

### Document Control

| Issue Date         | Comments  | Revisions   | Revision # |
|--------------------|---|---|------------|
| 10-7-99            |   | Deleted I-75 project info   | 1          |
| 11-3-99            |   | Corrected the Multi-Cell conduit description in the payment section.  | 2          |
| 12/30/99           | Project: CM-00TS(10) Ct. 1<br>Fulton County<br>P.I. No. 713155<br>Project: CM-00TS(10) Ct. 2<br>DeKalb And Fulton County<br>P.I. No. 713157   |   |            |
| 2/3/00             | Project: CM-056-1(57)<br>Fulton County<br>P.I. No. 721950   |   |            |
| 3/21/00<br>3/22/00 | Revised measurement to include drilling shoulder, installing #4 rebar, replacing transverse joint material, directional bore (for trench/bore option), restore concrete.<br>Add steel as material for conduit spacers; delete rqmt for molded base<br>Revise mat'l certification text, including reference to transmittal form<br>Delete prohibition on gluing outerduct.<br>Delete ref to "flexible" bends/sweeps; include expansion joints for bridge attached multi-cell<br>Add rqmts for accessories and fittings for bullet resistant fiberglass<br>Add statement for alternate innerduct colors<br>Delete flexible bends; allow > bend radii for fixed bends/sweeps.<br>Slack pull tape in conduit, not vault.<br>Inner rings on duct plugs.<br>Test tone wire before and after full-depth conduit backfill.<br>Add underbridge installation requirements<br>Add text to retain existing 682 and add this Special Provision | 682.13<br><br>682.06.1.3<br>682.02.1<br>682.05.4<br>682.05.5<br>682.05.6.1.4<br>682.05.6.2.1, 682.05.6.2.2<br>682.05.6.4<br>682.08.2<br>682.09<br>682.10.3<br>682.12.1<br>p.1 | 3          |
| 3/30/00            | Add 1" innerduct.<br>Correct dimensions on 1" Nonmetal, Type 3 conduit  | 682.04.1<br>682.07.1.1  | 4          |
| 4/3/00             | Reword exception for marking tape where full depth concrete backfill.<br>Prohibit coupling in bores   | 682.03.1<br>682.07.2  | 5          |
| 4/3/00             | Project: CM-285-1(360)<br>DEKALB COUNTY<br>P.I. NO. 713410  |   |            |
| 5/17/00            | Add "Conduit, Fiberglass" section 682.08 and renumber 682.08 through 682.11<br>Modify the alignment line and text requirements (added sketch).  | 682.02<br><br>682.05.2  | 6          |

|           |   |   |     |
|-----------|---|---|-----|
|           | Add "All conduit and fittings shall be black."<br>Insert new subsection for "Conduit, Fiberglass"<br>Add detectable pull tape<br>Add fiberglass pay items for multicell and conduit | 682.05.6.1(4)<br>682.08<br>682.09<br>682.14   |     |
| 8-23-2000 | Revised section numbers so that they won't be in conflict with the current 682 spec.  |   |     |
| 12-6-00   | Replaced omitted words per SCR No 68-1.   | 682.09.1; 682.14  | 7   |
| 12-6-00   | Project: CM-285-1(360)<br>DEKALB COUNTY<br>P.I. NO. 713410  |   |     |
| 2-9-01    | Document control no. NAV01-047  |   | 1.0 |
| 11-9-01   | Changes as per SCR # 283  | 682.04<br>682.05.6<br>682.05.6.1<br>682.05.6.3  | 2.0 |
| 1/7/02    | Changes as per SCR # 285 and SCR # 287  | 682.06.1.2<br>682.06.1.2.2<br>682.06.037<br>682.06.3<br>682.07  | 3.0 |
| 2/4/02    | Document to Mike England for additional changes as per SCR # 285  |   | 3.1 |
| 3/11/02   | Published   |   | 4.0 |
| 7/31/02   | Further changes as per SCR # 285<br>To Mike England for QA  | 682.06.1.2<br>682.04.2<br>682.06.3<br>682.07.1.4<br>682.07.2<br>682.06.3  | 4.1 |
| 8/1/02    | Published to server   |   | 5.0 |
| 8/15/02   | Inclusion of metric equivalent units.<br>SCR # 327  | 682.03.2; 682.03.3; 682.04;<br>682.05.1; 682.05.2; 682.05.2.1;<br>682.05.6.1; 682.05.6.1.2;<br>682.05.6.1.4; 682.05.6.2.1;<br>682.05.6.2.2; 682.05.6.3;<br>682.05.6.4; 682.06.1; 682.07.1;<br>682.08.1; 682.09.1; 682.09.2;<br>682.11.2; 682.14 | 5.1 |
| 10/8/02   | Published to server   |   | 6.0 |
| 11/25/02  | Reformatted as per SCR # 372  |   | 6.1 |
| 12/18/02  | Published to server   |   | 7.0 |
| 9/4/03    | Update as per SCR # 409   | 682.2.04.2; 682.2.04.3;<br>682.2.06.1.A; 682.2.06.1.B;<br>682.2.07.1.A; 682.2.07.1.B;<br>682.2.07.1.C; 682.2.07.1.D;<br>682.2.09.2; 682.2.10;   | 7.1 |
| 9/4/03    | QA  | 682.2.04.3 change from<br>SDR11.5 to SDR11  | 7.2 |
| 9/4/03    | Published to server   |   | 8.0 |
| 10/8/03   | Update per SCR 418  | 682.2.06.2; 682.2.07.2  | 8.1 |
| 10/9/03   | Published to server   |   | 9.0 |

**DEPARTMENT OF TRANSPORTATION  
STATE OF GEORGIA  
SPECIAL PROVISION**

**Project:  
County  
P.I. NO.**

**Section 682 - Electrical Wire, Cable, And Conduit**

*Delete Subsection 682.1 General Description and substitute the following:*

**682.1 General Description**

This work includes furnishing and installing wire, cable, and conduit for roadway and structure lighting systems, complete or as indicated on the Plans. This work also consists of furnishing and installing a Multi-cell or Continuous Flexible Conduit System for Fiber Optic Cable, complete or as indicated on the Plans. The installation of conduit for fiber optic cable shall not require the presence of a qualified electrician on the job site.

*Add the following to Subsection 682.2:*

All multi-cell and continuous flexible conduit products shall meet the General Specifications as set out in this specification. Those products shall be installed, applied, inspected, and/or utilized in accordance with the Construction Section of this Specification. Prior to any conduit work and within 60 days after Notice to Proceed, submit catalog sheets, engineering drawings, and maintenance procedures for review by the Engineer for all products and procedures in this Specification to be used on the Project. If the products to be used are not specified within these specifications or not listed separately and/or completely on the details of the Plans, submit catalog sheets, engineering drawings, factory specifications, a set of installation procedures, and a set of operation and maintenance procedures (for multi-cell conduit) for review by the Engineer. No work shall be done using these products until after submittals have been approved by the Engineer. Sec. 680.01 requirements do not apply to the installation of multi-cell and continuous flexible conduit.

A summary of the products, their Sections, and each product’s specification included in this Specification are listed below:

- A. MARKING TAPE..... Section 682.2.03  
Visible marking tape, location and warning system.
- B. INNERDUCT..... Section 682.2.04  
All innerduct shall be high density polyethylene or polyvinyl chloride when enclosed in main solid conduit for outside plant, and PVC, riser, or plenum when used inside a building in accordance with the National Electric Code.
- C. MULTI-CELL FACTORY INSTALLED DUCT SYSTEM..... Section 682.2.05

The multi-cell innerducts shall be colored red, white, yellow, and orange, and utilized as noted: red = hybrid fiber optic cable; white = open spare/interconnect/control circuit; yellow = single mode fiber optic cable; and orange = multi-mode fiber optic cable.

- D. CONDUIT DUCT BANK..... Section 682.2.06

Conduit duct bank shall be a configuration of high density polyethylene conduits.

- E. CONDUIT, NONMETAL, TYPE 3..... Section 682.2.07
- F. CONDUIT, FIBERGLASS ..... Section 682.2.08
- G. PULL TAPE ..... Section 682.2.09
- H. DUCT PLUGS ..... Section 682.2.10
- I. CONDUIT DETECTION WIRE ..... Section 682.2.11

**682.2.02 MATERIAL CERTIFICATION**

The following chart provides an outline of the submittal requirements for the equipment and components for this pay item. This chart shall be used as a guide and does not relieve the Contractor from submitting additional information to form a complete submittal package.

Submit submittal data for all equipment, materials, test procedures, and routine maintenance procedures required for these items within 60 calendar days after the Notice To Proceed and prior to any installation, unless noted otherwise in the Contract Documents.

Submit to the Engineer for approval, six (6) copies of the manufacturer’s descriptive literature (catalog cuts), technical data, operational documentation, service and maintenance documentation, and all other materials required within these Specifications.

Provide submittal data that is neat, legible, and orderly. Neatly organize each package of submittal data and separate by hardware item. Use the “Materials Certification Package Index and Transmittal Form”, contained in Section 105.02 of the Special Provisions, for each pay item to document and list all material and components that are included in the submittal package. Any submittal data submitted without the index/transmittal form or that is incomplete will be rejected.

| Item                                     | Specification Section | Catalog Cuts | Installation Procedure | Installation Equipment | Maintenance Procedures |
|--|-----------------------|--------------|------------------------|------------------------|------------------------|
| Marking Tape                             | 682.03                | X            |                        |                        |                        |
| Innerduct                                | 682.04                | X            |                        |                        |                        |
| Multi-Cell Factory Installed Duct System | 682.05                | X            | X                      |                        | X                      |
| HDPE Conduit in Duct Banks               | 682.06                | X            |                        |                        |                        |
| Couplings                                | 682.06                | X            | X                      | X                      |                        |
| Conduit, Nonmetal, Type 3                | 682.07                | X            |                        |                        |                        |
| Couplings                                | 682.07                | X            | X                      | X                      |                        |
| Conduit, Fiberglass                      | 682.08                | X            |                        |                        |                        |
| Pull Tape                                | 682.09                | X            |                        |                        |                        |
| Duct Plugs                               | 682.10                | X            |                        |                        |                        |
| Conduit Detection Wire                   | 682.11                | X            |                        |                        |                        |

Submittal data shall include complete technical and performance specifications on all elements of the conduit system. Below is a sample listing of submittal data requirements by 682.X.X subsection.

For *Subsection 682.2.03 Marking Tape* submit materials submittal data for the marking tape.

For *Subsection 682.2.04 Innerduct* submit materials submittal data for the innerduct and the installation procedure.

For *Subsection 682.2.05 Multi-Cell Factory Installed Conduit System* submit materials data for the conduit system, innerduct, outerduct, coupling body, fittings, accessories, bends and sweeps, installation procedures, and maintenance procedures.

For *Subsection 682.2.06 Conduit Duct Bank* submit materials submittal data for conduit, couplings, and coupling procedures.

For *Subsection 682.2.07 Conduit, Nonmetal, Type 3* submit materials submittal data for conduit, couplings, and coupling procedures.

For *Subsection 682.2.08 Conduit, Fiberglass* submit materials submittal data for conduit, couplings and fittings, and coupling and fittings procedures.

For *Subsection 682.2.09 Pull Tape* submit materials submittal data for pull tape and installation procedure.

For *Subsection 682.2.10 Duct Plug* submit materials submittal data for duct plugs for empty conduit and duct plugs with cable installed.

For *Subsection 682.2.11 Conduit Detection Wire* submit materials submittal data for conduit detection wire and testing procedure.

## **682.2.03 MARKING TAPE SPECIFICATIONS**

### **682.2.03.1 Requirement For Use**

When fiber optic cable is installed underground in conduit or directly buried or when empty conduit is installed, install a dielectric marking tape directly over the conduit or cable below finished grade. The tape shall be installed for the full length of the cable or conduit run. When the conduit or cable is in a trench backfilled with full depth concrete, no marking tape shall be installed.

### **682.2.03.2 Printing**

The color of the tape shall be orange with “GA DOT FIBER OPTIC CABLE-CALL 1-404-624-2661” printed every 6.5 ft (2.0 m).

### **682.2.03.3 Physical Properties**

The tape shall be a dielectric, polyolefin film tape, 0.004 in. (0.1 mm) thick, 3 in. (76 mm) wide. The tape shall be constructed using material and ink colors which will not change when exposed to acids and other destructive substances commonly found in the soil.

The physical test methods along with typical properties and values are specified below:

| <u>PROPERTY</u>        | <u>METHOD</u> | <u>VALUE</u>  |
|------------------------|---------------|---|
| Standard Weight        | ASTM-D2103    | 0.02 lb/ft <sup>2</sup><br>(0.1 kg/m <sup>2</sup> ) |
| Thickness-Overall      | ASTM-D2103    | 0.004 in.<br>(0.1 mm)                               |
| 3" Tensile Break-MD    | ASTM-D882     | 35 lbf<br>(160 N)                                   |
| 3" Tensile Strength-MD | ASTM-D882     | 2900 psi<br>(20000 kPa)                             |
| 3" Tensile Break-TD    | ASTM-D882     | 38 lbf<br>(170 N)                                   |

|                          |            |                         |
|--------------------------|------------|-------------------------|
| 3" Tensile Strength-TD   | ASTM-D882  | 3160 psi<br>(21790 kPa) |
| Elongation-MD            | ASTM-D882  | 530%                    |
| Elongation-TD            | ASTM-D822  | 660%                    |
| PPT Resistance-MD        | ASTM-D2582 | 12 lbf<br>(53 N)        |
| PPT Resistance-TD        | ASTM-D2582 | 14 lbf<br>(62 N)        |
| Tear Strength-3" x 8"-MD | ASTM-D2261 | 24 lbf<br>(110 N)       |
| Tear Strength-3" x 8"-TD | ASTM-D2261 | 32 lbf<br>(140 N)       |

PPT – Puncture Propagation Tear

MD/TD – Machine Direction/ Transverse Direction

### 682.2.04 INNERDUCT

Conduit shall be manufactured from virgin high-density polyethylene. Conduit shall be extruded from colored material for uniform full-thickness coloring. Where striping is required, a minimum of three colored longitudinal stripes of HDPE material shall be co-extruded on the conduit outer wall. The three stripes shall be equally spaced around the circumference and continuous for the entire length of conduit. Printed or embossed striping is not permitted.

All conduit shall be labeled with durable identification giving the name of the manufacturer, conduit size (inner diameter trade size and wall thickness/rating), manufacture/date codes, and sequential foot marking. Labeling shall occur a maximum of every 2 ft (0.6 m).

Innerduct to be used in bends and sweeps shall have a minimum burn through time of 30 minutes when tested in accordance with Generic Requirement GR-356-CORE, Issue 1, October 1995.

All innerduct used on this project shall conform to the same color scheme as the conduit used in conduit duct bank (Subsection 682.2.06) unless specified otherwise.

#### 682.2.04.1 1 in. (25 mm) Innerduct

1 in. (25 mm) innerduct shall conform to ASTM D-2239 and shall meet the following requirements:

- Smoothwall SIDR 13
- Nominal outer diameter: 1.231 in. (31.27 mm)
- Minimum inner diameter: 1.029 in. (26.14 mm)
- Minimum wall thickness: 0.091 in. (2.31 mm)

#### 682.2.04.2 1¼ In. (32 mm) Innerduct

1¼ in. (32 mm) innerduct shall conform to ASTM D-3035 and meet the following requirements:

- Smoothwall SDR 11
- Nominal outer diameter: 1.660in. (42.16 mm)
- Minimum inner diameter: 1.313 in. (33.35 mm)
- Minimum wall thickness: 0.151 in. (3.84 mm)

#### 682.2.04.3 2 In. (51 mm) Innerduct

2 in. (51 mm) innerduct shall conform to ASTM D-3035 and meet the following requirements:

- Smoothwall SDR 11
- Nominal outer diameter: 2.375 in. (60.32 mm)
- Minimum inner diameter: 1.885 in. (47.88 mm)
- Minimum wall thickness: 0.216 in. (5.49 mm)

### 682.2.05 MULTI-CELL “FACTORY INSTALLED” CONDUIT SYSTEM

#### 682.2.05.1 DESCRIPTION

The multi-cell conduit system shall be a pre-assembled conduit manufactured from a 4 in. (102 mm) round outerduct containing either 3 or 4 factory installed round innerducts. The innerducts shall be held together in a square (4 conduit system) or triangular (3 conduit system) configuration by a system of spacers, bands, or other mechanism. The coupling system shall be resistant to water infiltration, air loss during cable installation and shall be capable of locking the system tightly together in order to not allow free twisting of the innerducts.

**682.2.05.2 OUTERDUCT**

All outerduct shall be 4 in. (102 mm) trade size and shall have a nominal 20 ft (6 m) lay length except for the steel conduit which shall have a minimum lay length of 10 ft (3 m). Types to be used shall be designated on the plans or in the proposal. All outerduct shall conform to the following requirements.

1. The outerduct shall have the following identification information:



Line text height shall be at least ½ in. (10 mm). Text labeling shall occur a maximum of every 2 ft (0.6 m). The text shall be indelibly printed in high contrast to the conduit. The text shall be oriented to face up for underground installation; the text shall be oriented to face down for under bridge installation.

2. The duct shall be marked with data which will provide traceability of the manufacturer, plant location, date, shift, and machine of manufacturer.
3. Any additional wording on the conduit, such as “this side up” or “this side down”, shall be consistent with the installation orientation.
4. The spigot end of the duct shall have a circumferential insertion depth mark to insure that proper insertion depth is achieved. This mark is not required for spigots with threaded fittings.

**682.2.05.3 INNERDUCT**

Innerduct shall be manufactured from Poly-vinyl Chloride (PVC) or High Density Polyethylene (HDPE).

**682.2.05.4 COUPLING BODY**

The multi-cell conduit shall be joined by use of a coupling system which effectively seals the outerducts and innerducts but allows for expansion or contraction in the system.

**682.2.05.5 ACCESSORIES AND FITTINGS**

The multi-cell conduit system shall be furnished with all necessary fittings and accessories. These shall include, but shall not be limited to, coupling kits, lubrication fittings, repair kits, manhole terminator kits w/plugs, installation accessories, deflection fittings, and epoxy adhesive kits. Each multi-cell system shall offer a complete line of fixed, rigid bends and sweeps. For applications in which the multi-cell conduit system is specified on the Plans and/or by the Engineer to be attached to a bridge or other structure, bridge hanger assemblies, expansion joints, and conduit support devices shall be required. These hanger assemblies, expansion joints, and support devices shall be designed for application to the specific bridge or structure for which they will be used, and their materials and design shall be approved by the Department prior to their use.

**682.2.05.6 MATERIALS**

Provide the Engineer with Manufacturer’s test results for the required testing and certification in accordance with Subsection 106.05 of the Georgia Specifications.

**682.2.05.6.A OUTERDUCT**

1. Schedule 40, Polyvinyl Chloride (PVC) Conduit - Schedule 40, polyvinyl chloride (PVC) conduit shall conform to the requirements of the National Electrical Manufacturers Association (NEMA) Standards Publication No. TC-10-1983, Type

DB-120, except that the conduit shall be white in color and shall have a minimum 5 in. (127 mm) long integral bell to accommodate the coupling body.

2. Type “C”, Polyvinyl Chloride (PVC) Conduit - Type “C,” polyvinyl chloride (PVC) conduit shall conform to the requirements of the National Electrical Manufacturers Association (NEMA) Standards Publication No. TC-10-1983, Type DB-120, except that the conduit shall be white in color and shall have a minimum 5 in. (127 mm) long integral bell to accommodate the coupling body.

3. Steel Conduit - Rigid steel conduit shall meet the requirements of Sub-Section 923.02 of The Georgia Specifications. All metal accessories and fitting used with the conduit shall be compatible and shall meet the galvanization requirements of Sub-Section 923. 2.

4. “Bullet Resistant” Fiberglass Conduit - Bullet resistant fiberglass conduit shall have a minimum wall thickness of 0.250 in. (6.35 mm). The conduit shall prevent the penetration of a .45 caliber slug fired from a distance of 20 ft (6 m). The conduit shall conform to the following requirements when tested in accordance with the referenced specification. All accessories and fittings, including outerduct couplings and expansion joints, shall meet all the same “bullet resistant” requirements as the conduit. All conduit and fittings shall be black.

| <u>PHYSICAL AND MECHANICAL PROPERTIES</u>               | <u>TEST METHODS</u> |
|---|---------------------|
| Ultimate Tensile Strength - 11,000 PSI (75800 kPa) Min. | ASTM D 2105         |
| Dielectric Strength - 500 Volts/Mil.                    | ASTM D 149          |
| Water Absorption - 1% Max.                              | ASTM D 570          |
| Specific Gravity - 1.9 - 2.0                            | ASTM D 792          |
| Glass Content - 68 +/- 2%                               | API SPEC 15 LR      |
| Barcol Hardness - 58-52                                 | ASTM D 2583         |

**682.2.05.6.B INNERDUCT (WITHIN MULTI-CELL)**

Innerducts shall be manufactured from polyvinyl chloride (PVC) or high density polyethylene (HDPE). Innerducts shall be factory treated with an atomized silicone or manufactured in a manner to reduce friction during pulling of fiber optic cable. Innerduct to be used in bends and sweeps shall have a minimum burn through time of 30 minutes when tested in accordance with Generic Requirement GR-356-CORE, Issue 1, October 1995. The dimensions of innerduct shall meet the requirements of the manufacturer’s catalog cuts approved by the Department.

**682.2.05.6.B.1 PVC INNERDUCT**

PVC innerduct shall be factory treated with an atomized silicone to reduce friction. The innerduct shall conform to the following requirements:

| <u>COLOR OF INNERDUCTS</u> | <u>NOMINAL SIZE</u> |
|----------------------------|---------------------|
| 3-way (2 gray & 1 white)   | 1 1/2" (38 mm)      |
| 4-way (3 gray & 1 white)   | 1 1/4" (32 mm)      |

Note: The white innerduct shall be located directly under the print line on the outerduct.

Alternate innerduct colors shall be permitted only when requested in writing and upon receiving written approval from the Engineer.

**682.2.05.6.B.2 HDPE INNERDUCT**

HDPE innerduct shall have a permanent dry lubricant extruded within the inner wall and shall incorporate longitudinal ribs within the inner wall. HDPE innerduct shall conform to the following requirements:

| <u>COLOR OF INNERDUCTS</u>         | <u>NOMINAL SIZE</u> |
|------------------------------------|---------------------|
| 3-way (yellow, orange, red)        | 1 1/2" (38 mm)      |
| 4-way (red, white, yellow, orange) | 1 1/4" (32 mm)      |

Innerduct colors shall be oriented in a clockwise direction as shown above, looking at the spigot end of the multi-cell conduit system. The white innerduct for 4-way and yellow innerduct for 3-way shall be located directly under the print line on the outerduct.

Alternate innerduct colors shall be permitted only when requested in writing and upon receiving written approval from the Engineer.

#### **682.2.05.6.3 COUPLING BODY**

The coupling body shall be designed with either 3 or 4 bores as required. The coupling body shall be designed so that when the conduit is joined, the outer walls of the innerducts and the inner walls of the outerduct shall be sealed, providing an airtight seal from within the innerduct system and a watertight seal from the outside of the outerduct. The coupling body shall be tested for water tightness and air tightness in accordance with BellSouth Telecommunications Specification BS 622-0004, Issue 3, June, 1993. The coupling body shall conform to the following requirements.

- Water tightness - 6 psi (41.4 kPa) Minimum
- Air tightness - no leakage at 100 psi (690 kPa)

#### **682.2.05.6.4 BENDS AND SWEEPS**

Each multi-cell system shall offer a complete line of fixed bends and sweeps. No flexible bends will be permitted. HDPE, PVC, and bullet resistant fiberglass bends and sweeps shall have compatible bell and spigot ends. Steel conduit bends and sweeps shall have compatible threads and reversing couplings for connection to the conduit. PVC innerducts shall not be allowed in bends and sweeps. In no case shall bends and sweeps exceed a 90 degree direction change. Bends and sweeps shall be available as follows:

Fixed Bends: Fixed bends for steel conduit shall be available in no less than 4 ft (1.22 m) radii in 11 1/4 degrees, 22 1/2 degrees, 45 degrees, and 90 degree bends. Fixed bends for PVC and bullet resistant fiberglass multicell conduit shall be available in radii no less than the following:

| <u>RADIUS</u>  | <u>DEGREE BEND</u> |
|----------------|--------------------|
| 4 ft. (1.22 m) | 11 1/4 degrees     |
| 6 ft. (1.83 m) | 22 1/2 degrees     |
| 9 ft. (2.74 m) | 45 and 90 degrees  |

#### **682.2.06 CONDUIT DUCT BANK**

##### **682.2.06.1 MATERIAL**

Install Conduit Duct Banks by configuring individual conduits into a continuous duct bank from termination point to termination point as shown in the Standard Details and other Contract Documents. Conduit Duct Bank, Type 1 shall include six 1-1/4" (32 mm) conduits and three 2" (51 mm) conduits. Conduit Duct Bank, Type 2 shall include eight 1-1/4" (32 mm) conduits and three 2"(51 mm) conduits. Conduit Duct Bank, Type Special shall be as shown in the Plans.

Conduit shall be manufactured from virgin high-density polyethylene. Conduit shall be extruded from colored material for uniform full-thickness coloring. Where striping is required, a minimum of three colored longitudinal stripes of HDPE material shall be co-extruded on the conduit outer wall. The three stripes shall be equally spaced around the circumference and continuous for the entire length of conduit. Printed or embossed striping is not permitted.

All conduit shall be labeled with durable identification giving the name of the manufacturer, conduit size (inner diameter trade size and wall thickness/rating), manufacture/date codes, and sequential foot marking. Labeling shall occur at a maximum of every 2 ft (0.6 m).

Where required in the Contract Documents, conduits shall be located and secured in the conduit duct bank by conduit spacers configured into an assembly that is appropriate for the duct bank type.

##### **682.2.06.1.A 1-1/4 In. (32 mm) Conduit**

1-1/4 in. (32 mm) conduit shall conform to ASTM D-3035 and meet the following requirements:

- Smoothwall SDR 11
- Nominal outer diameter: 1.660 in. (42.16 mm)
- Minimum inner diameter: 1.313 in. (33.35 mm)
- Minimum wall thickness: 0.151 in. (3.84 mm)

##### **682.2.06.1.B 2 In. (51 mm) Conduit**

2 in. (51 mm) conduit shall conform to ASTM D-3035 and meet the following requirements:

- Smoothwall SDR 11
- Nominal outer diameter: 2.375 in. (60.32 mm)
- Minimum inner diameter: 1.885 in. (47.88 mm)
- Minimum wall thickness: 0.216 in. (5.49 mm)

#### **682.2.06.1.C Conduit Spacer**

Conduit spacers shall be steel or molded high impact polystyrene that is resistant to rot and moisture absorption. Spacers shall be manufactured to have an interlocking design such that spacers for different conduits can be assembled for the appropriate duct bank configuration. All spacers on the bottom of an assembly shall be “base” that includes a flat base with a minimum of 6 in<sup>2</sup> (3900 mm<sup>2</sup>) of bearing area for each bottom conduit.

#### **682.2.06.2 COUPLING**

Make every effort to minimize coupling. Coupling shall only be permitted with the advance permission of the Engineer.

Couplings shall be airtight and watertight. All couplings shall be installed in accordance with the conduit and the coupling manufacturer’s recommendations. Only couplings of the type specified below and approved by the conduit manufacturer are permitted.

Couplings shall be accomplished only by hydraulic press-on or electro-fusion coupling methods. Use hydraulic press-on couplings of seamless tool-grade tubular aluminum with sealing barbs and center stop. Use hydraulic compression duct coupling tools and follow all manufacturer’s installation procedures, fully inserting both conduit sections to the coupling center stop. Use pre-fabricated electro-fusion couplings that are field-installed using the coupling manufacturer’s recommended automatic self-monitoring fusing machine and installation procedures. Do not use any other coupling methods.

#### **682.2.06.3 TERMINATION**

Conduit duct banks shall be terminated in electrical communications boxes (ECBs) as shown in the Standard Details of the Contract Documents. Duct banks shall be terminated in factory-installed knockout windows only, which shall be fully grouted and sealed around all conduits and to the full thickness of the box wall.

### **682.2.07 CONDUIT, NONMETAL, TYPE 3**

#### **682.2.07.1 MATERIAL**

Conduit shall be manufactured from virgin high-density polyethylene (HDPE). Conduit shall be extruded from colored material for uniform full-thickness coloring. Where striping is required, a minimum of three colored longitudinal stripes of HDPE material shall be co-extruded on the conduit outer wall. The three stripes shall be equally spaced around the circumference and continuous for the entire length of conduit. Printed or embossed striping is not permitted. Unless otherwise noted in the Contract Documents, color code for conduit used for Type 3 installation shall comply with the Conduit Duct Bank Color Code schedule listed on the plan detail sheet. .

All conduit shall be labeled with durable identification giving the name of the manufacturer, conduit size (inner diameter trade size and wall thickness/rating), manufacture/date codes, and sequential foot marking. The conduit shall also be labeled with the following: “Georgia DOT Cable – For Assistance Call 404-624-2661”. Labeling shall occur a maximum of every 4 ft. (1.2 m).

#### **682.2.07.1.A 1 In. (25 mm) Conduit**

1 in. (25 mm) conduit shall conform to ASTM D-3035 and shall meet the following requirements:

- Smoothwall SDR 11
- Nominal outer diameter: 1.315 in. (33.40 mm)
- Minimum inner diameter: 1.030 in. (26.16 mm)
- Minimum wall thickness: 0.120 in. (3.05 mm)

#### **682.2.07.1.B 1¼ In. (32 mm) Conduit**

1¼ in. (32 mm) conduit shall conform to ASTM D-3035 and shall meet the following requirements:

- Smoothwall SDR 11
- Nominal outer diameter: 1.660 in. (42.16 mm)
- Minimum inner diameter: 1.313 in. (33.35 mm)
- Minimum wall thickness: 0.151 in. (3.84 mm)

**682.2.07.1.C 1½ In. (38 mm) Conduit**

1½ in. (38 mm) conduit shall conform to ASTM D-3035 and shall meet the following requirements:

- Smoothwall SIDR 11
- Nominal outer diameter: 1.900 in. (48.26 mm)
- Minimum inner diameter: 1.506 in. (38.25 mm)
- Minimum wall thickness: 0.173 in. (4.39 mm)

**682.2.07.1.D 2 In. (51 mm) Conduit**

2 in. (51 mm) conduit shall conform to ASTM D-3035 and shall meet the following requirements:

- Smoothwall SDR 11
- Nominal outer diameter: 2.375 in. (60.32 mm)
- Minimum inner diameter: 1.885 in. (47.88 mm)
- Minimum wall thickness: 0.216 in. (5.49 mm)

**682.2.07.2 COUPLING**

Make every effort to minimize coupling. Coupling shall only be permitted with the advance permission of the Engineer.

Couplings shall be airtight and watertight. All couplings shall be installed in accordance with the conduit and the coupling manufacturer’s recommendations. Only couplings of the type specified below and approved by the conduit manufacturer are permitted.

Couplings shall be accomplished only by hydraulic press-on or electro-fusion coupling methods. Use hydraulic press-on couplings of seamless tool-grade tubular aluminum with sealing barbs and center stop. Use hydraulic compression duct coupling tools and follow all manufacturer’s installation procedures, fully inserting both conduit sections to the coupling center stop. Use pre-fabricated electro-fusion couplings that are field-installed using the coupling manufacturer’s recommended automatic self-monitoring fusing machine and installation procedures. Do not use any other coupling methods.

**682.2.07.3 TERMINATION**

Type 3 conduits shall be terminated in electrical communications boxes (ECBs) using factory-installed terminators in the ECB as shown in the Standard Details of the Contract Documents. Adhesive sealants recommended by the terminator and conduit manufacturers shall be used.

**682.2.08 CONDUIT, FIBERGLASS**

**682.2.08.1 MATERIAL**

Conduit shall be manufactured from fiberglass reinforced epoxy. The conduit shall be “bullet resistant”, capable of preventing the penetration of a .45 caliber slug fired from a distance of 20 ft. (6 m). The conduit shall conform to the following physical and mechanical properties when tested in accordance with the referenced specification. All accessories and fittings, including outerduct couplings and expansion joints, shall meet all the same “bullet resistant” requirements as the conduit. All conduit and fittings shall be black.

PHYSICAL AND MECHANICAL PROPERTIES

TEST METHODS

|   |                |
|---|----------------|
| Ultimate Tensile Strength - 11,000 PSI (75800 kPa) Min. | ASTM D 2105    |
| Dielectric Strength - 500 Volts/Mil.                    | ASTM D 149     |
| Water Absorption - 1% Max.                              | ASTM D 570     |
| Specific Gravity - 1.9 - 2.0                            | ASTM D 792     |
| Glass Content - 68 +/- 2%                               | API SPEC 15 LR |
| Barcol Hardness - 58-52                                 | ASTM D 2583    |

All conduit shall conform to the following requirements:

1. The conduit shall have the following identification information:



Line text height shall be at least ½ in. (10 mm). Text labeling shall occur a maximum of every 2 ft. (0.6 m). The text shall be indelibly printed in high contrast to the conduit. The text shall be oriented to face up for underground installation; the text shall be oriented to face down for under bridge installation.

2. The duct shall be marked with data which will provide traceability of the manufacturer, plant location, date, shift, and machine of manufacturer.

3. Any additional wording on the conduit, such as “this side up” or “this side down”, shall be consistent with the installation orientation.

4. The spigot end of the duct shall have a circumferential insertion depth mark to insure that proper insertion depth is achieved. This mark is not required for spigots with threaded fittings.

**682.2.08.1.A 2 In. (51 mm) Conduit**

2 in. (51 mm) conduit shall meet the following requirements:

- Nominal outer diameter: 2.500 in. (tolerance +0.028”/-0.018”)
- [63.50 mm (tolerance +0.71/-0.46)]
- Minimum inner diameter: 2.000 in. (50.80 mm)
- Minimum wall thickness: 0.250 in. (6.35 mm)

**682.2.08.1.B 4 In. (102 mm) Conduit**

4 in. (102 mm) conduit shall meet the following requirements:

- Nominal outer diameter: 4.500 in. (tolerance +0.034”/-0.028”)
- [114.3 mm (tolerance +0.86/-0.71)]
- Minimum inner diameter: 4.000 in. (101.6 mm)
- Minimum wall thickness: 0.250 in. (6.35 mm)

**682.2.08.2 COUPLINGS AND FITTINGS**

Coupling shall be by epoxy adhesive interference joint with bell and spigot or stop coupling fittings only. Couplings shall be airtight and watertight. All couplings shall be installed in accordance with the conduit and the coupling manufacturer’s recommendations. Only couplings of the same type of fiberglass as specified above are permitted.

Fixed bends and sweeps shall be used; no flexible bends are permitted. Bends and sweeps shall be compatible with the coupling requirements above. Bends and sweeps shall be of consistent radius and inner diameter, with a minimum radius of 10 times the inner diameter. In no case shall bends exceed a 90 degree direction change.

Where the fiberglass conduit is specified in the Plans and/or by the Engineer to be attached to a bridge or other structure, bridge hanger assemblies, expansion joints, deflection fittings, and conduit support devices are required and shall be designed for application to the specific bridge or structure for which they will be used. The Department shall approve all materials and design of bridge-attached conduit systems prior to any field installation. All bridge hanger assembly components that are in contact with the conduit’s outer surface shall be manufactured of the same fiberglass reinforced epoxy material or shall employ low-friction roller bushings.

**682.2.08.3 TERMINATION**

Fiberglass conduits shall be terminated in ECBs using factory-installed terminators in the ECB or by grouting and setting in a knockout window as shown in the Standard Details of the Contract Documents. Adhesive sealants recommended by the terminator and conduit manufacturers shall be used.

**682.2.09 PULL TAPE**

### **682.2.09.1 MATERIAL**

Non-detectable pull tape shall be a polyester tape (Fibertek Part No. WP1250, NEPTCO Part No. WP1250P, or approved equal). The tape shall have the following properties:

- 1250 lb (567 kg) tensile strength
- flat, not round, construction
- printed foot markings
- pre-lubricated for reduced pulling tension at start of cable pull
- low susceptibility to absorption of moisture; moisture resistant

Detectable pull tape shall consist of a single 24 AWG copper wire with polyethylene or PVC jacket woven into a polyester tape (Fibertek Part No. WPT1250, NEPTCO Part No. DP1250P, or approved equal). The tape shall have the following properties:

- 1250 lbs. (567 kg) tensile strength
- flat, not round, construction
- printed foot markings
- pre-lubricated for reduced pulling tension at start of cable pull
- low susceptibility to absorption of moisture; moisture resistant
- corrosion resistant embedded conductor

### **682.2.09.2 INSTALLATION**

Install pull tape, by hand pulling, blowing, or via vacuum method, into each empty conduit and innerduct and empty cell within a multi-cell conduit during conduit installation. Install the pull tape after conduit testing has been completed. Install and secure 5 ft (1.5 m) of slacked pull tape in each empty conduit or cell at each vault. Secure the pull tape by tying it to the duct plug for the conduit in which it is installed.

### **682.2.10 DUCT PLUGS**

Install blank duct plugs in each empty conduit that enters an ECB, pull box, hub, or building entrance. The plug shall be sized to fit the conduit in which it is used and shall provide a watertight and airtight seal by use of mechanical expansion. No sealants or caulks shall be used. The duct plug shall have inner rings to which pull tape can be tied. All metallic components shall be stainless steel.

Install a fiber optic innerduct plug in each conduit that enters an ECB, pull box, hub, or building entrance and has a cable installed in it. The plug shall be sized to fit the conduit and cable with which it is used and shall be a split plug with a bushing assembly for sealing around the cable by mechanical compression. All metallic components shall be stainless steel.

Install a multi-conduit duct plug in each conduit that enters an ECB, pullbox, hub, or building entrance and has one or more innerducts installed in it. The plug shall be sized to fit the outer conduit and the innerducts with which it is used and shall have split holes for each innerduct with a bushing assembly for sealing around the innerducts by mechanical compression. Seal unused innerduct holes with the appropriate plug or solid bushing. All metallic components shall be stainless steel.

Install a multi-cable duct plug in each conduit that enters an ECB, pullbox, hub, or building entrance and has two or more cables installed in it. The plug shall be sized to fit the outer conduit and the cables (with appropriately-sized split bushings) with which it is used and shall have split holes for each cable with an overall bushing assembly for sealing around the cable bushings by mechanical compression. Where the conduit is 4-inch I.D. or greater, use a multi-cable duct plug with a minimum of four cable holes. Seal unused cable holes with the appropriate plug or solid bushing. All metallic components shall be stainless steel.

### **682.2.11 CONDUIT DETECTION WIRE**

#### **682.2.11.1 MATERIAL**

Conduit detection wire shall be #10 AWG stranded green-insulated THWN conductor.

#### **682.2.11.2 INSTALLATION**

Install one conduit detection wire in the trench during conduit installation, directly below the conduit or at the same level as the conduit. All conduit installed by use of directional boring shall include the installation of a conduit detection wire. The conduit detection wire shall be pulled with, but not in, the bored conduit. If more than one conduit is being installed in a single bore, only one conduit detection wire shall be required.

When conduit detection wire installation is required in existing conduit, install one conduit detection wire in the existing conduit or in one of the existing innerducts.

The conduit detection wire shall be continuous and unspliced between pull boxes or vaults and shall enter the pull boxes or vaults at the same location as the conduit with which it is installed. Coil and secure 5 ft (1.5 m) of conduit detection wire in each pull box or vault.

#### **682.2.11.3 TESTING**

Perform a continuity or tone test after installation to confirm that a continuous run of conduit detection wire was installed between pull boxes or vaults. For conduit detection wire installed in a trench, test the conduit detection wire after backfilling, compaction, and ECB installation is complete. For conduit detection wire installed in a trench with full-depth conduit backfill, test the conduit detection wire before and after backfilling. The purpose of this test is to document that no damage or separation of the conduit detection wire has occurred during the installation of wire, backfilling of the trench, or ECB installation.

Prepare a test plan, supplying equipment, conducting the test and documenting the results. Submit a test plan at least 15 working days prior to the desired testing date. Testing shall not begin until the Engineer has approved the test plan, and all tests shall be conducted in the presence of the Engineer.

#### **682.2.12 CONDUIT TESTING**

Test every conduit after the conduit is installed and before cable or pull tape is installed. Perform testing on all conduit types in this Specification, including but not limited to each cell of multi-cell conduit, each conduit in duct banks, and each innerduct. All testing shall be performed using the procedures and mandrel size recommended by the conduit manufacturer. Testing shall be performed in the presence of the Engineer. Payment for all testing is included in the cost of the conduit.

*Add the following to Subsection 682.3.05:*

##### **682.3.05.1 Multi-Cell Conduit System**

Secure from the manufacturer or supplier of the multi-cell system and provide to the Department complete and comprehensive written installation manuals for the complete system. At the start of the multi-cell installation, have the manufacturer or supplier provide technical assistance, as needed. At any time during the construction process, ensure that the manufacturer or supplier provides technical assistance to the Contractor and/or the Department.

For multi-cell conduit system installation under bridges, only fiberglass or steel multi-cell conduit systems shall be used. Install expansion and deflection joints according to the multi-cell conduit system manufacturer's and support hanger manufacturer's recommendations. Steel couplings shall be securely tightened; fiberglass coupling shall be epoxied. Ensure that during the construction process and at the request of the Department, the multi-cell conduit system or support hanger manufacturer provides on-site technical assistance at no additional cost to the Department.

##### **682.3.05.2 Continuous Flexible Conduit**

Whenever possible, conduits shall be placed in continuous manufactured lengths without coupling.

Conduit shall be placed in the straightest orientation possible, reducing bends, rises, and waves. Conduits shall be held in place during backfilling when necessary to keep straight. Where field conditions require the trench to change direction and bends are necessary, the bends shall be formed in the trench and should be smooth and gentle and shall not have less than a 4 foot radius (as measured to the inside surface of the conduit)

*Add the following to Subsection 682.4:*

Multi-cell conduit system, innerduct, conduit duct bank, fiberglass conduit, and conduit nonmetal type 3 will be measured for payment by the amount actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, all costs for materials, cutting asphalt or concrete, trenching, installing, backfilling trench, restoring asphalt or concrete, drilling existing concrete shoulder, installing #4 rebar, replacement of existing transverse joint material, directional boring, and testing of multi-cell conduit system, innerduct, conduit duct bank, conduit nonmetal type 3, fiberglass conduit, marking tape, pull tape, duct plugs, and conduit detection wire shall be included in the overall cost of the multi-cell conduit system, innerduct, conduit duct bank, fiberglass conduit, and conduit nonmetal type 3.

Conduit detection wire installed in existing conduit will be measured for payment by the amount actually installed, complete, functional, and accepted. Payment for installing Conduit Detection Wire in existing conduit will be paid for at the Contract unit price per linear foot or linear meter. Such payment will be full compensation for furnishing, installing, and testing the wire.

*Add the following to Subsection 682.5:*

|  |        |       |                         |
|--|--------|-------|-------------------------|
| Item No. 682. Conduit - Nonmetallic, Type ____.                  | (Size) | ..... | per Linear Foot (Meter) |
| Item No. 682. Multi-Cell Conduit System, 4-Way, Fiberglass.....  |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Multi-Cell Conduit System, 4-Way, Rigid Metal..... |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Innerduct, 1", HDPE.....                           |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Innerduct, 1¼", HDPE.....                          |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Innerduct, 2", HDPE.....                           |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit Detection Wire.....                        |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit Duct Bank, Type 1.....                     |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit Duct Bank, Type 2.....                     |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit Duct Bank, Type Special.....               |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit, Nonmetal, Type 3, 1".....                 |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit, Nonmetal, Type 3, 1¼".....                |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit, Nonmetal, Type 3, 1 ½".....               |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit, Nonmetal, Type 3, 2".....                 |        | ..... | per Linear Foot (Meter) |
| Item No. 682. Conduit, Fiberglass, (size).....                   |        | ..... | per Linear Foot (Meter) |