

Special Specification 6014

Multi-Duct Conduit System



1. GENERAL

Furnish conduit of the type and sizes shown on the plans and as directed. Ensure the conduit system is suitable for installation in an outdoor underground environment including constant immersion in water, and hung from a bridge without any degradation in the conduit.

Provide new conduit and materials that is UL-listed, and meet NEMA and NEC requirements.

Fabricate, expansion joints and conduit from a material similar to the connecting conduit unless otherwise shown on the plans.

Ensure all components of the Multi-Duct Conduit (MDC) system are provided by the same manufacturer.

Ensure the material used to construct the MDC Type 1 system conforms to the material and performance requirements of the Bellcore Document TR-NWT-000356, Issue 2, October 1992, "Generic Requirements for Optical Cable Innerduct," relating to material quality and performance standards. These conduit products will also conform to the requirements of ASTM D1785, ASTM D2122, ASTM D2412 which address quality issues, such as materials, requirements, workmanship, test methods, retest and rejection, and marking and quality assurance and performance.

Ensure the material used to construct MDC Type 2 will conform to the material and performance requirements as specified elsewhere, which address quality issues, such as materials, requirements, workmanship, test methods, retest and rejection, and marking, quality assurance and performance.

Furnish, install and test the MDC system. Provide all required sweeps, bends, repair couplings, ground box/manhole termination kits, alternative outer ducts, adapters, pre-assembled split repair kits, lubrication access fittings, tug-plugs, slit- innerduct plugs, hangers, brackets, expansion joints, and accessories to complete the MDC system as incidentals. Provide all materials for installation, and testing.

2. DESCRIPTION

Ensure the MDC system is a pre-assembled conduit section manufactured from a three inch round outer duct containing three factory installed round inner ducts (Type A) or a four inch round outer duct containing four factory installed round inner ducts (Type B).

The inner ducts will be held together in a square configuration by a system of spacers. The spacers, which hold the individual conduits in formation, will be capable of locking them tightly together to prevent free twisting of the inner ducts.

The MDC, including respective bends, couplings, adapters, and other accessory fittings, will contain a coupling body for sealing the outer and inner ducts of adjacent conduit sections in an end to end relationship.

Ensure the factory assembled length and associated bends of all multi-duct is manufactured without the use of adhesives to allow for inner duct movement relieving internal stresses experienced during field handling and due to variations in coefficient of thermal expansion.

The MDC will have available a complete line of available accessory items including, but not limited to, alternative outer ducts, sweeps and bends, repair couplings, ground box/manhole termination kits, pre-assembled split repair kits, and lubrication access fittings.

Provide a single protective end cap for each end of all 20-ft. conduit sections, factory bends and fittings.

The percent ovality of the conduit system will not exceed 5%.

Ensure the MDC Type 1 system will perform in underground installation in an ambient temperature range of 30°F to 130°F without degradation of material properties. Provide a conduit system that is resistant to most harsh chemicals and protected against degradation due to oxidation or general corrosion. The conduit system will be capable of being direct buried by trenching or boring with no special consideration to using selective backfill.

Ensure the MDC Type 2 system will perform in exposed application. This MDC Type 2 conduit will perform in an ambient temperature range of minus 40°F to 248°F without degradation of material properties. The conduit system will be resistant to most harsh chemicals and protected against degradation due to oxidation or general corrosion. It will also have low coefficient of thermal expansion, such that expansion and contraction is minimal.

Ensure the conduit system is free of visible cracks, holes or other physical defects that would degrade its performance. It will be as uniform as practical in respect to overall dimensions, color, density, thickness, etc. Provide a conduit system with a UV light stabilizer which will protect it in direct sunlight. The conduit system will have durable identification showing the name and trademark of the manufacturer, conduit size, date of manufacture and "TxDOT - Fiber Optic Cable System" identification.

- 2.1. **Outer Duct.** The three inch and four inch round outer duct MDC Types 1A and 1B will be heavy walled schedule 40 polyvinyl chloride conduit (PVC) as shown on the plans and as directed. Schedule 40 PVC conduit will respectively meet the requirements of schedule 40 PVC conduit and conform to telecommunication industry standard TC-2, UL 651, and the NEC and will incorporate a longer (what is minimum bell that is acceptable) integral bell in place of the standard 3.5 inch bell to accommodate the length of the coupling body.

The average outside diameter (OD) of the four inch schedule 40 outer duct will be 4.5 inch minimum. The wall thickness for the schedule 40 will be 0.237 inch minimum.

The average outside diameter (OD) of the three inch schedule 40 outer duct will be 3.5 inch minimum. The wall thickness for the schedule 40 will be 0.237 inch.

The MDC Type 2 system will be hot-dipped galvanized steel conduit. All conduit, elbows and fittings will be hot-dipped galvanized steel.

- 2.2. **Inner Ducts.** Provide Inner ducts that are extruded from a 90 percent Virgin High Density Polyethylene (PE) compound. This compound will be specifically blended to produce inner ducts for use in multi-duct systems. Characteristics of this blend will add rigidity to the extruded PE inner ducts, minimize the differences between the expansion and contraction rates of PVC and the PE inner ducts, create a burn resistant PE inner duct to minimize the chance of damaging the inner duct during the cable placing operation, and provide a permanent dry lubricant that is extruded within the wall of the inner duct.

Ensure the inner ducts incorporate longitudinal ribs within the extruded wall.

Inner ducts will be uniquely defined by the extrusion of a different color for each of the inner ducts; colors will be orange, yellow, red, and white. The white inner duct will be placed directly in-line with the manufacturer's identification on the outer duct for ease of identification and installation.

Inner ducts will be extruded in a controlled outside diameter (OD) fashion. Inner duct will have a minimum inside diameter (ID) of one inch.

- 2.3. **Coupling Body.** Provide a factory installed primary coupling body that is manufactured as a hard plastic coupling body incorporating conical shaped target areas to accommodate self-alignment of each inner-duct

upon field assembly. This coupling body will incorporate sealing devices to facilitate field assembly and prevent water and foreign material leakage from outside the multi-duct system and to prevent air leakage from inside the inner ducts. No lubricant will be required for field assembly of this conduit system and assembly will be accomplished solely by hand without use of special tools.

Ensure that the coupling body with its sealing members will seal the outer walls of the inner ducts and the inner wall of the outer duct, providing an airtight seal from within the inner duct system, and a watertight seal from the outside of the outer duct.

Ensure that the gasket or sealing members will be an anti-reversing design, in such that the lengths of conduit stay joined together without the need for solvent cement.

Ensure that the field connection end of the internal coupling body will incorporate shaped target areas to accommodate self-alignment of the inner ducts, with bore openings, during field assembly.

Ensure that the coupling body will have one of the bore openings on the field assembly side uniquely identified to facilitate proper continuous inner duct alignment, during field assembly.

3. CONSTRUCTION METHODS

Place conduit in accordance with the lines, grades, details and dimensions shown on the plans or as otherwise approved. Install underground conduit MDC Type 1 (A and B) at depths shown on the plans unless otherwise shown on the plans. Installation of conduit will be in accordance with the requirements of the NEC.

Ream all conduit ends to remove burrs and sharp edges. Fasten all conduit placed on structures with conduit straps or hangers as shown on the plans and as directed. Fit the conduit terminations with bushings or bell ends.

Ensure that prior to installation of cables or final acceptance, a spherical template having a diameter of not less than 75 percent of the inside diameter of the inner duct will be drawn through the inner duct to insure that the inner duct is free from obstruction. The ends of all empty inner duct placed for future use will be fitted with caps.

Trench excavation and backfilling will be as shown on the plans, and in accordance with Item 400, "Excavation and Backfill for Structures," except for measurement and payment. An approved detectable underground metalized Mylar conduit marking will be placed over the MDC on top of a six inch backfill, prior to final backfill of the trench. The marking tape will be imprinted with "TxDOT Conduit and Fiber Optic Cable System - Call Before Proceeding" every 18 inches. Where existing surfacing is removed for placing conduit, repair will be made by backfilling with material equal in composition and density to the surrounding areas, and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

The furnishing and installing of the detectable underground metalized Mylar conduit marking tape along the MDC system will not be paid for directly, but will be subsidiary to this Special Specification.

Jacking and boring when required will be in accordance with Item 476, "Jacking, Boring or Tunneling Pipe", except for measurement and payment.

4. TESTING

- 4.1. **General.** Performance test all materials and equipment not previously tested and approved. If technical data is not considered adequate for approval, samples may be requested for testing. The contract period will not be extended for time lost or delays caused by testing prior to final Department approval of any items.

Satisfy all, inspection requirements prior to submission for inspection and acceptance unless otherwise specified. The Engineer reserves the right to have his representative witness all tests.

The results of each test will be compared with the requirements specified herein. Failure to conform to the requirements of any test will be counted as a defect and the materials will be subject to rejection. Rejected materials may be offered again for retest, provided all non-compliances have been corrected and retested by the Contractor, and evidence thereof submitted to the Engineer.

- 4.2. **Examination Product.** The contractor will ensure each conduit system component will be examined carefully to verify that the materials, design, construction, markings, and workmanship

- 4.3. **Testing Of Product.** Provide a coupling body that will seal the inner duct so that after the application of 100 psi to an inner duct, the inner duct will be capable of maintaining a minimum of 15 psi for 24 hours. Employ, at the contractor's expense, an approved independent commercial testing laboratory to perform the above test. Submit certified reports of such test to the Engineer.

Furnish the Department with certified documentation of compliance with PVC and PE requirements based on random testing of products by an independent testing laboratory. Such testing will be in accordance with all ASTM, NEMA STANDARD TC-2, UL 651, and Bellcore standards as referenced in this specification.

5. REFERENCES

The Multi-Duct Conduit System Supplier will submit three references, preferably from other State Departments of Transportation, where this supplier's conduit system has functioned successfully for a period of no less than one year. Reference data will include current name and address of organization, and the current name and telephone number of an individual from the organization who can be contacted to verify system installation. This information will be provided prior to documentation submittal. Failure to furnish the above references will be sufficient reason for rejection of the supplier's equipment.

6. MEASUREMENT

This Item will be measured by the foot of the conduit system furnished, installed and tested in accordance with this specification.

7. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "Multi-Duct Conduit" of the various types and sizes as specified. This price will be full compensation for furnishing, and installing conduit; for jacking, boring, excavating, furnishing and placing backfill, replacing pavement structure, sod, riprap, curbs or other surface; for furnishing and installing all fittings, sweeps, bends, repair couplings, adapters, ground box and manhole termination kits, pre-assembled split repair kits, lubrication access fittings, hangers, brackets, expansion joints, and detectable underground metalized Mylar conduit marking tape; and for all labor, tools, equipment and incidentals.

Special Specification 6177

Multi-Duct Conduit System



1. DESCRIPTION

Furnish and place a Multi-Duct Conduit (MDC) system that is suitable for installation in an outdoor underground environment including constant immersion in water, and/or hung from a bridge without any degradation in the conduit.

2. MATERIALS

Provide new materials that conform to the details shown on the plans, the requirements of this Item, and to the pertinent requirements of the following Items:

- UL-listed,
- Meet NEMA requirements, and
- Meet NEC requirements.

Provide underground MDC that conforms to the pertinent requirements of the following items:

- Telcordia Technologies document GR-356, October 1995,
- ASTM D1785,
- ASTM D2122, and
- ASTM D2412.

Provide aerial MDC that conforms to the pertinent requirements of the following items:

- ASTM D2996,
- ASTM D2310, and
- ASTM D2517.

Provide all required sweeps, bends, repair couplings, ground box/manhole termination kits, alternative outer ducts, adapters, pre-assembled split repair kits, lubrication access fittings, tug-plugs, slit-innerduct plugs, hangers, brackets, expansion joints, and accessories to complete the MDC system.

Provide expansion joints and conduit that is similar to the connecting conduit.

Furnish components of the MDC system that are provided by the same manufacturer.

Provide a pre-assembled conduit section manufactured from a 4-in. round outer duct containing 4 factory installed round inner ducts held together in a square configuration by a tightly locking system of spacers to prevent free twisting of the inner ducts.

Provide a coupling body for sealing the outer and inner ducts of adjacent conduit sections in an end-to-end relationship.

Provide a MDC system that is manufactured without the use of adhesives to allow for inner duct movement.

Provide a MDC system with the availability of a complete line of accessory items including, but not limited to, alternative outer ducts, sweeps and bends, repair couplings, ground box/manhole termination kits, pre-assembled split repair kits, and lubrication access fittings.

Provide a single protective end cap for each end of all 20 ft conduit sections, factory bends and fittings, to minimize the risk of damage to the conduit system during shipping and handling.

Provide a MDC system that conforms to the following requirements:

- A percent ovality of less than 5%,
- An underground system that performs in an ambient temperature range of -30°F to 130°F without degradation of material properties,
- An aerial system that performs in an ambient temperature range of -104°F to 200°F without degradation of material properties,
- Resistant to most harsh chemicals,
- Protected against degradation due to oxidation or general corrosion
- Capable of being direct buried by trenching or boring with no special consideration to using selective backfill,
- Has a low coefficient of thermal expansion, such that expansion and contraction is minimal.
- Free of visible cracks, holes or other physical defects that would degrade its performance,
- Uniform as practical in respect to overall dimensions, color, density, thickness, etc,
- Contains a UV light stabilizer which will protect it, for a minimum of 12 mo., in direct sunlight,
- Durable identification showing the name and trademark of the manufacturer, conduit size, date of manufacture and "TxDOT - Fiber Optic Cable System".

- 2.1. **Outer Duct.** Provide 4 in. round outer duct MDC heavy walled schedule 40 or schedule 80 polyvinyl chloride conduit (PVC) as shown on the plans. Incorporate a longer integral bell in place of the standard 3-1/2 in. bell to accommodate the length of the coupling body.

Provide Schedule 40 or schedule 80 PVC conduit that conforms to the pertinent requirements of the following items:

- Telecommunication industry standard TC-2,
- UL 651, and
- The NEC.

Provide 2 in., 4 in., or 5 in. schedule 40 PVC as shown on the plans.

Provide a Fiberglass MDC that is bullet resistant, heavy walled, pure, high grade, filament wound fiberglass reinforced epoxy conduit. Provide conduit, elbows and fittings that are manufactured from the same resin/hardener/glass systems manufactured by the same filament wound system. Provide MDC aerial elbows, conduit, fittings and hangers that are gray in color.

Provide rigid metal MDC system that is hot-dipped galvanized steel conduit.

- 2.2. **Inner Ducts.** Provide inner ducts that are extruded from a 90%, or higher, Virgin High Density Polyethylene (PE) compound. Provide this compound specifically blended to produce inner ducts for use in MDC systems. Furnish this blend with characteristics that add rigidity to the extruded PE inner ducts, minimize the differences between the expansion and contraction rates of PVC and the PE inner ducts, create a burn resistant PE inner duct to minimize the chance of damaging the inner duct during the cable placing operation, and provide a permanent dry lubricant that is extruded within the wall of the inner duct.

Incorporate longitudinal ribs within the extruded wall.

Provide inner ducts that are uniquely defined by the extrusion of a different color for each of the inner ducts, colors shall be orange, yellow, red, and white. Provide white inner duct that is placed directly in-line with the manufacturer's identification on the outer duct for ease of identification and installation.

Provide inner ducts that are extruded in a controlled outer diameter that meet the requirements of Table 1.

Size	O.D.	I.D.
1 in.	1.375 (Max)	1.000 (Min)
1-1/4 in.	1.670 (Max)	1.250 (Min)
1-1/2 in.	2.000 (Max)	1.500 (Min).

Provide inner ducts that are capable of being stored, installed and used under any humidity.

2.3.

Coupling Body. Provide a factory installed primary coupling body that is manufactured as a hard plastic coupling body incorporating conical shaped target areas to accommodate self-alignment of each inner-duct upon field assembly. Provide a coupling body that incorporates sealing devices to facilitate field assembly and prevent water and foreign material leakage from outside the multi-duct system and to prevent air leakage from inside the inner ducts. Assemble solely by hand without use of special tools such that no lubricant will be required for field assembly of this conduit system.

Provide the coupling body with a plurality of bores containing principal seals which are molded as an integral part of the coupling body.

Provide the coupling body with its sealing member(s) sealing the outer walls of the inner ducts and the inner wall of the outer duct providing an airtight seal from within the inner duct system and a watertight seal from the outside of the outer duct.

Provide the gasket or sealing member(s) that is an anti-reversing design in such that the lengths of conduit stay joined together without the need for solvent cement.

Provide the field connection end of the internal coupling body that incorporates shaped target areas to accommodate self-alignment of the inner ducts with bore openings during field assembly.

Provide the coupling body that has 1 of the bore openings on the field assembly side uniquely identified to facilitate proper continuous inner duct alignment during field assembly.

3.

CONSTRUCTION

Place conduit in accordance with the lines, grades, details and dimensions shown on the plans or as directed. Install underground MDC system at a minimum of 18 in. unless otherwise shown on the plans. Install conduit in accordance with the requirements of the NEC.

Ream all conduit ends to remove burrs and sharp edges. Fasten all conduit placed on structures with conduit straps or hangers as shown on the plans or as directed. Fit the conduit terminations with bushings or bell ends.

Prior to installation of cables or final acceptance, draw a spherical template having a diameter of not less than 75 percent of the inside diameter of the inner duct through the inner duct to insure that the inner duct is free from obstruction. Fit the ends of all empty inner duct with caps.

Trench excavate and backfill as shown on the plans and in accordance with Item 400, "Excavation and Backfill for Structures", except for measurement and payment. Place underground conduit marking tape provided by Entergy as directed, 12 in. above the top of Entergy conduit before final backfill of the trench. Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Provide a bare copper no. 6 AWG in all multi-duct runs, if no other cable is to be installed in the MDC system.

4. TESTING

- 4.1. **General.** Performance test of all materials and equipment not previously tested and approved. If technical data is not considered adequate for approval, samples may be requested for test. The contract period will not be extended for time lost or delays caused by testing prior to final approval of any items.

Compare the results of each test with the requirements specified herein. Failure to conform to the requirements of any test shall be counted as a defect and the materials will be subject to rejection by the Engineer. Offer rejected materials again for retest provided all non-compliances have been corrected and retested by the Contractor and evidence thereof submitted to the Engineer.

- 4.2. **Examination of Product.** Examine each conduit system component carefully to verify that the materials, design, construction, markings, and workmanship comply with the requirements of this specification.

- 4.3. **Testing of Product.** The coupling body must seal the inner duct so that after the application of 100 psi to an inner duct, the inner duct shall be capable of maintaining a minimum of 15 psi for 24 hours. Employ an approved independent commercial testing laboratory to perform the above test. Submit certified reports of test.

Furnish certified documentation of compliance with PVC, Fiberglass and PE requirements based on random testing of products by an independent testing laboratory. Such testing must conform with all ASTM, NEMA STANDARD TC-2, UL 651, and Telcordia Technologies standards as referenced in this specification.

5. REFERENCES

The MDC System Supplier shall submit 3 references, preferably State Departments of Transportation, where this supplier's conduit system has functioned successfully for a period of no less than 1 year. Include current name and address of organization, and the current name and telephone number of an individual from the organization who can be contacted to verify system installation. Provide this information prior to documentation submittal. Failure to furnish the above references will be sufficient reason for rejection of the supplier's equipment.

6. MEASUREMENT

This Item will be measured by the foot of the conduit system furnished, installed and tested.

7. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "Multi-Duct Conduit" of the type specified. This price is full compensation for furnishing, and installing conduit; for jacking, boring, excavating, furnishing and placing backfill, replacing pavement structure, sod, riprap, curbs or other surface; for furnishing and installing all fittings, sweeps, bends, repair couplings, adapters, ground box/manhole termination kits, pre-assembled split repair kits, lubrication access fittings, hangers, brackets, expansion joints, concrete, and detectable underground metalized mylar conduit marking tape; and for all labor, tools, equipment and incidentals necessary to complete the work. Copper cable will not be paid for directly but shall be subsidiary to this Special Specification. The furnishing and installing of the detectable underground metalized mylar conduit marking tape along the MDC system shall be subsidiary to this item.