applicable except trenches for the conduit shall be backfilled with 2 in. (50 mm) of sand before the conduit is placed in the trench. Materials excavated may be used for backfill, if approved. If the Engineer deems it necessary, approved B borrow shall be placed over the conduit to a depth of 12 in. (300 mm) and the remainder of the trench shall be filled with excavated material.

805.13 Foundations

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

During excavation of the foundation, all material shall be removed to the full depth as shown on the plans, except if class X material is encountered, the work shall be performed in accordance with 206.02(b).

805.14 Final Clean-Up

When the installation is completed, all disturbed portions of sidewalk, pavement, shoulders, driveways, sod, etc., shall be cleaned and any excess excavation or other materials shall be disposed. All cutting in the sidewalk and pavement areas shall be done with a saw. Sidewalk removal and replacement shall be to the nearest tool joint. Unless

otherwise directed, cuts in pavement areas shall be no greater than 12 in. (300 mm) in width.

805.15 Method of Measurement

Traffic signal head, pedestrian signal head, pedestrian push button, controller cabinet foundation, M foundation modified to P-1 foundation signal steel strain pole, signal wood pole, signal cantilever structure, signal support foundation, signal service, disconnect hanger, magnetometer detector, microloop detector, loop detector delay amplifier, *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.

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

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

The accepted quantities for payment for electrical signal or loop lead-in cable will be the quantities shown in the Schedule of Pay Items. Such quantities may be corrected if they are in error by more than 25%.

Saw cut for roadway loop detector and sealant will be measured by the linear foot (meter) for the full depth of slot cut in the pavement as shown on the plans or as directed.

If class X material is encountered during foundation excavation, measurement will be made in accordance with 206.10.

Traffic signal installation or modernization, flasher installation or modernization, miscellaneous equipment for traffic signals, and final cleanup in accordance with 805.14 will not be measured for payment.

Traffic signal equipment removal and transportation of salvageable signal equipment will not be measured.

805.16 Basis of Payment

Traffic signal installation, flasher installation, traffic signal modernization, and flasher modernization, all of the type and the location number specified, will be paid for at a contract lump sum price.

If specified as pay items, traffic signal controller and cabinet, traffic signal head, pedestrian signal head, pedestrian push button, controller cabinet foundation, M foundation modified to P-1 foundation, signal steel strain pole, signal wood pole, signal cantilever structure, signal support foundation, signal pedestals, signal service, disconnect hanger, magnetometer detector, microloop detector, loop detector delay

amplifier, *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).

Performed pave-over loops will be paid at the contract unit price per each.

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

Class X excavation will be paid for in accordance with 206.11.

Miscellaneous equipment for traffic signals will be paid for at a contract lump sum price.

Payment will be made under:

Pay Item	Pay Unit Symbol
Controller and Cabinet, _____, _____ Phase.....	EACH
type no.	
Controller and Cabinet, Flasher, _____.....	EACH
type	
Controller Cabinet Foundation, _____.....	EACH
type	
Controller Cabinet Foundation, M, Modify to P-1	EACH
Disconnect Hanger.....	EACH
Flasher Installation, Location No. _____.....	LS
Flasher Modernization, Location No. _____.....	LS
Handhole, Signal.....	EACH
Loop Detector Delay Amplifier, _____ Channel.....	EACH
no.	
Loop Detector Delay <i>Counting</i> Amplifier, _____ Channel.....	EACH
no.	
<i>Loop Detector Rack</i>	<i>EACH</i>
Magnetometer Detector.....	EACH
Microloop Detector.....	EACH
Miscellaneous Equipment for Traffic Signals.....	LS
Pedestrian Push Button	EACH
Pedestrian Signal Head, _____, _____.....	EACH
type lens size	
Saw Cut for Roadway Loop and Sealant	LFT (m)
Signal Cable, _____, No. _____ Copper, _____ C/ _____.....	LFT (m)
type conductors/size	

Signal Cable, Preformed Pave-Over Loop	EACH
Signal Cantilever Structure, Mast Arm _____ ft (m).....	EACH
length	
Signal Detector Housing	EACH
Signal Interconnect Cable, _____, No. _____	
type	
Copper, _____ C/ _____	LFT (m)
conductors/size	
Signal Pedestal, _____ ft (m).....	EACH
length	
Signal Pole, Wood, _____, _____ ft (m)	EACH
class length	
Signal Service.....	EACH
Signal Strain Pole, Steel, _____ ft (m).....	EACH
length	
Signal Support Foundation, _____ in. (mm) x _____ in. (mm)	
x _____ in. (mm).....	EACH
Span and Catenary for Flasher	EACH
Span, Catenary, and Tether	EACH
Traffic Signal Equipment, Remove.....	LS
Traffic Signal Head, _____ Way, _____ Section, _____	EACH
no. no. lens sizes & colors.....	EACH
Traffic Signal Installation, _____, Location No. _____	LS
type	
Traffic Signal Modernization, _____, Location No. _____	LS
type	
Transportation of Salvageable Signal Equipment.....	LS

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

The cost of all wiring, hardware, anchor bolts, and associated equipment required to operate the intersections shall be included in the cost of controller and cabinet, flasher.

The cost of signal face hook-up wire, pole plates and arms for side mounts, mid-mast arm mount, pipe arms, signal brackets, visors, louvers, bulbs, span hanger, backplates, balance adjuster, weatherhead, and all additional hardware required to assemble a combination of signal faces as shown on the plans shall be included in the cost of traffic signal head or pedestrian signal head.

The cost of the push button, pedestrian actuated signal sign, and all hardware required to complete the installation shall be included in the cost of pedestrian push button.

The cost of concrete, conduits, grounding bushings, ground rod, ground wire, drainage, and all hardware required to complete the installation shall be included in the cost of controller cabinet foundation.

The cost of the base plate, metal skirt base plate, anchor bolts, handhole and cover grounding lug, 2 in. (50 mm) pipe cable entrance, J hook, and top cover as shown on the plans shall be included in the cost of signal strain pole, steel.

The cost of downguys, anchor rods, downguy guards, and hub-eyes as shown on the plans, and all hardware required to complete the installation shall be included in the cost of signal pole, wood.

The cost of all hardware including the metal skirt base plate, where necessary, to complete the installation as shown on the plans shall be included in the cost of signal cantilever structure.

The cost of concrete, reinforcing steel, conduits, ground rod, ground wire, grounding bushings, and all hardware required to complete the installation shall be included in the cost of signal support foundation.

The cost of the pedestal metal base, pedestal pole, pole cap when necessary, anchor bolts, and all hardware required to complete the installation shall be included in the cost of signal pedestal.

The cost of weatherhead, 1 in. (25 mm) conduit riser, entrance switch, 1 in. to 2 in. (25 mm to 50 mm) conduit reducer, ground rod, ground wire, and all hardware required to complete the installation, including the meter base when required and supplied by the utility company shall be included in the cost of signal service.

The cost of the detector unit, lead-in cable, and all work necessary for proper installation shall be included in the cost of magnetometer detector or microloop detector.

The cost of the slot cut on the pavement, ~~sash cord~~, backer rod, loop sealant, and all testing in accordance with 805.09 shall be included in the cost of saw cut for roadway loop and sealant.

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

The cost of all work and hardware required to properly install overhead or underground signal cable as shown on the plans or as directed shall be included in the cost of signal cable and signal interconnect cable.

~~The cost of the independent shelf mount unit or card rack unit, and power module shall be included in the cost of loop detector delay amplifier.~~

The cost of concrete reinforcing pipe, ring and cover eye bolts, hardware, handhole bottom, and aggregate under the handhole bottom as shown on the plans shall be included in the cost of handhole, signal.

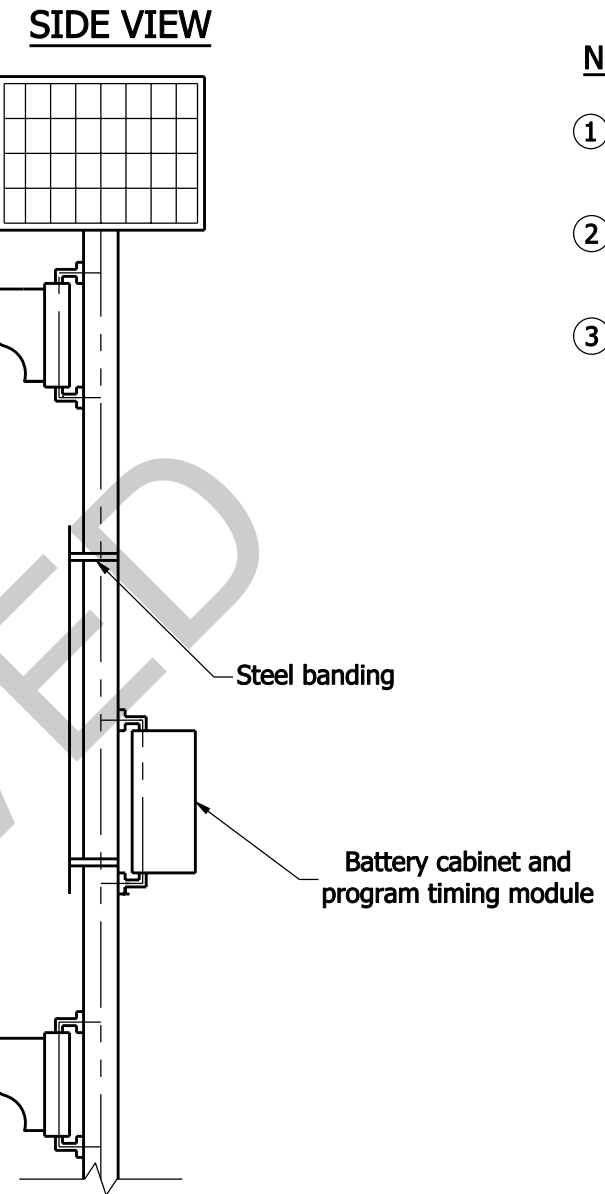
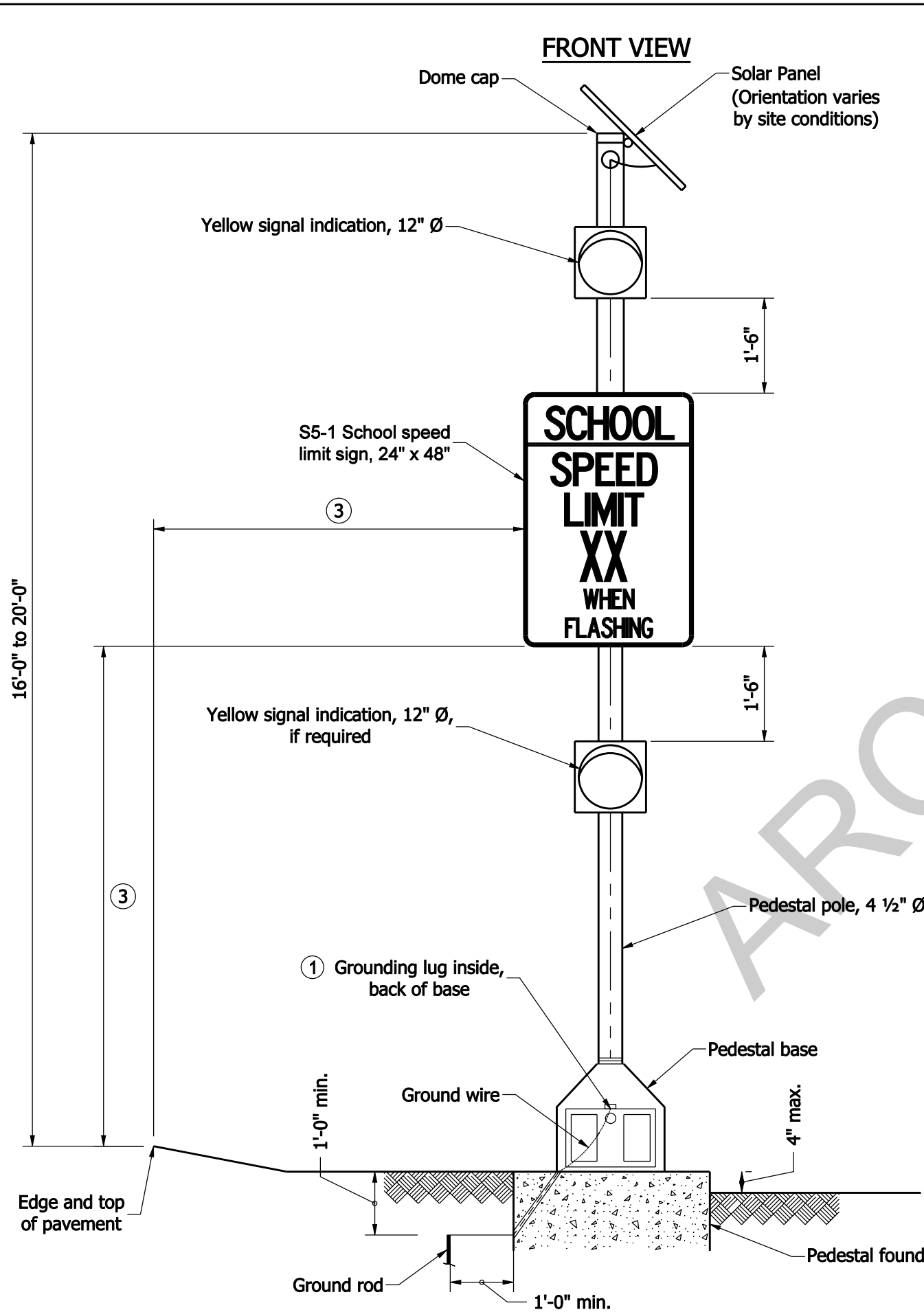
The cost of aluminum casting, enclosure concrete, steel conduit and elbow, and all hardware required to complete the installation shall be included in the cost of signal detector housing.

The cost of steel pole bands or straight eye bolts, span, catenary, and tether of wire rope cables, cable rings, type A support cable, wire rope clips, safety cable, thimble, service sleeve, and all hardware required to complete the installation as shown on the plans shall be included in the cost of span, catenary, and tether for signal, or span and catenary for flasher.

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

The cost of excavation, backfill, final cleanup in accordance with 805.14, and necessary incidentals shall be included in the cost of the pay items in this section.

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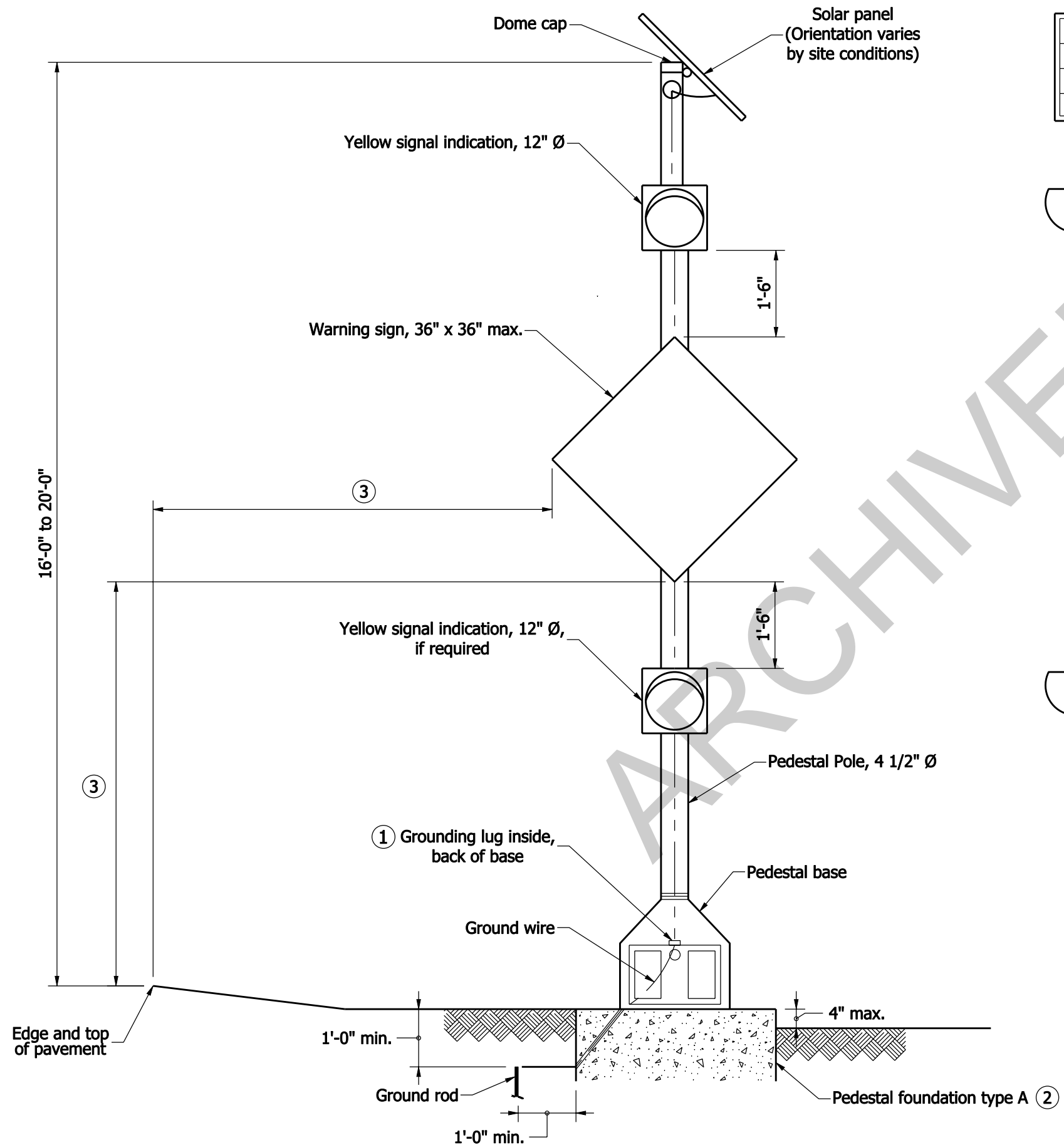


- NOTES:**
- ① See Standard Drawing E 805-SGGR-03 for grounding lug details.
 - ② See Standard Drawing E 805-SGCF-03 for type A foundation details.
 - ③ See Standard Drawing E 802-SNPL-02 for edge of pavement offset and sign height.

INDIANA DEPARTMENT OF TRANSPORTATION
 PEDESTAL MOUNTED SOLAR POWERED
 SCHOOL SPEED LIMIT
 FLASHING BEACON ASSEMBLY

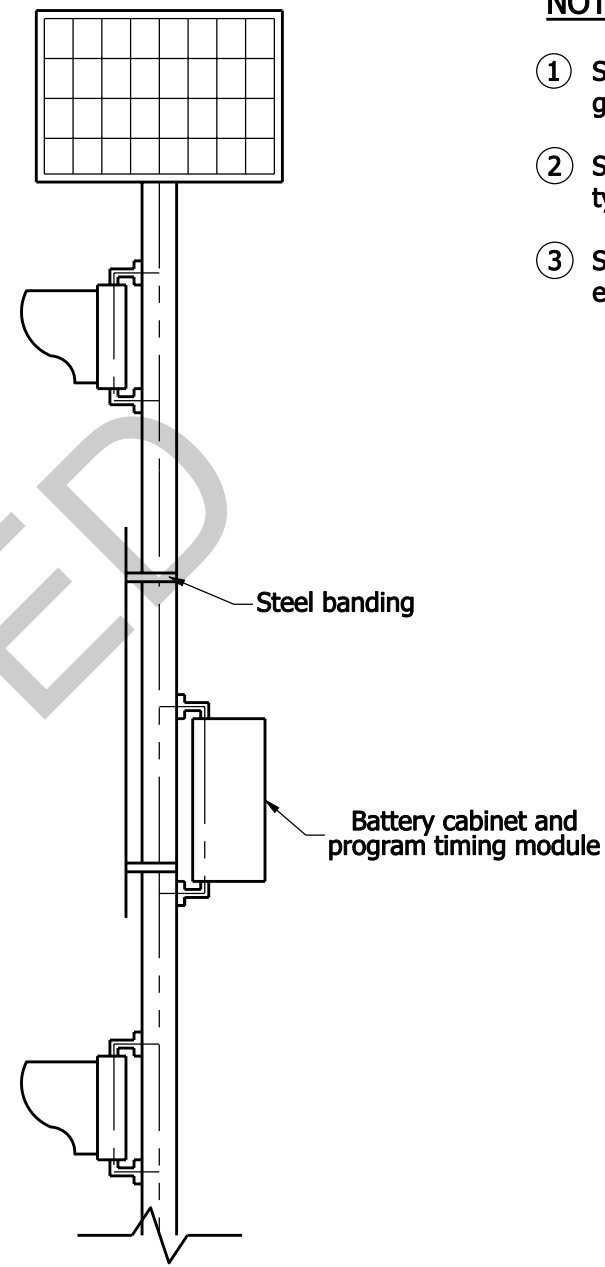
FRONT VIEW

SIDE VIEW

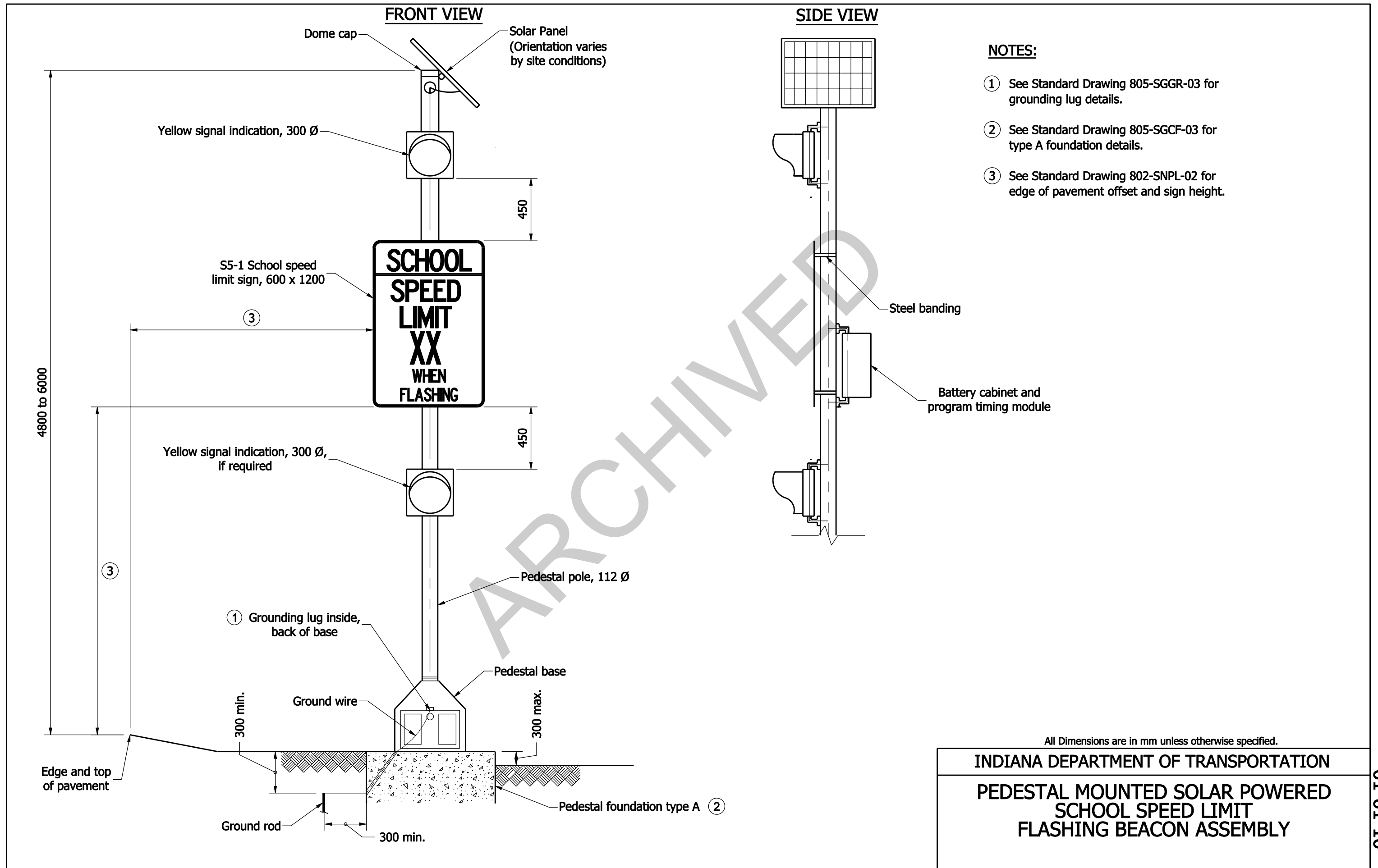


NOTES:

- ① See Standard Drawing E 805-SGGR-03 for grounding lug details.
- ② See Standard Drawing E 805-SGCF-03 for type A foundation details.
- ③ See Standard Drawing E 802-SNPL-02 for edge of pavement offset and sign height.

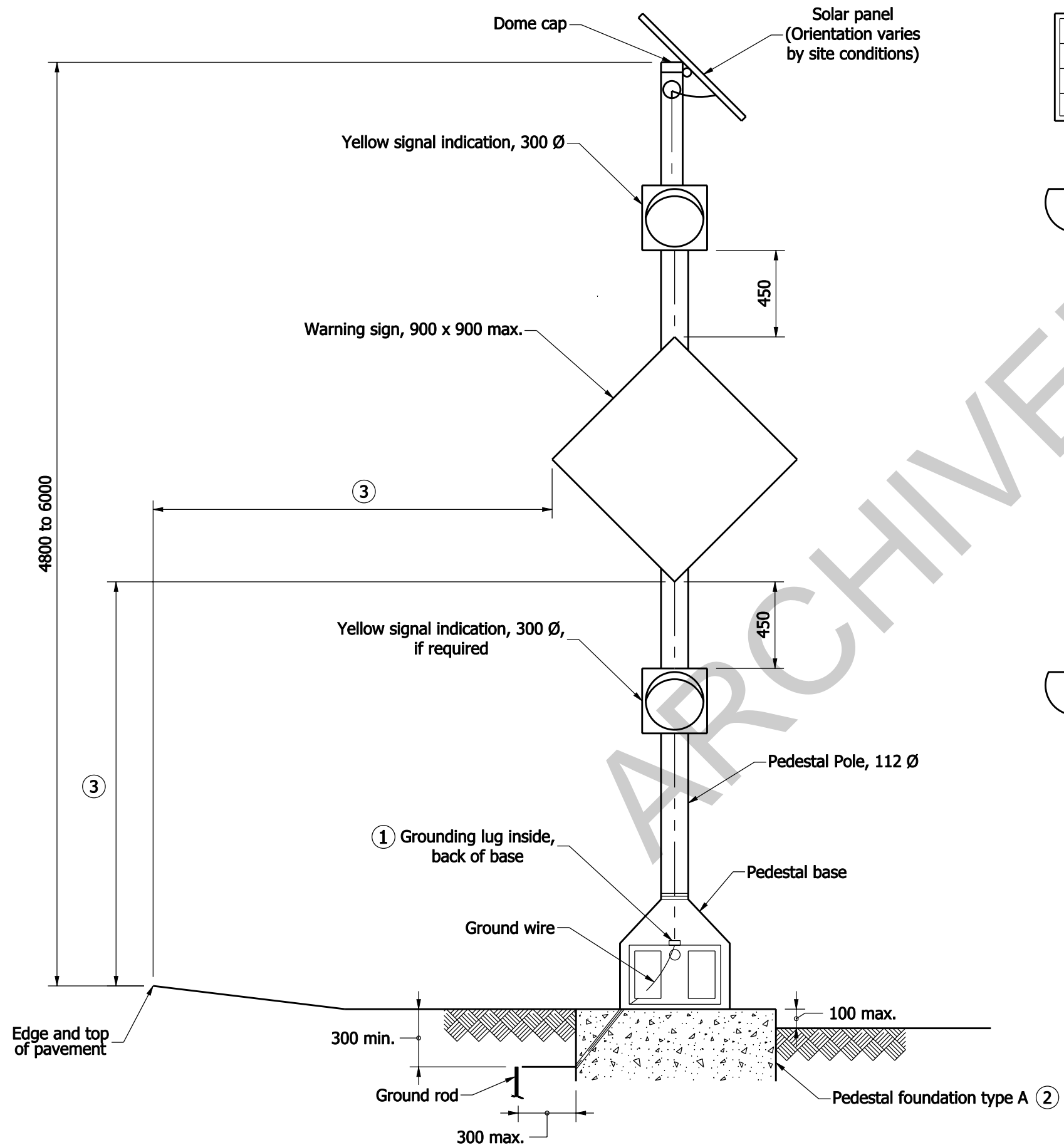


INDIANA DEPARTMENT OF TRANSPORTATION
 PEDESTAL MOUNTED SOLAR POWERED
 WARNING SIGN
 FLASHING BEACON ASSEMBLY



FRONT VIEW

SIDE VIEW



NOTES:

- ① See Standard Drawing 805-SGGR-03 for grounding lug details.
- ② See Standard Drawing 805-SGCF-03 for type A foundation details.
- ③ See Standard Drawing 802-SNPL-02 for edge of pavement offset and sign height.

All Dimensions are in mm unless otherwise specified.

INDIANA DEPARTMENT OF TRANSPORTATION

PEDESTAL MOUNTED SOLAR POWERED
WARNING SIGN
FLASHING BEACON ASSEMBLY