

Item F-162 Chain-Link Fence

DESCRIPTION

162-1.1 This item shall consist of furnishing and erecting a chain-link fence in accordance with these specifications, the details shown on the plans, and in conformity with the lines and grades shown on the plans or established by the RPR.

MATERIALS

162-2.1 Fabric. The fabric shall be woven with a 9-gauge galvanized steel wire in a 2-inch (50 mm) mesh and shall meet the requirements of ASTM A392, Class 2.

162-2.2 Barbed wire. Barbed wire shall be 2-strand 12-1/2 gauge zinc-coated wire with 4-point barbs and shall conform to the requirements of ASTM A121, Class 3, Chain Link Fence Grade.

162-2.3 Posts, rails, and braces. Line posts, rails, and braces shall conform to the requirements of ASTM F1043 or ASTM F1083 as follows:

- Galvanized tubular steel pipe shall conform to the requirements of Group IA, (Schedule 40) coatings conforming to Type A, or Group IC (High Strength Pipe), External coating Type B, and internal coating Type B or D.
- Posts, rails, and braces furnished for use in conjunction with aluminum alloy fabric shall be aluminum alloy or composite.

Posts, rails, and braces, with the exception of galvanized steel conforming to ASTM F1043 or ASTM F1083, Group 1A, Type A, or aluminum alloy, shall demonstrate the ability to withstand testing in salt spray in accordance with ASTM B117 as follows:

- External: 1,000 hours with a maximum of 5% red rust.
- Internal: 650 hours with a maximum of 5% red rust.

The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Federal Specification RR-F-191/3.

162-2.4 Gates. Gate frames shall consist of galvanized steel pipe and shall conform to the specifications for the same material under paragraph 162-2.3. The fabric shall be of the same type material as used in the fence.

162-2.5 Wire ties and tension wires. Wire ties for use in conjunction with a given type of fabric shall be of the same material and coating weight identified with the fabric type. Tension wire shall be 7-gauge marcelled steel wire with the same coating as the fabric type and shall conform to ASTM A824.

All material shall conform to Federal Specification RR-F-191/4.

162-2.6 Miscellaneous fittings and hardware. Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. All steel fittings and hardware shall be

protected with a zinc coating applied in conformance with ASTM A153. Barbed wire support arms shall withstand a load of 250 pounds (113 kg) applied vertically to the outermost end of the arm.

162-2.7 Concrete. Concrete shall have a minimum 28-day compressive strength of 3000 psi (2670 kPa).

162-2.8 Marking. Each roll of fabric shall carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

CONSTRUCTION METHODS

162-3.1 General. The fence shall be constructed in accordance with the details on the plans and as specified here using new materials. All work shall be performed in a workmanlike manner satisfactory to the RPR. The Contractor shall layout the fence line based on the plans. The Contractor shall span the opening below the fence with barbed wire at all locations where it is not practical to conform the fence to the general contour of the ground surface because of natural or manmade features such as drainage ditches. The new fence shall be permanently tied to the terminals of existing fences as shown on the plans. The Contractor shall stake down the woven wire fence at several points between posts as shown on the plans.

The Contractor shall arrange the work so that construction of the new fence will immediately follow the removal of existing fences. The length of unfenced section at any time shall not exceed 300 feet (90 m). The work shall progress in this manner and at the close of the working day the newly constructed fence shall be tied to the existing fence.

162-3.2 Clearing fence line. Clearing shall consist of the removal of all stumps, brush, rocks, trees, or other obstructions that will interfere with proper construction of the fence. Stumps within the cleared area of the fence shall be grubbed or excavated. The bottom of the fence shall be placed a uniform distance above ground, as specified in the plans. When shown on the plans or as directed by the RPR, the existing fences which interfere with the new fence location shall be removed by the Contractor as a part of the construction work unless such removal is listed as a separate item in the bid schedule. All holes remaining after post and stump removal shall be refilled with suitable soil, gravel, or other suitable material and compacted with tampers.

The cost of removing and disposing of the material shall not constitute a pay item and shall be considered incidental to fence construction.

162-3.3 Installing posts. All posts shall be set in concrete at the required dimension and depth and at the spacing shown on the plans.

The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within seven (7) days after the individual post footing is completed.

Should rock be encountered at a depth less than the planned footing depth, a hole 2 inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12 inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part Portland cement and two parts mortar sand. Any remaining space above the rock shall be filled with concrete in the manner described above.

In lieu of drilling, the rock may be excavated to the required footing depth. No extra compensation shall be made for rock excavation.

162-3.4 Installing top rails. The top rail shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion.

162-3.5 Installing braces. Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts.

162-3.6 Installing fabric. The wire fabric shall be firmly attached to the posts and braced as shown on the plans. All wire shall be stretched taut and shall be installed to the required elevations. The fence shall generally follow the contour of the ground, with the bottom of the fence fabric no less than one inch (25 mm) or more than 4 inches (100 mm) from the ground surface. Grading shall be performed where necessary to provide a neat appearance.

At locations of small natural swales or drainage ditches and where it is not practical to have the fence conform to the general contour of the ground surface, longer posts may be used and multiple strands of barbed wire stretched to span the opening below the fence. The vertical clearance between strands of barbed wire shall be 6 inches (150 mm) or less.

162-3.7 Electrical grounds. Electrical grounds shall be at 500 feet (150 m) intervals. The ground shall be accomplished with a copper clad rod 8 feet (2.4 m) long and a minimum of 5/8 inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. A No. 6 solid copper conductor shall be clamped to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction. The Contractor shall comply with FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities

162-3.8 Cleaning up. The Contractor shall remove from the vicinity of the completed work all tools, buildings, equipment, etc., used during construction. All disturbed areas shall be seeded per T-901.

METHOD OF MEASUREMENT

162-4.1 Chain-link fence will be measured for payment by the linear foot (meter). Measurement will be along the top of the fence from center to center of end posts, excluding the length occupied by gate openings.

162-4.2 Gates will be measured as complete units. The contractor shall be responsible for providing a complete and working automated gate at location proposed on the plans.

BASIS OF PAYMENT

The price shall be full compensation for furnishing all materials, and for all preparation, erection, and installation of these materials, and for all labor equipment, tools, and incidentals necessary to complete the item.

162-5.1 Payment for chain-link fence will be made at the contract unit price per linear foot (meter).

162-5.2 Payment for vehicle or pedestrian gates will be made at the contract unit price for each gate.

Payment will be made under:

Item F-162-5.1	Chain Link Fence (Temporary AOA Fence) (6' Tall W/ 3-Strand Barb Wire) (Installed On Grade) – per linear foot
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Item F-162-5.2	Chain Link Fence (Temporary AOA Fence) (6' Tall W/ 3-Strand Barb Wire) (Installed On Concrete Barricades) – per linear foot
Item F-162-5.3	Chain Link Fence (Permanent AOA Fence) (10' Tall W/ DBL Arm, 6 Strand Barb Wire & Razor Ribbon Incl Mow Strip) – per linear foot
Item F-162-5.4	Chain Link Fence – Manual Double Swing Gate (Non-AOA) (6' Tall, 24' Total Width) – per each
Item F-162-5.5a	Chain Link Fence – Automated Single Sliding Gate (AOA) (10' Tall, 24' Total Width) (Gate CD-3 Installation Only) – per each
Item F-162-5.5b	Chain Link Fence – Manual Double Swing Gate (AOA) (10' Tall, 40' Total Width) (Gate CD-3 Existing Access Control and Motorized Equipment Relocation) – per lump sum

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A121	Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A392	Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A491	Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A824	Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM F668	Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and other Organic Polymer Coated Steel Chain-Link Fence Fabric
ASTM F1043	Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
ASTM F1083	Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F1183	Standard Specification for Aluminum Alloy Chain Link Fence Fabric
ASTM F1345	Standard Specification for Zinc 5% Aluminum-Mischmetal Alloy Coated Steel Chain-Link Fence Fabric
ASTM G152	Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

ASTM G155 Standard Practice for Operating Xenon Arc Light Apparatus for
Exposure of Nonmetallic Materials

Federal Specifications (FED SPEC)

FED SPEC RR-F-191/3 Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and
Braces)

FED SPEC RR-F-191/4 Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

FAA Standard

FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding and Shielding
Requirements for Facilities and Electronic Equipment

FAA Orders

5300.38 AIP Handbook

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Item A-103 Fiber Optic Cable

GENERAL DESCRIPTION

The section describes the furnishing and installation of fiber optic cabling, necessary accessories and incidentals including required testing and warranties for a fiber optic system comprised of the equipment and materials as specified herein and shown in the Contract documents.

MATERIALS

103-2.1 Fiber Cable and Optical Requirements

a. General

1. Comply with ISO 9001 or Sigma Six quality manufacturing requirements.
2. Provide only fiber optic cables and components that are new (manufactured no more than one year prior to the Notice to Proceed) and provided by one manufacturer using the same model, part number, and revision. Provide the manufacturer date as part of the submittal process in Item L-106, Submittals, Record Documents, and Maintenance Manuals.
3. Provide SM fiber optic cable that is splice-compatible with the Authority's existing legacy SM fiber and requires no electronic equipment for dispersion compensation between new and existing fiber.
4. Provide fiber optic cables as noted in the Contract documents.
5. Provide cables that comply with NFPA 70.
6. Provide cables that comply with RoHS Directive 2011/65/EU.

b. Fiber Optical

1. Provide fiber optic cables that comply with ICEA S-87-640.
2. Provide fiber optic cables that comply with Telcordia GR-20-CORE.
3. Provide fiber optic cables that comply with USDA RUS 7 CFR 1755.900, 901, and 902 (PE-90).
4. Provide SM fiber optic cables that comply with ITU-T G.652.D.
5. Provide SM fiber optic cables that comply with ITU-T G.657.A I.
6. Provide SM fiber optic cables that comply with TIA-492-CAAB OS2.
7. Provide fibers that are 100% usable.
8. Provide SM fibers that meet the optical performance requirements when tested according to TIA-455:
 - a. Provide a fiber section that has attenuation of ≤ 0.35 dB/km at 1,310 nm with a variability of ≤ 0.03 dB/km between 1,285 nm and 1,330 nm. Test according to FOTP-78-B.
 - b. Provide a fiber section attenuation of ≤ 0.02 dB/km at 1,550 nm with a variability of ≤ 0.02 dB/km between 1,525 nm and 1,575 nm. Test according to FOTP-78-8.
 - c. Provide fiber that has a mode field diameter of $9.2 \mu\text{m} \pm 0.4 \mu\text{m}$ at 1,310 nm and $10.4 \mu\text{m} \pm 0.5 \mu\text{m}$ at 1,550 nm. Test according to FOTP-191-B.
 - d. Provide fiber that has uniform attenuation with no point discontinuities > 0.05 dB

at both 1,310 nm and 1,550 nm.

9. Provide a mechanically strippable, dual-layer, UV acrylate, color-coded protective coating.

c. Fiber Optic Cable Construction

1. Provide OSP fiber optic cables with the follow in characteristics:
 - a. Provide cable suitable for underground (i.e. in conduit) installation.
 - b. Provide cable with a single jacket that is unarmored.
 - c. Provide cable with an outside diameter of no greater than one inch.
 - d. Provide all-dielectric (no metal or electrically conductive) materials.
 - e. Provide water-blocking materials that are gel-free, dry-type, non-nutritive to fungus, electrically non-conductive, and homogenous.
 - f. Provide loose tube design that is SZ-stranded around an anti-buckling central strength member.
 - g. Provide buffer tubes that contain 12 optical fibers laced inside each tube for cables 24 count and higher.
 - h. Provide fibers and buffer tubes that are color coded according to TIA-598-D.
 - i. Colors shall be stable during temperature cycling and aging.
 - ii. Colors shall not fade or smear onto each other.
2. Provide cable outer jacket or sheath meeting the following minimum requirements:
 - a. Provide a minimum medium-density polyethylene black outer jacket as defined by ASTM D1248, Type II, Class C, Category 4 or 5 and Grades J4, E7, and E8.
 - b. Provide a track-resistant polyethylene black outer jacket if the fiber optic cable is installed in an aerial application and the space potential is > 12 kV.
 - c. Provide jacket that is smooth; concentric; free from holes; consistent thickness; free of splits, blisters, and any other surface flaws; and contains carbon black to provide UV protection and prevent the growth of fungus.
 - d. Provide a method for removal of the sheath.
3. Provide labeling for the fiber optic cable meeting the following minimum requirements:
 - a. Label fiber optic cables (trunk and drop) using the following template, unless otherwise listed in the Contract:
 - i. Manufacturer's name - Optical Cable - Year -Telecommunication Handset Symbol MSCAA or as required by the RPR which may consist of XX SM or MM, where XX denotes the fiber count.
 - ii. Sequentially mark the cable length reflecting the distance from the cable origin point in English units every 2 ft (0.6 m). Cable length markings shall be within 1% of the actual length of the cable.
 - iii. Provide cable marking that is contrasting in color to the cable jacket. Marking font height shall be no less than 0.10 in (2.5 mm).
 - b. Use cable marking that meets the following minimum requirements:
 - i. Use 2.5 in (64 mm wide, 4 in (100 mm) long, wrap-around type cable markers suitable for underground and aerial use.
 - ii. Use UV-stabilized marker material and printing inks to provide an aerial durability of at least five years.
 - iii. Print text in bold black type on orange or yellow PVC markers.
 - iv. Fabricate markers from PVC base material with a minimum thickness of 0.015 in (0.38 mm).
 - v. Pre-print the following text, or alternate text shown in the Contract

documents, legibly on markers used for the cables:

Cable ID: XXXXXXXX

MSCAA

Optical Cable

Where XXXXXXXX is the cable ID as defined in the Contract documents.

- iv. Print the text specified above twice on every cable marker with the text of the second image reversed and abutting the first image so that the text "reads right" when either short edge of the cable marker is held horizontally upright.

d. Cable Performance

Provide fiber optic cable that has been tested in accordance with TIA-455 as shown in Table 1, resulting in no permanent change in attenuation, no signs of water leakage, no mechanical damage to the cable, and no adverse effects to the jacket or fibers. Provide certification from an independent testing laboratory certifying the cable conforms to the following specifications and test procedures.

Table 1: Cable Performance Testing

ID	Parameter	Test Performed	Test Condition/Specification
Testing requirements that apply to all fiber optic cables			
1	Bend Test (Low and High Temperature)	FOTP-37-A	Four full turns around mandrel of 20 times cable outer diameter at 4 hours of -22°F and +140°F (-30°C and +60°C)
2	Impact Resistance	FOTP-25-D	25 impact cycles (at 4.4 nm) at different points along the sample
3	Compressive Strength (Crush Resistance)	FOTP-41-A	125 lb/in (220 N/cm) (short)
4	Tensile and fiber Strain (Macro-bending)	FOTP-33-B	Maximum 600 lb (2,700 N) - during tensile load. Maximum 180 lb (800 N) – without tensile load.
5	Cable Twist-Bend	FOTP-85-A	10 cycles ± 180 degrees of mechanical twisting
6	Cable Cyclic Flexing	FOTP-104-B	25 times mechanical flexing cycles around a sheave of 20 times cable outer diameter
7	Temperature-Humidity Cycling	FOTP-3-B	-40°F to +158°F (-40°C to +70°C)
8	Water (Fluid) Penetration	FOTP-82-B	1 m static head for 1 hour
9	Cable Freezing	FOTP-98	Frozen on ice
Testing requirements that apply to aerial fiber optic cable			
1	High Frequency (Aeolian) Vibration	IEEE P1222	100 million vibration cycles
2	Low Frequency (Galloping) Vibration	IEEE P1222	100 ousand vibration cycles

e. Fiber Patch Cord

1. Provide the same glass type and performance requirements as the manufacturer of the backbone and drop fiber optic cable provided in the Contract.
2. Provide factory pre-assembled, riser-rated, factory-tested, pre-terminated duplex patch cords with two fibers with connectors as described in Item 101.2.03 on each end.
3. Provide patch cords that meet UL 94-V0 flammability requirements.
4. Provide lengths as listed in the Contract with a minimum of 1 ft (30 cm) slack between connected equipment.
5. Provide optical fiber within the body of fiber optic connectors that are mechanically isolated from cable tension bending, and twisting.
6. Use yellow outer jackets for SM and orange for MM fiber optic cables.
7. Use connector boots of two colors for all duplex patch cords, zip cord, or round to distinguish between the two zip legs of the duplex cord.
8. Label duplex patch cords to distinguish between the two zip legs of the duplex cord.
9. Provide protective dust caps on the connector ferrules.
10. No splices of any type shall be within a patch cord assembly.
11. Provide certification data from the manufacturer.
12. Package each assembly individually within a plastic bag and clearly mark on the outside of that bag the submitted manufacturer's part number.

f. Environmental

Provide fiber optic cables, connectors, and splice trays that meet Telcordia GR-20-CORE and ICEA S-87-640 temperature and humidity requirements.

103-2.2 Fiber Optic Components Requirement

a. Fiber Optic Splice Closure

1. House optical fiber splices within a fiber optic splice closure, complete with fiber splice trays and expressed buffer tube organizer, dome, grommets, end late, mounting hardware and bracket, cable restraint hardware, buffer tube storage, splice protection, sealant materials, and any other materials and components needed to provide a completely scaled fiber splice closure installation.
2. Provide splice closures, organizers, cable end reparation tools, and procedures that are compatible with the fiber optic cable.
3. Provide splice closures that are stand-alone.
4. Use splice closures that are either "cylindrical dome" or "rectangular dome" type with cable entries at one end only and sealed, one-piece, high-density black UV-resistant polyethylene (thermoplastic) dome bodies.
5. Provide splice closures that are designed and tested in accordance with Telcordia GR-771-CORE requirements.
6. Use only Rural Utilities Service (RUS) splice closures.
7. Provide splice closures consisting of three types depend in on the number of splices required that meet the following requirements:
 - a. Up to 48 fiber splice capacity (including both trunk and drop cable splices): determine the number and type of splice trays by the number of splices required in the Contract documents. Provide splice closures that support up to four cable entries of at least 0.75

- in (19 mm) diameter. These splice closures shall have maximum dimensions of 10 in (254 mm) diameter and 22 in (580 mm) length (smaller physical size is preferred).
- b. Greater than 48 and up to 144 fiber splice capacity (including both trunk and drop cable splices): determine the number and type of splice trays by the number of splices required in the Contract documents. Provide splice closures that support up to four cable entries of at least 1.0 in (25 mm) and at least two additional cable entries of at least 0.75 in (19 mm) diameters. These splice closures shall have maximum dimensions of 10 in (254 mm) diameter and 22 in (580 mm) length (smaller physical size is preferred).
 - c. Greater than 144 and up to 288 fiber splice capacity (including both trunk and drop cable splices): determine the number and type of splice trays shall be the number of splices required in the Contract documents. Provide splice closures that support up to four cable entries of at least 1.0 in (25 mm) and at least two additional cable entries of at least 0.75 in (19 mm) diameters. These splice closures shall have maximum dimensions of 10 in (254 mm) diameter and 28 in (711 mm) length (smaller physical size is preferred).
8. Provide splice closures that are capable of storage and expressing through all unopened buffer tubes when configured for any number of splices as specified above.
 9. Provide a flexible thermoplastic compression seal grommet for each end plate cable port that matches the required number and size of cables coming in and out of the splice closure without jeopardizing the weathertight characteristics of the splice closure.
 10. Hermetically seal closures to protect fiber, splices, and internal components from water entry, including being submerged in standing water, without the use of an encapsulate material.
 11. Provide splice closures that are sealed from insects, rodent proof, airtight, crush resistant, chemical-resistant, and corrosion resistant.
 12. Provide an external pressurization air valve or port for flash testing the splice closure.
 13. Provide fiber organizers that comply with Telcordia GR-769-CORE and splice trays that organize fiber buffers, protect fibers splices, and provide fiber and buffer slack storage.
 14. Provide splice closures that can be re-entered and resealed using no special tools.
 15. Provide reusable seal in materials (grommets, O-rings etc.) that allow multiple re-entries and closures without removal of any component and without disruption to the surrounding cables.
 16. Provide splice closures that are suitable for mounting on the inside wall of an underground buried ECB, pull box, or aerial messenger or strand as listed in the Contract documents.
 17. Use corrosion-resistant aluminum, hot-dipped steel, or stainless-steel mounting brackets and hardware.
 18. For aerial installation, provide closure that also meets the following minimum requirements:
 - a. Provide universal mounting bracket with features to permit aerial strand mounting with strand clamps or approved by the Authority.
 - b. Provide a product that is designed to eliminate the need for drip collars and sealing collars.
 - c. Package the closure with all hardware required for aerial mounting.

b. Fiber Splice Tray

1. Hold each fiber strand and buffer tube in the tray so that no stress or tensile force is placed on completed and finished fusion splices within the tray.
2. Loop individual fibers one full turn within the splice tray to avoid micro bending.
3. Maintain minimum bend radius of fiber at all times.

4. Provide slack storage for exposed fibers and buffer tubes to prevent damage to fibers.
5. Provide splice trays that include a cover with a locking mechanism to hold it in place.
6. Provide access to individual fibers without disrupting other fibers in the tray.
7. Provide fiber that is capable of being visually inspected.
8. Package and protect each fusion-spliced fiber housed within the splice tray with a minimum 1.5 in 40 mm).

c. Environmental

Provide fiber splice closures that meet Telcordia GR-771-CORE temperature and humidity requirements.

103-2.3 Pull Boxes

Provide pull box as detailed in the plans and per specification A-104.

103-2.4 Duct Banks and Conduits

Provide duct banks and conduits as detailed in the plans and per specification A-105.

103-2.5 Inner Duct

Inner ducts shall be provided in sizes as indicated on the drawings to provide cabling pathways within duct bank cells and empty conduits. Inner duct shall be smooth wall type manufactured of HDPE and with pre-installed pull tape. When a single inner duct is used in a conduit, the inner duct shall be orange in color. When multiple inner ducts are installed in a single conduit, each inner duct shall be of a different color including orange, blue, green, and yellow.

103-2.6 Counterpoise

Provide counterpoise wire as detailed in the plans.

CONSTRUCTION

The construction and installation of fiber optic cabling and components as specified herein shall meet the requirements in this section and the cable manufacturers' installation requirements and recommendations.

103-3.1 Construction Requirements

a. General Construction

1. Fiber Optic Installation Plan
 - a. Develop a fiber optic installation plan for review and approval by the RPR prior to fiber optic cable installation, splicing, and termination work. Include at a minimum the following components:
 - i. Fiber running path line route. Where not specifically shown in the Contract documents, show proposed trunk fiber and existing fiber (if any) to identify trunk to trunk fiber splice points, coordination of fiber allocation and associated splice details, and as-built drawings of the complete fiber system.

- ii. Vendor and part numbers for proposed materials and equipment (i.e., fiber optic trunk and drop cables, splice closures and splice trays, splicer equipment, fiber patch panels, connectors and other materials required or needed).
 - iii. Location of fiber drop cables and proposed splice locations.
 - iv. Location of fiber terminations.
 - v. Fiber splice details for each location, showing buffer/strand utilization and allocation plan.
2. Pack the cable and wrap in weathertight and temperature resistant covering to prevent damage during shipment, to facilitate unloading, and to allow for outdoor storage as approved by the Authority.

b. Cable Installation Guidelines

1. Before installation begins, inspect the cable reels for imperfections such as nails that might cause damage to the cable as it is unreeled.
2. When unreeled cable is placed on the pavement or surface above a manhole, provide means of preventing vehicular or pedestrian traffic through the area.
3. Comply with the manufacturer's recommended procedures and these specifications for cable handling.
4. Comply with the maximum recommended pulling tension during installation as specified by the cable manufacturer.
5. Comply with the minimum recommended bend radius during installation as specified by the cable manufacturer. Use large diameter wheels, pulling sheaves, and cable guides to maintain the bend radius. Provide tension monitoring at all times during the pulling operation.
6. Unless the manufacturer's recommendations are more stringent, use the following guidelines for minimum bend radius:
 - a. 20 times the outside cable diameter during installation
 - b. 10 times the outside cable diameter after installation
7. If a mechanical pulling machine is used, equip the machine with a monitored or recording tension meter. At no time shall the manufacturer's recommended maximum pulling tension be exceeded. Submit the method of monitoring cable stress during installation to the Authority for review and approval. The allowable pulling tension shall be the lesser of either of the two values below:
 - a. Cable manufacturer's recommended pulling tension from the outer jacket for the cable
 - b. 80% of the cable manufacturer's maximum pulling tension from the outer jacket
8. When using lubricants, comply with the cable manufacturer's recommendations for type, amount, application tools and method, and removal of the lubricant from the exposed cable. Pre-lubrication of cable is acceptable to provide uniform lubrication.
9. Use rollers and sheaves for difficult pulls to eliminate damage when entering and existing the conduit system.
10. During the installation of the fiber optic cable, record as-built fiber optic cable footage at riser locations, hand-holes, and slack storage locations.
11. Select fiber optic cable installation method that meets the following requirements:
 - a. If pulling is utilized:
 - i. Install the fiber optic cable by hand and/or by using a mechanical pulling machine.
 - ii. Attach the central strength member and aramid yarn directly to the pulling eye

during cable pulling. Use pulling attachments such as "basket grip" or "Chinese finger" type so that the optical and mechanical characteristics are not degraded during the fiber optic cable installation.

- iii. Coil excess cable in a figure eight and feed manually when pulling through pull boxes by hand.
 - iv. Provide a continuous section of cable throughout the pull. Cable breaks are permitted only at designated splice points.
- b. If air assisted/blowing is utilized:
- i. Use either the HASB method or the Piston method.
 - ii. When using the HASB method, the volume of air passing through the conduit shall not exceed 600 ft³/min or the conduit manufacturer's recommended air volume, whichever is more restrictive.
 - iii. In cold temperatures, an air dryer accessory is recommended to avoid introducing water condensation into the HASB air inlet chamber or conduit/duct system. Condensation may result in frost. In hot temperatures, an air cooler is recommended to avoid excessive temperatures at the conduit/duct and cable.
 - iv. When using the Piston method, comply with the conduit manufacturer's recommended air volume or limit to 300 ft³/min, whichever is less.

c. Cable End Sealing

1. Where a cable ends without termination in a fiber optic closure, seal the end of the cable by reusing a cable end cap shipped with a cable reel, or use a cap that is size-matched to the cable to be sealed.
2. Clean the end of the cable. Partly fill the cap with a weathertight silicone adhesive sealant and press the cap fully onto the cable end, rotating the cap to fully encapsulate the cable end with the sealant in the cap.
3. Apply a full sealant bead between the end of the cap and the cable jacket.

d. Cable Slack Storage

1. For underground applications, storage requirements shall be as are directed by contract documents.
 - a. Pull Box: Apply the following storage requirements for the indicated cable/splice closure situations.
 - i. Drop cable with no splice closure: 10 ft (3 m).
 - ii. One or more trunk cables with no splice closure: 110 ft (34 m) of each cable.
 - iii. Two or more trunk cables with one splice closure: Store 55 ft (17 m) of each trunk cable so that the splice closure can be removed from the pull box 55 ft (17 m). If a drop cable is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
 - iv. One trunk cable with one splice closure: 110 ft (34 m). Install splice closure in the center of the 110 ft (34 m) cable loop so that the splice closure can be removed from the ECB 55 ft (17 m). If a drop cable is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
 - v. One trunk cable with one splice closure and trunk cable ends: 95 ft (30 m). Install splice closure on the trunk cable at 55 ft (17 m) from the pull box. If a

- drop cable is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
- vi. Trunk cable ends with no closure: 95 ft (30 m).
- b. Electrical Communication Box (ECB): Apply the following storage requirements for the indicated cable/closure situations. More than one situation may occur in a single ECB, in which case apply each requirement.
 - i. Trunk cable with no splice closure: 110 ft (34 m).
 - ii. Trunk cable with one splice closure: 110 ft (34 m). Measure the storage amount from the top of the ECB manhole opening. Install closure in the center of the 110 ft (34 m) cable loop so that the splice closure can be removed from the ECB 55 ft (17 m). If a drop cable(s) is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
 - iii. Trunk cable with one splice closure and trunk cable ends: 95 ft (30 m). Install closure at 55 ft (17 m) from the ECB on the trunk cable. If a drop cable(s) is spliced to the trunk cable at this point, store 55 ft (17 m) of each drop cable.
 - iv. Trunk cable ends with no closure: 95 ft (30 m).
2. Unless otherwise noted in the Contract documents, the following are the minimum requirements for cable storage for aerial applications.
 - a. Install a minimum 150 ft (45 m) storage loop one-half the distance between every equipment drop or as shown in the Contract documents.
 - b. Where equipment drops are > 1,000 ft (300 m) apart install a minimum 150 ft (45 m) storage loop for every 1,000 ft (300 m) of uninterrupted cable length.

e. Cable Splicing

1. Splice together each individual reel of fiber optic cable to provide a continuous length of installed cable.
2. Splice cable only at splice points shown in the Contract documents.
3. Make no splices within a fiber patch cord assembly or fiber drop cable.
4. Use the fusion technique for splices and terminations. Use a fusion splicing machine (fusion splicer) to splice optical fiber. Mechanical splicing is not permitted.
5. Provide fusion splicing equipment supported by calibration records indicating a factory calibration within three months preceding their use.
6. Clean and calibrate fusion splicing equipment per the manufacturer's specifications, and specifically adjust the fiber and environmental conditions at the start of each splicing shift.
7. Comply with the cable manufacturer's and fusion splicer's procedures, accepted standards, codes, and practices. Do not install mechanical splices.
8. To prevent splice loss, meet the following requirements:
 - a. Splice SM optical fibers using the fusion splice method. The mean (average) splice loss shall not exceed 0.1 dB or new fiber to new fiber and 0.3 dB (per TIA-568.3-D) for new fiber to existing (legacy) fiber.
 - b. Obtain the mean splice loss by measuring the loss through the splice in both directions and then averaging the resultant values.
9. To protect splices, meet the following requirements:
 - a. Protect fusion
 - b. Provide the splice with strain relief and protection of the stripped fiber splice in a manner recommended by the splice tray or organizer manufacturer. Use splice types

- compatible with the tray design.
- c. Protect fusion splices with heat shrink tubing that protects the splice and extends over the fiber coating.
- d. Do not leave bare fiber exposed.
- e. Do not use silicone in any splice tray.

f. Connector Termination Procedures

Comply with procedures for the termination of the connectors as required by the connector manufacturer's fiber optic installation standard operating procedure for the field installation.

g. Cable Marking Installation

1. Clean the installed cable of dirt and grease before applying any marker.
2. Follow the marker manufacturer's recommended procedure for applying cable markers.
3. Mark cables in or at every hub building, ECB, pull box, hand-hole, field cabinet, aerial or underground splice closure, pole attachment, and pole conduit riser entrance.
4. At every trunk cable termination, reel end-to-reel ends splice, ECB, pull box, hand-hole, field cabinet, aerial splice closure, and aerial storage bracket, record the cable distance markings from the print-line for the cable entry and exit, along with the exact location by station number or location name.
5. Record the cable distance markings in a tabular format approved by the Authority or on a documentation form provided by the Authority.
6. Place cable markers in the following locations:
 - a. Within 18 in (450 mm) of every cable entry to a pull box, hand-hole, ECB, and hub building
 - b. Within 6 in (150 mm) of every cable entry or termination in a field cabinet
 - c. Within 18 in (450 mm) of every splice closure at cable entry points
 - d. Within 6 in (150 mm) of every FPP/FDU or splice cabinet in a hub building in which a cable terminates or enter
 - e. Every 20 ft (6 m) for the length of a cable in maintenance coils in ECBs or pull boxes,
 - f. Within 12 in (300 mm) of every pole attachment, aerial storage bracket, and pole conduit riser entrance.
7. Use orange markers at all locations, except as noted below:
 - a. Where a trunk cable enters and leaves a closure (mid-span cable entry or end-to-end splice), use orange markers for one leg of the trunk cable and yellow for the other leg, placing corresponding color labels at the closure end of a leg and at the conduit entrance (underground installation) or span attachment (aerial installation).
 - b. Where two drop cables terminate in a closure, use orange markers for one drop cable and yellow markers for the other drop cable throughout the drop cable's length to its other termination.

h. Splice Closures

1. Install waterproof fusion splice enclosures for active fibers according to manufacturer's recommendations.
2. Install splice closures where shown in the Contract documents and in the approximate center of fiber optic cable storage coils.
3. Mount splice closures in pull boxes to cable rack hooks or mounting brackets.

103-3.2 Equipment Configuration and Integration Requirements

Not Applicable.

103-3.3 Testing Requirements

a. Manufacturer's Testing

Documentation of all factory tests performed by the manufacturer for all fiber optic cable, splicing material, cable terminations, and patch panels shall be provided to the RPR.

b. Installation Testing

The RPR shall be notified of all cable testing at least 14 calendar days in advance. The testing procedures shall be submitted to the RPR for approval prior to commencement of testing. All tests shall be performed at 1,310/1,550 nanometer wavelengths and include the last calibration date of all test equipment with the test parameters set on the equipment in the test documentation. All installed fibers (terminated and unterminated) shall be tested using methods specified herein.

End-to-End Attenuation Testing

All fibers shall be tested to ensure that no discontinuities greater than 0.2 decibel per 300 feet (2.2 decibels per kilometer) exist. The Contractor shall repair or replace cable sections exceeding allowable attenuation at no cost to the Authority.

OTDR Tracing

All fibers shall be tested from both cable end points with an optical time domain reflectometer (OTDR) at wavelengths of 1310 and 1550 nm. The fibers that are not terminated at the time of installation shall be tested using a bare fiber adapter. The results of the OTDR testing (i.e., traces for each fiber) and a loss table showing details for each splice or termination tested shall be submitted to the RPR in an approved electronic format. All OTDR testing shall comply with the EIA/TIA-455-61 standard.

Splice Loss Testing

The splice loss for a SMF fusion splice shall not exceed a maximum bidirectional average of 0.1 decibel per splice. The Contractor shall repair or replace splices that exceed allowable attenuation at no cost to the Authority.

Connector Loss Testing

The attenuation in the connector at each termination panel and its associated splice shall not exceed 0.5 decibel. The Contractor shall repair or replace connectors exceeding allowable attenuation at no cost to the Authority.

103-3.4 Warranty

a. Warranty Requirements

1. Provide a minimum warranty length of two years for fiber optic cable and associated components. If the manufacturer's warranties for the components are for a longer period, those longer period warranties shall apply.

103-3.5 Pull Boxes

Provide pull box as detailed in the plans and per specification A-104.

103-3.6 Duct Banks and Conduits

Provide duct banks, conduits as detailed in the plans and per specification A-105.

103-3.7 Inner Duct

Provide MaxCell Edge inner duct or approved equal.

103-3.8 Tracer Wire.

Fiber Optic runs shall include #10 THWN stranded yellow tracer wire for locating purposes and connected in its entirety as a continuous conductor.

103-3.9 Detectable Warning Tape

Underground electrical warning tape shall be installed above all underground conduit installations not concrete encased in unpaved areas. Warning tape shall be located as shown on the plans.

METHOD OF MEASUREMENT

The fiber optic cabling that is complete, in place, accepted, and of the kind, size, and type specified will be measured as follows:

103-5.1 OSP Fiber Optic Cable Single Mode 24-Strand. Fiber optic cable shall be measured in units of actual linear feet installed and paid for at the Contract price per linear foot, including cable slack in place, completed, and accepted. The price will include the length in feet of actual cable installed and tested as measured from the cable sequential length marking cable print lines, ancillary and incidental materials, counterpoise, tracer wire, detectable warning tape, documentation, and labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in the contract documents. No separate measurement for payment will be made for innerduct installation, it shall be considered incidental to this item.

BASIS OF PAYMENT

103-5.1 Payment. Fiber optic cable will be paid at the Contract unit price per linear foot. Counterpoise, innerduct, patching, connections, terminations. This price shall be full compensation for furnishing all materials including innerduct and for all preparation, assembly, and installation of these materials including testing, and providing warranties necessary to complete the fiber optic system. Additionally, this price shall include all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications. testing, and providing warranty. This price shall be full compensation for all materials, preparation, hauling, placement, labor, equipment, tools, testing, and other incidentals necessary to complete this item(s).

Payment will be made under:

Item No. A-103-5.1 OSP Fiber Optic Cable Single Mode 144 Strand – per linear foot

END OF ITEM A-103

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Item A-104 Electrical and Communication Manholes and Junction Structures

DESCRIPTION

104-1.1 This item shall consist of electrical and communication manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the RPR. This item shall include the installation of each electrical or communication manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the RPR.

EQUIPMENT AND MATERIALS

104-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the RPR.

b. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

c. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of communications equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

104-2.2 Cast in place concrete structures. Not used.

104-2.3 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be

designed to withstand traffic loading, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans or as directed by the RPR.

Threaded inserts and pulling eyes shall be cast in as shown on the plans.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the RPR shall be submitted by the Contractor to allow for a full evaluation by the RPR. The RPR shall review per the process defined in the General Provisions.

104-2.4 Junction boxes. Not used.

104-2.5 Mortar. The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

104-2.6 Concrete mow apron. Concrete shall be proportioned, placed, and cured per state department of transportation structural concrete with a minimum 25% Type F fly ash, and a minimum allowable compressive strength of 4,000 psi.

104-2.7 Frames and covers. The frames shall conform to one of the following requirements:

- a. ASTM A48 Gray iron castings
- b. ASTM A47 Malleable iron castings
- c. ASTM A27 Steel castings
- d. ASTM A283, Grade D Structural steel for grates and frames
- e. ASTM A536 Ductile iron castings
- f. ASTM A897 Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the traffic loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word "MSCAA COMMUNICATIONS" or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a "DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

104-2.8 Ladders. Ladders, if specified, shall be galvanized steel or as shown on the plans.

104-2.9 Reinforcing steel. All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

104-2.10 Bedding/special backfill. Bedding or special backfill shall be as shown on the plans.

104-2.11 Flowable backfill. Flowable material used to backfill shall conform to the requirements of Item P-153, Controlled Low Strength Material.

104-2.12 Cable trays. Cable trays shall be of galvanized steel or nonmetallic. Cable trays shall be located as shown on the plans.

104-2.13 Plastic conduit. Plastic conduit shall comply with Item A-105, Airport Underground Communications Duct Banks and Conduits.

104-2.14 Conduit terminators. Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

104-2.15 Pulling-in irons. Pulling-in irons shall be manufactured with 7/8-inch (22 mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

104-2.16 Ground rods. Ground rods shall be one piece, copper clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet (2.4 m) long nor less than 5/8 inch (16 mm) in diameter.

CONSTRUCTION METHODS

104-3.1 Unclassified excavation. It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the RPR without additional expense to the Owner.

The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item A-104. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item A-104.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the RPR. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the RPR. Structures shall be placed after the RPR has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the RPR as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

104-3.2 Cast in place concrete structures. Not used.

104-3.3 Precast unit installations. Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

104-3.4 Placement and treatment of castings, frames and fittings. All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the RPR and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written approval is granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the RPR and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor's expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

104-3.5 Installation of ladders. Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.

104-3.6 Removal of sheeting and bracing. In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The RPR may direct the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

104-3.7 Backfilling. After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

Backfill shall not be placed against any structure until approval is given by the RPR. In the case of concrete, such approval shall not be given until tests made by the laboratory under supervision of the RPR establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the RPR may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

104-3.8 Connection of duct banks. To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

104-3.9 Grounding. A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch (100 mm) diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtailed shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

104-3.10 Cleanup and repair. After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer's recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

104-3.11 Restoration. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective Item A-104 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

104-3.12 Inspection. Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per

American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

104-3.13 Manhole elevation adjustments. The Contractor shall adjust the tops of existing manholes in areas designated in the Contract Documents to the new elevations shown. The Contractor shall be responsible for determining the exact height adjustment required to raise or lower the top of each manhole to the new elevations. The existing top elevation of each manhole to be adjusted shall be determined in the field and subtracted/added from the proposed top elevation.

The Contractor shall remove/extend the existing top section or ring and cover on the manhole structure or manhole access. The Contractor shall install precast concrete sections or grade rings of the required dimensions to adjust the manhole top to the new proposed elevation or shall cut the existing manhole walls to shorten the existing structure, as required by final grades. The Contractor shall reinstall the manhole top section or ring and cover on top and check the new top elevation.

The Contractor shall construct a concrete slab around the top of adjusted structures located in graded areas that are not to be paved. The concrete slab shall conform to the dimensions shown on the plans.

104-3.14 Duct extension to existing ducts. Where existing concrete encased ducts are to be extended, the duct extension shall be concrete encased plastic conduit. The fittings to connect the ducts together shall be standard manufactured connectors designed and approved for the purpose. The duct extensions shall be installed according to the concrete encased duct detail and as shown on the plans.

METHOD OF MEASUREMENT

104-4.1 Electrical and communications manholes and junction structures shall be measured by each unit completed in place and accepted. The following items shall be included in the price of each unit: All required excavation and dewatering; sheeting and bracing; mow apron installation, all required backfilling with on-site materials; restoration of all surfaces and finished grading and turfing; all required connections; temporary cables and connections, and ground rod testing

BASIS OF PAYMENT

104-5.1 The accepted quantity of electrical and communications manholes and junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials including mow apron, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

- | | |
|----------------|---|
| Item A-104-5.1 | Traffic Rated Fiber Optic Pull Box – per each |
| Item A-104-5.2 | Traffic Rated Electrical Pull Box – per each |

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/IEEE STD 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

Advisory Circular (AC)

AC 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits

AC 150/5345-26 Specification for L-823 Plug and Receptacle, Cable Connectors

AC 150/5345-42 Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories

AC 150/5340-30 Design and Installation Details for Airport Visual Aids

AC 150/5345-53 Airport Lighting Equipment Certification Program

Commercial Item Description (CID)

A-A 59544 Cable and Wire, Electrical (Power, Fixed Installation)

ASTM International (ASTM)

ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application

ASTM A47 Standard Specification for Ferritic Malleable Iron Castings

ASTM A48 Standard Specification for Gray Iron Castings

ASTM A123 Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products

ASTM A283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A536 Standard Specification for Ductile Iron Castings

ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A897 Standard Specification for Austempered Ductile Iron Castings

ASTM C144 Standard Specification for Aggregate for Masonry Mortar

ASTM C150 Standard Specification for Portland Cement

ASTM C206 Standard Specification for Finishing Hydrated Lime

FAA Engineering Brief (EB)

EB #83 In Pavement Light Fixture Bolts

Mil Spec

MIL-P-21035 Paint High Zinc Dust Content, Galvanizing Repair

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

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