SECTION 655 Electrical Construction

655.1 General

Electrical construction, in connection with a highway improvement contract, may include all or part of the installation of roadway lighting, illuminated signs, traffic counters, traffic signals, traffic signal detectors, rest areas, truck weighing stations, and other miscellaneous electrical systems.

Electrical work may be performed as a separate electrical contract, or it may be a part of another highway contract often performed by a subcontractor specializing in that line of work. The prime contractor, whether the electrical work is performed by the prime contractor's forces or by a subcontractor, is held responsible for the work, and the engineer is responsible to ensure the work is performed according to the requirements of the contract.

Highway electrical systems, National Electrical Code, Material Specifications, and standard detail drawings (SDDs) are all subject to frequent changes. Revisions in materials and specification requirements may occur on successive jobs. Both the contractor and the engineer should be alert to the fact that the way work was performed on a previous contract may not be applicable under the present contract. It is necessary to thoroughly read and understand the present contract and forget about previous contracts.

At the preconstruction conference, the contractor must supply the engineer with a list of names and qualifications of journey workers and electrical apprentices who will or may be working on this contract.

The contractor should be advised that electrical apprentices must work under the terms of their indentures, which require that an apprentice be under the direct supervision of a journey worker at all times with the exception of an apprentice in the final year as an apprentice. Any violation or suspected violation of these terms will be reported to the Bureau of Apprenticeship Standards.

Engineers should coordinate with and solicit input from utility representatives and municipal engineers who have interest in electrical work done on our projects. Occasionally, electrical utilities have requested inspection by local building or electrical inspectors of work performed by department personnel, or by the department's contractor. Those inspections often involve a permit fee. It is the position of the department that the engineer is responsible for the inspection of the work, and inspection by local units will not be allowed. Legal opinions have held that the state of Wisconsin and its agencies are not subject to local ordinances, such as building or electrical codes.

Electrical utilities making service connections require an affidavit stating that the work conforms to the Wisconsin State Electrical Code, National Electrical Code, and the requirements of the local utility. This affidavit must be on file with the local utility before an electrical power hookup will be done.

Questions and problems not able to be resolved at the project site or in the region office may be directed to DTSD-electrical unit in Madison.

655.1.1 Preliminary Inspection

Before the start of electrical work operations, the engineer and any inspector assigned to the work should carefully study the plans, specifications, and special provisions. Layout of plan requirements should be checked early in the field to determine if any omissions or necessary changes might require change orders. It should be determined before work starts that no surface, underground, or aerial obstructions exist, or will be erected, which will preclude the installation of a pole or standard, or which will interfere with the view of a sign or signal or inhibit its proper operation.

Lists of material to be used in the work should be pre-checked to avoid omissions or irregularities. When appropriate for the identity of a material item, the manufacturer's name and catalog number should be provided in the material list to allow proper checking.

State furnished materials such as poles, mast arms, luminaries, signal controllers, fixtures, or other specified equipment, should be ordered from the supplying region in sufficient time for pickup and delivery to the project by the contractor for his timely installation of those materials.

If a signal controller is being provided or being tested by the state electrical shop in Madison, its delivery time should be investigated for availability at the projected time of installation.

655.1.2 Materials

Generally, the inspection, sampling, and acceptance of materials for electrical work must conform to CMM 850, the department's materials testing and acceptance guide. Materials and construction methods for electrical work must conform to requirements of standard spec 659, the plan details, and applicable contract special provisions. Standard spec 651.3 requires that the work be performed in accordance with the requirements of the Wisconsin State Electrical Code, as found in the Administrative Code of the Department of Commerce.

Some materials, such as electrical conduit, nipples, elbows, etc., that are required by the specifications to have the Underwriters Laboratories, Inc., label firmly attached, are generally accepted without sampling and testing (see standard spec 651.2). Field inspection should be made for condition on arrival and compliance with plan requirements. Suspected inferior material and possible counterfeit U.L. labels should be referred to the DTSD-electrical unit in Madison for evaluation.

Many electrical devices may have the same general external appearance and are manufactured to various standards of quality. Those items should be carefully checked to ensure compliance with the specified brand, grade, or model number. To aid and facilitate positive identification, the special provisions often may require wiring devices be delivered to the job in original cartons.

Some materials may be field-accepted without sampling when accompanied by the manufacturer's certificate of compliance with specification requirements, or when the product of a particular manufacturer is on the APL.

Should a question arise in regard to acceptability of a material, the engineer should refer the matter to DTSD-electrical unit in Madison, if necessary.

Substitution of an alternate electrical item for the specified item will not be allowed unless specifically authorized in writing. A list of contractor-proposed alternate items should be sent to the DTSD-electrical unit in Madison for review and possible approval. The list should include all pertinent data that would justify equal status of the alternate with the original item.

655.1.3 Inspection Checklists

Check lists to guide the inspector during installation of conduit, lighting, traffic signals, and loop detectors are included in figures 655-1, 655-2, 655-3, and 655-4, respectively.

655.1.4 Final Inspection and Acceptance

A representative of the authority which will be maintaining the electrical installation should be invited to review the project with the engineer before construction begins, during construction, and during development of a contractor's punch list of work to be completed and should be invited to suggest input into the list. The representative should also be invited to be present at final acceptance and be a participant. A representative of the WisDOT region electric unit or the DTSD-electrical unit in Madison, who would be knowledgeable in electrical construction, should also be present at final acceptance.

655.2 Conduit

Conduits provide secure raceways for the wires and cables of an electrical system. Metal and PVC conduits are used for raceways in traffic signal and street lighting installations. Materials furnished for and methods of constructing conduits are to be in accordance with the requirements of standard spec 652, plan details, and applicable contract special provisions.

Before allowing the work to start, the inspector should ascertain that the materials to be used have been approved. All conduit runs are required to be installed (sloped) in a manner providing for drainage of the conduit.

Conduit on or in above ground structures must be drained at low spots by one of the following methods:

- Drain T's in metallic conduit.
- Drain to a junction box or underground pull box.
- Cut out a 1" section of gasket at the bottom of the junction box cover.

Where conduit is installed below ground, drainage is accomplished in accordance with Standard Detail Drawing SDD 9B2.

The specifications require that the contractor, upon completion of the work and in the presence of the engineer or the inspector, make an inspection of all installed conduit to determine that the bore is fully open for its entire length and the conduit is acceptable.

655.2.1 Underground Installations

Where conduit is installed underground, it should be determined that the trench is at the required location at proper depth and grade, unsuitable materials encountered are removed and properly replaced with suitable material, and any required drain tees and gravel-filled drainage sumps are provided as explained above. See standard spec 651.3 for proper trenching methods and for the handling of unsuitable material during the trenching operation. Close attention should be given to proper compaction of backfill material in trenches to preclude later detrimental settlement of the roadbed.

Where the contract does not include installation of wiring cable or conductors, it is required that the ends of the installed conduit are tightly plugged or capped to preclude the infiltration of water and soil, and a 12 AWG XLP insulated stranded copper pull wire must be installed in the conduit. The ends of the conduit should be suitably referenced to aid in future identification and retrieval.

Auguring, boring, or drilling operations to install conduit must not disturb the existing pavement under which it will pass. The conduit must be installed in accord with SDD 9B2, unless otherwise provided in the contract.

655.2.2 Conduit on Structures

When conduit is installed on structures, it is attached to the structure or embedded in the concrete, as required by the plans. In either case, inspection should be made during the placing to determine that it is in acceptable condition and properly installed. Conduit risers should be located to preclude interference with other facilities. Conduit embedded in concrete should normally have a minimum cover of 2 inches and should be pitched to drain, preferably to a junction or pull box.

Where the conduit crosses an expansion joint in the structure, an expansion fitting (sized as shown in the plans) is required in the conduit. Expansion fittings must also be installed in the number(s) required by the manufactures and in the method as recommended by the manufacturer. Install expansion/deflection coupling per manufacturers recommendations.

Expansion fittings are required to be provided with a bonding jumper. Some expansion fittings are designed and furnished with an internal bonding jumper as an integral part of the fitting, while other types require an external bonding jumper. It should be determined that the external bonding jumper is accordion-pleated and placed for free movement of the conduit.

655.2.3 Metal Conduits

Metal conduits are installed both underground and on structures. Inspection should be made during installation operations to determine that the work conforms to specified requirements. Field-made bends in the conduit should be made only with proper bending tools that produce a smooth, uniform bend without reducing the effective diameter of the conduit. The radius of the curve of the inner edge of any field bend should be not less than six times the nominal diameter of the conduit.

Not more than 4 one-quarter bends (360 degrees) or equivalent, are allowed between pull boxes and junction boxes. Bends should be sufficiently away from a threaded end to preclude fracture at the threads introduced by the bending stress. Pull box to pull box location of conduit must not have any bends. Runs must be straight.

During the placing of the conduit, it should be determined that the couplings are properly installed. The ends of each section length of the conduit should be square cut, threaded, reamed free of burrs and screwed tightly together within the coupling so that the coupling covers all the threads. All installed conduits designated to receive future conductors must be examined to ascertain that properly installed pull wires/rope have been installed.

Conduit terminating in junction boxes should extend into the box to provide maximum clearance for connections and bushings. Use Erickson or no-thread couplings. Do not use running threads.

655.2.4 Nonmetallic Conduit

Make sure nonmetallic conduit is installed according to the plan details. Nonmetallic conduit is easily damaged by construction operations; precautions should be taken to protect it. Nonmetallic conduit should not be installed until immediately before paving to avoid damage from trucking or other construction operations. After completion of other contract work in the vicinity of installed conduits, an inspection must be made to determine that the conduit is still in acceptable condition.

655.2.5 Pull Boxes and Junction Boxes

Pull boxes and junction boxes are used with conduit installed both underground and on structures. They provide access to conduit runs and facilitate placing wires in long conduit runs.

On structures, junction boxes are generally galvanized cast iron boxes with accessible covers and are of the size and type specified. They are installed at the locations and in the manner the plans show. They may be used to house fuses and fuse holders as well as for splicing of wire and cable.

Pull boxes for underground conduit are made of corrugated metal culvert pipe with cast iron frames and covers. When installed in shoulder areas, they must be set 2" - 3" below the shoulder surface. See SDD 9B4 and standard spec 653. Bearing should be provided under the box to prevent settlement under axle loads. Make sure drainage is provided according to SDD 9B4 and SDD 9B2.

FIGURE 655-1 Conduit Installation Checklist

1. MATERIALS

___ a. Does conduit have the U.L. label on each pipe and fitting?

2. RUNS

___ a. Is a conduit run the same pipe size from one end to the other?

___ b. Does the conduit extend a maximum of 3" into the pull boxes?

___ c. Does the conduit extend 24" beyond the edge of the pavement?

3. BENDS

___ a. Are proper tools used to bend conduit?
___ b. Are radius curves bent with proper diameters?
___ c. Do bends total no more than 360 degrees per run between junction boxes and pull boxes?
___ d. Are bends made far enough from metallic conduit threaded ends so the threaded ends won't fracture?

4. JOINTS

___ a. Are expansion fittings or flexible conduit used at expansion joints? Are they installed properly?
___ b. Are bonding jumpers used at expansion joints? Are they installed properly?

5. PULL WIRES AND BOXES

___ a. Is a pull wire installed where required?
___ b. If installed, is the pull wire 12 AWG?
___ d. Is the pull wire doubled back 24" at each end of the run?
___ e. Does the pull box have proper support and is it 2"- 3" below grade or in accord with SDD 9B4?
___ f. Are holes cut into the pull boxes sufficiently large and in accordance with SDD 9B4 to accept the conduit but not so large to admit dirt?

6. BURIAL

___ a. Is conduit under the traveled way buried at least 24" but not more than 36"? If outside the traveled way, is it buried at least 18" but not more than 36"?
___ b. Is unsuitable fill material removed and replaced by acceptable fill? Is the fill material compacted properly below and above the conduit? Where cinder fill is encountered, is the conduit encased in at least 2" of concrete, or as an alternative, is 12" removed below the conduit trench and replaced with suitable fill?

7. DRAINAGE

___ a. If holes are drilled to drain PVC conduit, are the holes ¼" in diameter?
___ b. Are all conduits laid so they drain and have no pockets of trapped water in long runs? If encased or embedded in concrete, is the conduit properly drained?
___ c. Are drain sumps installed where needed? Are they built according to SDD 9B2?
___ d. Is at least 0.5 cubic feet of No. 2 coarse aggregate placed under each drainage tee?

8. END TREATMENT

___ a. Are plugs or caps in place on all conduits in which wire or cable has not been installed? Have they been cleaned for easier removal when wire or cable is installed in the future?
___ b. Are metal conduit ends square-cut, threaded, and reamed? Has all metal conduit received bushings, caps, or plugs? Has all PVC conduit received end bells?
___ c. Are couplings properly installed?
___ d. Are exposed new threads or damaged places on rigid conduit coated with a suitable zinc rich material?
___ e. Are conduit ends 1" above the top of signal and lighting concrete bases? Has a 1" diameter conduit been installed for grounding as required on pertinent SDD's?

9. AFTER INSTALLATION

___ a. Is the bore open all the way through?
___ b. Is PVC conduit checked after backfilling its trench to make sure it is not damaged or crushed?
___ c. If attached to a structure, is the conduit attachment secure?
___ d. Are conduit location "arrow" marks cut in the pavement (or curb) over conduit lines at each pavement edge?
___ e. Are pull boxes accessible?

655.3 Lighting Units

A lighting unit consists of a pole, concrete base, luminaire arm, luminaires, ballast, lamp, cable, fuse, hardware, fixtures, fittings, and attachments necessary to integrate the components into a single unit connected to the branch circuit.

Before erection, each lighting unit should be checked with the approved shop drawing to determine the required luminaire arm and pole are furnished. Luminaire arms do not carry size markings, so length determination must be made from plan details.

Concrete bases are to be constructed in accordance with plan details and location as shown on the plans. The base should be positioned to allow erecting the pole with the vertical plane of the bracket arm at right angles to the center line of the roadway on tangents and on the radial line of the curvature of the roadway on curves. At ramp connections where the pole is set back of the ramp, the pole must be squared to the mainline while other poles along the ramp are squared to the ramp alignment. Poles along the mainline and at ramp connections are designated by the mainline stationing and the other poles along the ramp carry the stationing of the ramp. Other special arrangements, if required, will be detailed on the plans.

A pole should be erected to avoid the appearance of leaning towards the roadway. This is accomplished by having the back side of a tapered pole truly vertical. Median lighting poles having twin bracket arms should have the center line of the poles vertical.

It should be determined that the cable is not pinched when the arm is bolted to the pole, that the handholes are at the designated locations, and that the pole is properly grounded. To preclude interaction between the stainless-steel screws in the handhole cover and the aluminum column, the screws should be lubricated with an anti-seize compound. When unit identification numbers are required by the plans, aluminum plaques bearing the numbers will be per contract requirements.

Luminaires are typical of producing a wide range of light distribution patterns on the roadway through adjustment of internal components. The engineer must verify the correct luminaire settings before installation on the pole, by a review of the project requirements and the manufacturer's instructions to verify the distribution required on the plans.

After the pole has been erected to its true and required position, the luminaires must be set to a level position. Luminaires are required to be equipped with an integral level indicator.

Refer to figure 655-2 for a checklist on lighting installation and related construction.

655.3.1 Cable

Cable-in-duct maybe installed as the electrical branch circuit from the distribution center, or other source of power, to lighting units, illuminated signs or lighted sign bridges. Cable-in-duct must be installed at a depth of at least 30" and backfilled in layers not exceeding 12" in depth.

The cable is required to be laid continuously without splices from terminal to terminal. For its protection, it should be delivered and remain on reels until uncoiled for placing in the trench. To preclude injury to the cable (or wire), it should never be dragged along the roadway, over stones, or on the ground and should always be free from sharp bends or kinks. It should be placed without tension in the conduit.

At each entrance to an underground conduit or at other cable entrances, 36" of cable slack should be provided. At the base of a standard or sign bridge, this slack cable should be provided in the column.

655.3.2 Splices, Connections, Fuses, and Fuse Holders

It should be determined that all conductor connections and splices are made electrically and mechanically secure. Approved pressure- or compression-type fittings are required on all electrical connections. Those made by Burndy and Thomas and Betts or equal are usually accepted. Each splice must be protected and insulated with an approved vinyl tape that will provide insulation and mechanical protection equal to that of the conductor. Vinyl tape equal in quality to Scotch #33+ may be accepted.

Irregular-shaped splices and connectors are required to be built up with insulating putty to eliminate sharp corners before applying the tape. All insulating materials used on a connection or splice should be of the same brand to preclude possible adverse chemical reaction between them. The entire completed, taped splice should be liberally coated with an approved insulating varnish.

When installing the secondary in-line fuse assembly in the phase wire at the handhole, a sufficient length of No. 12 AWG pole and bracket wire is required to be installed in the pole to allow removal of the fuse holder through the handhole.

FIGURE 655-2 Lighting Installation Checklist

1. BASES
__ a. Are concrete bases in their proper location as shown on the plans? Are they round?
__ b. Are entrance conduits properly installed in the bases?
__ c. Is the top of the base level, trowelled smooth and free of holes?
__ d. Does the bolt circle template fit the pole base?
__ e. Are anchor bolts straight (misalignment less than 1:40 from vertical) and of proper height and diameter?
__ f. Is the base and bolt circle oriented according to the plans and specifications?
__ g. Is a rust prohibitor, corrosion-resistant, anti-seize compound used on all bolts?
__ h. Is a 5/8" x 8' grounding electrode installed at each Type 2 and Type 5 base? Is the grounding rod electrode exothermically welded properly to the ground wire, (sized as called for in the plans), and connected to the pole grounding lug as shown on the plans? Is the wire continuous and without splices?
__I. Are junction boxes mounted in the structure grounded and the cover screws stainless steel hex headed.

2. CONDUIT AND CABLE
__ a. Are all rigid metallic conduits, when required, cut, reamed, and threaded properly?
__ b. Are bushings placed on all metal conduit? Are bell ends placed on all non-metallic conduit?
__ c. Is the cable delivered and stored on reels until placed in the trench?
__ d. Are electrical cables buried at the specified depth?
__ e. Are trenches for cable-in-duct provided with curves rather than sharp bends?
__ f. Are stones, boulders and debris are they removed and replaced by suitable backfill?
__ g. Is the cable, when not in duct, handled carefully and not damaged?
__ h. Is cable laid in the trench without tension?
__ I. Is slack left at conduit entrances?
__ j. Is the cable continuous, without splices, from base to base?
__ k. Is the backfill tamped?
__ l. Are disturbed areas restored to the condition existing before burial operations?

3. POLES AND ARMS
__ a. Do all the delivered poles and arms match the shop drawings?
__ b. When installed, are the poles plumbed and oriented according to the specifications?
__ c. Are unit pole plaques mounted as specified?

4. INTERNAL WIRING
__ a. When cable is pulled up the pole and into the arm, is the cable free at the hole in the pole where the wire enters the arm, and not pinched after the arm is bolted down? Where "J" hooks are installed in a pole, is the wire looped (attached/hung) from the hook?
__ b. Is the specified type of fuse (voltage, amperage) being used?
__ c. Is enough wire left in the base of the pole to allow the fuse holder to be taken out of the pole for service?
__ d. Are the proper wires connected to the "load" and "line" side on in-line fuse assemblies?
__ e. Does the wire improperly protrude into the fuse cavity of the connector?
__ f. Was a proper crimping tool used if ferrule-type connections were made?
__ g. Are all connections and splices both mechanically and electrically secure?
__ h. Are only approved compression-type connectors used for splicing?
__ I. Is an approved insulating tape or putty used to build up connections so sharp edges are eliminated?
__ j. Is approved tape used to cover the connection?
__ k. Have all circuits been tested as required by the specifications?

5. LUMINAIRE AND PHOTOELECTRIC CONTROL
__ a. Is the luminaire of the specified voltage?
__ b. Is the luminaire lamp of the specified wattage and type?
__ c. Is the luminaire socket set for the proper distribution of light according to the plans and in accordance with the manufacturer's instructions?
__ d. Are luminaires leveled properly?
__ e. Is the photoelectric control placed in a position where best possible function of the unit occurs?

When attaching a ferrule to a conductor, a crimping tool must be used to properly indent the ferrule and the conductor. Using long-nose pliers for this purpose is unacceptable and could result in poor mechanical contact or injury to the wire and could contribute to a premature failure.

It should be determined the manner of terminating the No. 12 AWG wire in the ferrule of the fuse holder will avoid the conductor protruding into the cavity of the fuse holder. A check should be made on the fuses to determine that the types and sizes as required in the contract are installed.

655.3.3 Testing Completed Circuits

Under standard spec 651, the contractor is required to perform tests and demonstrate to the engineer that a completed lighting circuit is acceptable.

Testing of a completed lighting circuit will include tests for continuity, ground, insulation resistance, and operation of the circuit. With all fuses removed in all poles on a circuit, the resistance to ground of non-grounded circuits between any two adjacent terminals must be not less than infinity as determined with an insulation tester (megger) on wire or cable having a rating of 600 VAC or higher.

A copy of test results must be given to engineer. The engineer should give a copy of the results to the municipality or agency having jurisdiction.

655.3.4 Photo Electric Control

Where photo electric controls are installed, the "eye" should be positioned to the north or, if this is not practical, in another position where other light sources do not operate the control. The on and off calibration of the control is preset at the factory and will not need adjustment.

655.4 Traffic Signals and Loop Detectors

Figure 655-3 contains a checklist for traffic signal construction inspection, and figure 655-4 contains a checklist for inspection of loop detector construction.

FIGURE 655-3 Traffic Signal Installation Checklist

1. GENERAL
__ a. Are all materials delivered to the job site in accordance with the specifications
2. CONDUIT AND CABLE
__ a. Is any conduit used underground of a thin wall type? If so, it is unacceptable. Only PVC of Schedule 40 or heavier, or rigid metallic conduit is acceptable for underground use.
__ b. Is the specified underground multi-conductor cable used?
__ c. Is the traffic signal cable routed per plan?
__ d. Is a loop of approximately 24" of multi-conductor cable left in the base of signal columns for splice purposes?
__ e. Is an unused wire in the underground cable stripped back to be used for the equipment grounding conductor?
__ f. Are bushings used on all rigid metallic conduit and end bells on non-metallic conduit?
__ g Are all pipe and bolt threads coated with a heavy coating of an approved rust-prohibitor, anti-corrosion, anti-seize compound?
3. BASES AND PEDESTALS
__ a. Are all concrete bases of a proper depth?
__ b. Are pole caps installed to keep water and snow out of the poles and standards?
__ c. Is the signal pedestal leveled on the concrete base?
__ d. Are the shims used for leveling under all four corners of the base? (If so, start over leveling. At most, shims may be used under three corners).
__ e. When finished leveling bases, are all shims tight enough to remain in place?
__ f. If a transformer base is used under the mast arm pole, is it mounted level before the pole is set?
__ g. Are the mounting nuts tight, and leveling shims firmly in place after poles are mounted?
4. POLES AND ARMS
__ a. If signal standards and bases are delivered in two parts, are the standards tightened in the bases with chain wrenches, and tight enough so they will not work loose?
__ b. Is the pole which holds the trombone mast arm, of a proper length?
__ c. Is the trombone mast arm of the proper length?
__ d. Is the pole holding the trombone mast arm, plumb?
__ e. Is the pole cap installed?
5. SIGNAL HEADS
__ a. Is the signal face lens configuration in accordance with the Uniform Manual of Traffic Control Devices?
__ b. Is the signal face mounted in the trombone mast arm tight enough so it doesn't tilt after it is mounted?
__ c. Is the overhead signal face aimed for the most effective sight line to the head?
__ d. Are all ground-mounted signal faces aimed properly?
__ e. Are signal faces mounted in a plumb or level manner as required?
__ f. Are signal and walk light faces mounted with proper clearance above ground level?
__ g. Are overhead signal faces mounted at the proper height?
__ h. Are side-mount brackets tight and plumb?
__ i. If slipfitters are used, are they bolted down tight?
__ j. Are the signal face lenses mounted in their signal face bodies in accordance with manufacturers specifications?

6. WIRING

__ a. Is the electrical service in accordance with the contract specifications?

__ b. Is the wire being handled with care to protect the insulation?

__ c. Is a grommet or bushing provided to protect the wires at points where wires exit from standards to enter a side-mounted head?

__ d. Is a grommet or bushing installed in the pole where the hole for cable leads into the trombone mast arm?

__ e. Are cables free to move from the standard or pole onto the side mounting signal faces or trombone mast arm, and not pinched?

__ f. Are the furnished circuit breakers rated according to specs?

__ g. Are the cable from the signal base to the signal faces of a proper color, as specified?

7. GROUNDS

__ a. Are equipment grounding electrodes driven for the electrical service in accordance with the National Electrical Code and the local utility requirements?

__ b. Are grounding electrodes connected by a grounding electrode conductor without any breaks or splices?

__ c. Does the single, unbroken wire or cable from the grounding electrode(s) connect to the grounding lug provided in the breaker enclosure?

8. CABINETS

__ a. Is the controller post mounted cabinet fitted to the bolt circle provided by the manufacturer?

__ b. Is a 1" duct installed in each cabinet base for the equipment grounding conductor entrance?

__ c. Is the door closed and locked except when being serviced?

9. LED Modules

__ a. Are the LED Modules installed correctly in the signal head housing?.

10. ACCEPTANCE AND OPERATION

__ a. Are scratched or damaged pieces of equipment repaired before the job is accepted?

__ b. Has the signal been turned on and operated for some time before the job is accepted? See standard spec 651.4.

FIGURE 655-4 Loop Detector Installation Checklist

1. CONDUIT
__ a. Are PVC conduits pitched for drainage the pull box?
__ b. Are joints in PVC conduit properly glued?
__ c. Is the PVC conduit properly buried and backfilled?
__ d. Are PVC conduits sealed into the side of the junction box so they are watertight?
__ e. Does the loop ground resistance read "infinity"?
2. SAW SLOTS
__ a. Are adjacent loop sides or corners the minimum distance apart?
__ b. Are pavement slots the proper width?
__ c. Are the slots sawed to the proper depth?
__ d. Are the bottom and sides of the slot clean?
__ e. Is the saw slot depth maintained around or across corners?
3. WIRE LOOPS
__ a. Is the loop wire of the type specified?
__ b. Has the loop wire been damaged in any way? If so, don't use.
__ c. If any loops in duct are buried in the base course, is the duct protected from traffic to prevent crushing and subsequent damage before paving?
__ d. Are the proper number of turns of wire placed in the slots?
__ e. Are the loop wires twisted from under the pavement to the splice?
__ f. Is the polyethylene pipe top (in pavement) stuffed with a rag to prevent tar from running into the pull box? Are the loop wires twisted from under the pavement to the splice?
4. SPLICES
__ a. Are extra loops of wire left at a splice connection rather than cutting off wires to an "only needed" length?
__ b. Before the splice is made and after the loop sealant has been poured, was the loop tested for ground resistance?
__ c. Are splice kits of an approved type?
__ d. Are wires soldered at the splice?
__ e. Are spliced wires insulated from each other in the splice kit?
__ f. Are the ends of the splice kit taped or blocked so the sealant does not run out?
__ g. Is the sealant in the splice kit poured into the tipped or lower end to force out all air?
5. PULL BOX
__ a. Are pull boxes installed per SDD 9B4?
6. PULL WIRE
__ a. If the loop wire is not installed when building the PVC loop, is a pull wire installed?
7. LEAD-IN WIRES
__ a. Are loop wires twisted at least three turns per 12"?
__ b. Is the type "T" access fitting marked with the ease of future retrieval in mind?
__ c. Is the hole drilled in the pavement of a size sufficient to hold the PVC Conduit tight?
__ d. Is the PVC conduit pitched to drain into a pull box, if a pull box is used?
8. AS-BUILT PLAN
__ a. Has an as-built loop layout been filed?
__ b. Are loop lead wires identified in relation to the loops they are tied to?

655.5 Detectable Warning Fields

655.5.1 General

The department conforms to the Americans with Disabilities Act requirements that mandate detectable warning fields for all curb ramps that are newly constructed or modified under the oversight of the department.

The department does not allow stamped concrete installations for curb ramp detectable warning fields. Under standard spec 602.2, contractors must provide a detectable warning field from the APL.

655.5.2 Construction Method

Curb ramp detectable warning fields should be installed 6 to 8 inches from the flow line of the curb. In installations where the orientation of the ramp and the radius of the curb skews the detectable warning field, the closest edge of the curb ramp detectable warning field should maintain the 6 to 8-inch offset from the flow line of the curb.

The rectangular warning fields are 2' deep and vary in length from 1' to 3'. The length of the rectangular warning field should be perpendicular to the down-slope direction. This will align the grid pattern with the direction of travel of the ramp to provide unimpeded access to the pedestrian walkway for wheel chair

users. This is independent of the direction of the crosswalk, although efforts should be made to keep the orientation of the crosswalk to the ramp similar to provide directional cues for handicapped users.

Curb ramp detectable warning fields are to be installed with the floor of the product equal in elevation to the surrounding curb ramp.

The cross slope of the sidewalk, curb ramp, and warning field should not exceed 2%. Additionally, landing areas should not exceed 2% in either direction as specified in the contract detail drawings.

- SDD 8D5-10a Curb Ramps Types 1, 1-A
- SDD 8D5-10b Curb Ramps Type 2 and 3
- SDD 8D5-10c Curb Ramps Type 4A
- SDD 8D5-10d Curb Ramps Type 4B
- SDD 8D5-10e Curb Ramps Type 5, 6, 7A, 7B, & 8

Inset product installations should be finished with a concrete edging tool to provide a clean rounded edge. When applying the broom finish to the curb ramp care should be taken to pull the broom away from the warning field. Excess concrete broomed onto the curb ramp detectable warning field will cause uncontrolled cracking and subsequent spalling at the inset product interface.