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I. GENERAL REQUIREMENTS FOR ALL ELECTRICAL WORK

The location of all conductors, conduits, junction boxes, ground boxes, and electrical services is diagrammatic only and may be shifted by the Engineer to accommodate local conditions.

Materials shall be new and unused. Materials and installation shall comply with the applicable provisions of the National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA) standards, and shall be Underwriters Laboratories (UL) Listed unless otherwise shown on the plans or specifications or approved by the Engineer in writing. Faulty fabrication or poor workmanship in any material, equipment, or installation shall be justification for rejection. When reference is made to UL, it can be considered to mean a Nationally Recognized Independent Testing Lab (NRTL). Comparable standards of Canadian Standard Association, Electrical Testing Laboratories or Factory Mutual can be equal to the referenced UL standard. Where reference is made to NEMA listed devices, IEC listed devices shall not be considered to be an acceptable equal to a NEMA listed device. Acceptable devices may have both a NEMA and IEC listing.

With the exception of high strength bolts, miscellaneous nuts, bolts and hardware may be stainless steel when plans specify galvanized, provided that bolts are 1/2 inch or less in diameter. The Contractor shall provide the following electrical test instruments as required by the Engineer to confirm compliance with the contract and the NEC. Those test instruments are voltmeter, amp probe, megger (1000 volt DC) and torque wrenches. All meters shall have been properly calibrated within one year. Calibration certification shall be provided to the Engineer upon request. Calibration certification tag shall also be applied to the meter. The Contractor shall operate meters during inspection as requested by the Engineer. Grounding shall be as shown on the plans and in accordance with the NEC. Metallic conduit, light poles, luminaires on bridge structures, and all metal enclosures shall be bonded to the system-grounding conductor. The ground rod in each ground box or junction box at the bridge ends, and in each ground box installed for underpass lighting will also be bonded to the system grounding conductor. The grounding conductor shall be bare or, if insulated, shall be green. Ground rods, connectors, and bonding jumpers will not be paid for separately, but will be subsidiary to the various bid items.

SUBMITTALS:

The contractor shall submit for approval six (6) copies of catalog cut sheets for each of the following three (3) categories.

- Category 1. Electrical services including photocell.
 - Category 2. Breakaway disconnects, heat shrink tubing, heat shrink filler tape, GelCaps and ground boxes which will include loading capacity certification.
 - Category 3. Highmast assembly kits, when applicable. See Item 614 "Highmast Illumination Assemblies". Submittals shall be legible and shall be marked to indicate which product on a cut sheet is to be supplied. Where manufacturers provide warranties and guarantees as a customary trade practice, the Contractor shall furnish to the State such warranties and guarantees.
- Any deviation from plans or specifications, including deviations due to plan error should be prominently displayed on the submittal. Any changes not prominently noted in submittal and incorporated into the work without proper authorization will constitute grounds for rejection of that portion of the work.

II. CONDUIT

A. MATERIALS

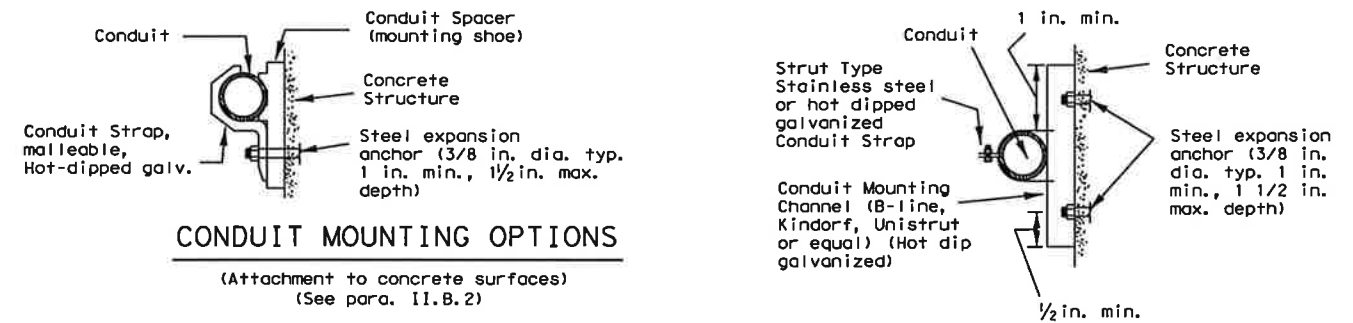
1. Conduit and fittings shall be UL Listed for the intended use shown on plan sheets.
2. Conduit shall be the type shown by descriptive code or shown elsewhere on the plans. Substitution of the various types of conduits will not be permitted. All flexible conduit in rigid metallic conduit (RMC) systems shall be Liquidtight Flexible Metal (LFMC) conduit. All flexible conduit in PVC systems shall be Liquidtight Flexible Non-metallic conduit (LFNC).
3. All exposed conduits shall be RMC, unless otherwise specifically shown on the plans. All metal conduit shall be properly grounded.
4. Couplings, connectors, conduit bodies, grounding bushings, and offset nipples for RMC shall be electro-zinc plated steel or hot dipped galvanized malleable iron, threaded or threadless compression type, rain-tight and shall be UL listed for the intended use.
5. Expansion joints for metal conduit shall be provided with an internal or external bonding jumper and shall be UL listed.
6. Unless otherwise shown on the plans, junction box minimum sizes shall be in accordance with the following table which applies to the greatest number of conductors entering the box through one conduit with no more than four conduits per box. When a mixture of conductor sizes are present, the conductors shall be counted as if all are of the larger size. Situations not applicable to the table shall be sized in accordance with NEC 370-28.

AWG	3 CONDUCTORS	5 CONDUCTORS	7 CONDUCTORS
#1	10" x 10" x 4"	12" x 12" x 4"	16" x 16" x 4"
#2	8" x 8" x 4"	10" x 10" x 4"	12" x 12" x 4"
#4	8" x 8" x 4"	10" x 10" x 4"	10" x 10" x 4"
#6	8" x 8" x 4"	8" x 8" x 4"	10" x 10" x 4"
#8	8" x 8" x 4"	8" x 8" x 4"	8" x 8" x 4"

7. RMC system junction boxes equal to or smaller, in any dimension, than 12 x 12 x 6 (HxWxD), surface mounted and containing conductors #8 or larger, shall be hot dipped galvanized cast iron with minimum wall thickness of 3/16 inch, shall have external mounting lugs, and shall be UL listed Crouse-Hinds Type WAB, OZ/Gadney Type YS or approved equal. Unless otherwise shown elsewhere on the plans, RMC system junction boxes larger than the aforementioned boxes but equal to or smaller, in any dimension, than 18 x 18 x 6 (HxWxD) shall be 14-ga. stainless steel; RMC system junction boxes larger than 18 x 18 x 6 (HxWxD) shall be 12-ga. stainless steel. All metal junction boxes shall be equipped with a threaded hole or lug for grounding. Stainless steel boxes 12 x 12 x 6 and larger need not be UL Listed but shall meet the other requirements of the NEC and shall have ribs, stiffeners, or thicker metal and shall have external mounting feet. Junction boxes with an internal volume of more than 100 cu. in. may be supported by connection of two or more rigid metal conduits, where specifically shown on the plans or where approved by the Engineer.
8. Junction boxes containing only #10 or #12 AWG conductors shall be Crouse Hinds Type GRFX, Appleton Type JBOX, two-gang FD, or similar approved cast iron box. Boxes shall be sized according to NEC Table 370-16(a).
9. IMC and EMT conduit shall not be used unless specifically required by the plan layout sheets. Junction boxes in EMT conduit systems shall be made from galvanized sheeting and shall be UL listed and approved for outdoor use, unless otherwise noted on the plans. Sheet metal junction boxes shall be sized in accordance with the NEC. Junction boxes for IMC conduit systems shall meet the requirements of boxes used with RMC systems.
10. Junction boxes in PVC conduit systems shall be PVC, intended for outdoor use, unless otherwise noted on the plans.
11. Elbows in PVC conduit systems one inch and larger shall be rigid metal, with the exception of traffic signal systems which may have PVC elbows instead of rigid. If any part of the rigid metal elbow is buried less than 18 inches underground the elbow and rigid metal extension shall be grounded. Grounding shall be accomplished by means of a grounding bushing installed on the extension. Unless specifically shown on the plans, rigid metal elbows containing, or entering ground boxes containing only communications conductors, loop detectors, or other low voltage power limited circuits need not be grounded unless a ground wire is present in the conduit or ground box. The rigid metal elbows located in concrete foundations may be extended with PVC conduit and need not be grounded provided that the end of the elbow nearest the end of the conduit run exiting the foundation is at least 2 inches below the concrete. RMC elbows will not be eliminated. RMC elbows will not be paid for directly, but will be subsidiary to various bid items.
12. High-Density Polyethylene (HDPE) conduit shall meet the requirements of Item 622, Duct Cable, except that the HDPE conduit, when bid under Item 618, Conduit, shall not contain factory installed conductors. Fittings for HDPE conduit shall be UL listed as an electrical conduit connector or shall be thermally fused using an electrically heated wound wire resistance welding method. HDPE conduit may be substituted for bored schedule 40 or schedule 80 PVC conduit. When such substitution is made, bored HDPE shall be schedule 40 of the size PVC being replaced. The HDPE conduit shall transition to PVC (or RMC elbow when required) at the bore pit. Size and schedule shall be as shown on the plans. Substituted conduit may not be extended to ground boxes or foundations; RMC elbows shall be installed at ground boxes and foundations. RMC elbows will not be eliminated.
13. All conduit support hardware including straps, nuts, bolts, screws, retaining anchors and washers shall be hot dipped galvanized or stainless steel. Strut type conduit straps shall be stainless steel or hot dipped galvanized. Strut type straps need not be made of malleable type material. Stamped-cadmium plated straps will not be allowed. Straps having only one mounting hole shall not be allowed for use on conduits 2 inches and larger with the exception of electrical service poles where stainless steel standoff straps will be allowed. Two piece conduit straps designed to be used with a mounting shoe shall be installed only with the correctly sized shoe.

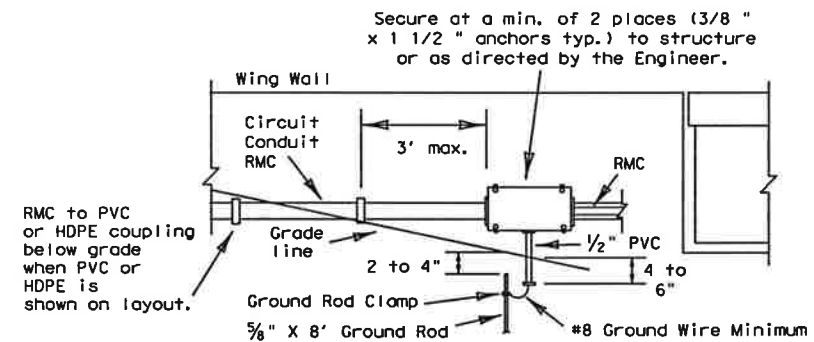
B. CONSTRUCTION METHODS

1. Conduit in structures shall have expansion fittings at structure expansion joints. All straight runs of RMC conduit exposed on structures such as bridges shall have expansion joints installed at maximum intervals of 150 feet. Expansion joints shall be installed so they allow for movement of the conduit. Installation of the joint in such a manner that will not allow for movement shall be repaired at no expense to the state. The method of determining the final setting length of the expansion joint shall be provided to the Engineer upon request.
2. Conduit supports shall be spaced at maximum intervals of 5 feet. Conduit spacers shall be used with metal conduit placed on surfaces of concrete structures (See conduit mounting options).
3. Conduit supports shall not be attached directly to prestressed concrete beams except as shown specifically in the plans and approved by the Engineer.
4. Unless otherwise shown on the plans, conduit placed beneath existing roadways, driveways, or sidewalks, or after the base or surfacing operation has begun, shall be accomplished by jacking or boring. The Contractor shall back fill and compact the bore pits to the bottom of the conduit prior to installing connecting conduit or duct cable to prevent bending of the connection.
5. Conduit trenching in the subgrade of new roadways shall be backfilled with excavated material, unless otherwise noted on the plans. Conduit trenching in the sub-base of new roadways shall be backfilled with cement-stabilized base.
6. Open ends of all conduit and raceways shall be fitted with temporary caps or plugs to prevent entry of dirt, debris and rodents during construction. The temporary cap may be constructed of duct tape, but in all cases shall be tightly fixed to the conduit and shall be durable. The contractor shall clean out the conduit and prove it clear in accordance with Standard Specifications Item 618.3 prior to installing any conductors.
7. Conduit entry into the top of enclosures such as safety switches, meter cans, service enclosures, auxiliary enclosures and junction boxes shall be made weatherproof using conduit sealing hubs, or threaded bosses.
8. A bonding jumper shall be installed from each grounding bushing to the nearest grounding rod, grounding lug, and/or equipment grounding conductor. All jumpers shall be the same size as equipment grounding conductor. Conduit used as casing under roadways for duct cable need not be grounded if duct extends full length through the casing. At electrical services, grounding electrode conductor shall be a solid Copper #6 AWG.
9. Metal junction boxes shall be bonded to the grounding conductor in accordance with the NEC.
10. Conduits entering ground boxes shall be placed so that the conduit ends shall be not less than 3 inches nor more than 6 inches from bottom of box (See ground box detail on sheet ED(1)).
11. Conduit ends shall be sealed with heat shrink boots with waterproof sealant, urethane foam, or by other methods approved by the Engineer. Sealing shall be done after completion of any required pull tests. Duct tape shall not be used as a permanent conduit sealant. Silicone caulking shall not be used as a sealant.
12. All strut mounting material and hardware shall be hot-dip galvanized or shall be stainless steel. The cut ends of strut and non-galvanized rigid metal conduit threads shall be coated with a zinc rich paint (90% or more zinc content). Zinc rich paint may only be used to touch up galvanized material as allowed under item 445.6 galvanizing. The painting of non-galvanized material with a zinc rich paint shall not be considered as an approved alternative for galvanized materials.
13. All PVC conduit terminations shall be fitted with bushings or bell ends. All metal conduit terminations shall be fitted with a grounding type bushing.

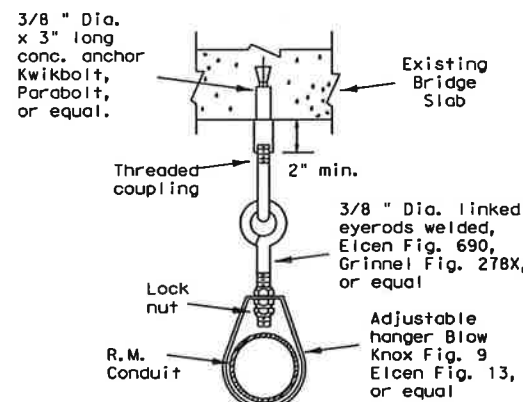


CONDUIT MOUNTING OPTIONS

(Attachment to concrete surfaces)
(See para. II.B.2)



TYPICAL CONDUIT ENTRY TO BRIDGE STRUCTURE DETAIL



CONDUIT HANGER DETAIL

(Attachment to horizontal surfaces)
Hangers need not be UL listed for electrical use
i.e: plumber pipe hangers are acceptable

NOTES

1. Ground rod clamp to be UL listed for direct burial.
2. For conduit placed in structure, use flush-mounted box.
3. Bond junction box and metal conduits to equipment grounding conductor and grounding electrode conductor using listed connector.
4. Seal all conduits entering the junction box from underground.
5. Install bell end or bushing on 1/2 inch PVC conduit both ends.
6. Ground rod to be driven within 8 inches of 1/2 inch PVC conduit end.

Texas Department of Transportation
Traffic Operations Division

**ELECTRICAL DETAILS-
CONDUIT**

ED(1)-03

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REVISIONS		CONT	SECT	JOB	HIGHWAY
4-98					
12-00					
3-03					
5-03					
		COUNTY		SHEET NO.	

71A

5/03 Revision
Revised notes.