

**ATTACHMENT B – REQUIREMENTS FOR COMMUNICATIONS INSTALLATION  
VA256-13-R-1853**

**SECTION 27 05 11**

**REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.

B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

**1.2 MINIMUM REQUIREMENTS**

A. References to industry and trade association standards and codes are minimum installation requirement standards.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

**1.3 QUALIFICATIONS (PRODUCTS AND SERVICES)**

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:

1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.

2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

**1.4 MANUFACTURED PRODUCTS**

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.

2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

3. Components shall be compatible with each other and with the total assembly for the intended service.

4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

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### **E. When Factory Testing Is Specified:**

1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
2. Four copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

### **1.5 EQUIPMENT REQUIREMENTS**

Where variations from the contract requirements are requested in accordance with Section 00 72 00, GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

### **1.6 EQUIPMENT PROTECTION**

A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:

1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
2. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

### **1.7 WORK PERFORMANCE**

- A. Job site safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences. See Section 00 72 00, GENERAL CONDITIONS.

### **1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.

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B. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

**1.9 EQUIPMENT IDENTIFICATION**

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

**1.10 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
  1. Mark the submittals, "SUBMITTED UNDER SECTION \_\_\_\_\_".
  2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  3. Submit each section separately.
- E. The submittals shall include the following:
  1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
  2. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
  1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified

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in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.

2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.

3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.

4. The manuals shall include:

- a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
- b. A control sequence describing start-up, operation, and shutdown.

- c. Description of the function of each principal item of equipment.

- d. Installation and maintenance instructions.

- e. Safety precautions.

- f. Diagrams and illustrations.

- g. Testing methods.

- h. Performance data.

- i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.

- j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:

- 1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.

- 2. Each type of conduit and pathway coupling, bushing and termination fitting.

- 3. Raceway and pathway hangers, clamps and supports.

- 4. Duct sealing compound.

I. In addition to the requirement of SUBMITTALS, the VA reserves the right to request the manufacturer to arrange for a VA representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

**1.11 SINGULAR NUMBER**

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are

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required to complete the installation as shown on the drawings.

**1.12 TRAINING**

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Resident Engineer at least 30 days prior to the planned training.

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**SECTION 27 05 26**

**GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

**1.2 RELATED WORK**

- A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 27.
- B. Section 27 11 10, VOICE AND DIGITAL TELECOMMUNICATION DISTRIBUTION CABLE EQUIPMENT AND SYSTEMS.
- C. Section 26 41 00, FACILITY LIGHTNING PROTECTION: Requirements for a lightning protection system.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
  - 1. Certification that the materials and installation is in accordance with the drawings and specifications.
  - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

**1.4 APPLICABLE PUBLICATIONS**

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Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Society for Testing and Materials (ASTM):
  - B1-2001.....Standard Specification for Hard-Drawn Copper Wire
  - B8-2004.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
  - 70-2005.....National Electrical Code (NEC)
- D. Telecommunications Industry Association, (TIA)
  - J-STO-607-A-2002.....Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- E. Underwriters Laboratories, Inc. (UL):
  - 44-2005 .....Thermoset-Insulated Wires and Cables
  - 83-2003 .....Thermoplastic-Insulated Wires and Cables
  - 467-2004 .....Grounding and Bonding Equipment
  - 486A-486B-2003 .....Wire Connectors

### **PART 2 - PRODUCTS**

#### **2.1 GROUNDING AND BONDING CONDUCTORS**

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm<sup>2</sup> (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm<sup>2</sup> (4 AWG) and larger shall be permitted to be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm<sup>2</sup> (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.
- C. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 50mm<sup>2</sup> (1/0 AWG) insulated stranded copper grounding conductor unless indicated otherwise.

#### **2.2 SPLICES AND TERMINATION COMPONENTS**

Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

#### **2.3 TELECOMMUNICATION SYSTEM GROUND BUSBARS**

- A. Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as follows:
  - 1. Room Signal Grounding: 300 mm x 100 mm (12 inches x 4 inch).
  - 2. Master Signal Ground: 600 mm x 100 mm (24 inches x 4 inch).

#### **2.4 GROUND CONNECTIONS**

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
  - 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.

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2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

#### **2.5 EQUIPMENT RACK AND CABINET GROUND BARS**

Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x ¾ inch).

#### **2.6 GROUND TERMINAL BLOCKS**

At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

#### **2.7 SPLICE CASE GROUND ACCESSORIES**

Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm<sup>2</sup> (6 AWG) insulated ground wire with shield bonding connectors.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

#### **3.2 INACCESSIBLE GROUNDING CONNECTIONS**

Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

#### **3.3 CORROSION INHIBITORS**

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

#### **3.4 TELECOMMUNICATIONS SYSTEM**

- A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.
- B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
- D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milli ohms or less.
- E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use

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exothermic welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Resident Engineer prior to backfilling any ground connections.

F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.

G. Bonding Jumpers:

1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm<sup>2</sup> (6 AWG) insulated copper wire.
2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.

H. Bonding Jumper Fasteners:

1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

### **3.5 COMMUNICATION ROOM GROUNDING**

A. Telecommunications Ground Busbars:

1. Provide communications room telecommunications ground busbar hardware at 950 mm (18 inches) at locations indicated on the Drawings.
2. Connect the telecommunications room ground busbars to other room grounding busbars as indicated on the Grounding Riser diagram.

B. Telephone-Type Cable Rack Systems: aluminum pan installed on Telephonetype cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:

1. Install a 16 mm<sup>2</sup> (6 AWG) bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
2. Use 16 mm<sup>2</sup> (6 AWG) bonding jumpers across aluminum pan junctions.

C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:

1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using



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- solid copper splice plates supplied by the ground bar manufacturer.
2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm<sup>2</sup> (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
  3. Provide a 16 mm<sup>2</sup> (6 AWG) bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.
- D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm<sup>2</sup> (16 AWG) bonding jumper.
- E. Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 16 mm<sup>2</sup> (6 AWG) ground wire bonding jumpers.

**3.6 COMMUNICATIONS CABLE GROUNDING**

- A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
  2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

**3.7 COMMUNICATIONS CABLE TRAY SYSTEMS:**

- A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:
1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one splice plate connection in the presence of the Contractor.
  2. Install a 16 mm<sup>2</sup> (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.
  3. When cable tray terminations to cable rack, install 16 mm<sup>2</sup> (6 AWG) bonding jumper between cable tray and cable rank pan.

**3.8 COMMUNICATIONS RACEWAY GROUNDING**

- A. Conduit: Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic

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enclosures.

B. Wireway: use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground or Bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.

C. Cable Tray Systems: Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).

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**SECTION 27 05 33**

**RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all communications cabling unless shown or specified otherwise.

B. Definitions: The term conduit, as used in this specification, shall Mean any or all of the raceway types specified.

**1.2 RELATED WORK**

A. Bedding of conduits: Section 31 20 00, EARTH MOVING.

B. Mounting board for communication closets: Section 06 10 00, ROUGH CARPENTRY.

C. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.

D. Fabrications for the deflection of water away from the building Envelope at penetrations: Section 07 60 00, FLASHING AND SHEET METAL.

E. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building: Section 07 92 00, JOINT SEALANTS.

F. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.

G. General electrical requirements and items that is common to more than one section of Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

H. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

**1.3 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

A. Shop Drawings:

1. Size and location of panels and pull boxes

2. Layout of required conduit penetrations through structural elements.

3. The specific item proposed and its area of application shall be identified on the catalog cuts.

B. Certification: Prior to final inspection, deliver to the Resident Engineer four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

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**1.4 APPLICABLE PUBLICATIONS**

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. National Fire Protection Association (NFPA):

70-05.....National Electrical Code (NEC)

C. Underwriters Laboratories, Inc. (UL):

1-03.....Flexible Metal Conduit

5-01.....Surface Metal Raceway and Fittings

6-03.....Rigid Metal Conduit

50-03.....Enclosures for Electrical Equipment

360-03.....Liquid-Tight Flexible Steel Conduit

467-01.....Grounding and Bonding Equipment

514A-01.....Metallic Outlet Boxes

514B-02.....Fittings for Cable and Conduit

514C-05.....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers

651-02.....Schedule 40 and 80 Rigid PVC Conduit

651A-03.....Type EB and A Rigid PVC Conduit and HDPE Conduit

797-03.....Electrical Metallic Tubing

1242-00.....Intermediate Metal Conduit

D. National Electrical Manufacturers Association (NEMA):

TC-3-04.....PVC Fittings for Use with Rigid PVC Conduit and Tubing

FB1-03.....Fittings, Cast Metal Boxes and Conduit Bodies  
for Conduit, Electrical Metallic Tubing and Cable

**PART 2 - PRODUCTS**

**2.1 MATERIAL**

A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown. Where permitted by the NEC, 13 mm (1/2 inch) flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:

1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.

2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.

3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.

4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.

5. Flexible galvanized steel conduit: Shall Conform to UL 1.

6. Liquid-tight flexible metal conduit: Shall Conform to UL 360.

7. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

8. Surface metal raceway: Shall Conform to UL 5.

C. Conduit Fittings:

1. Rigid steel and IMC conduit fittings:

a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.

b. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral

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- retractable type IMC couplings are also acceptable.
- c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
- d. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
- e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
- f. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- 2. Electrical metallic tubing fittings:
  - a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  - b. Only steel or malleable iron materials are acceptable.
  - c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
  - d. Indent type connectors or couplings are prohibited.
  - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- 3. Flexible steel conduit fittings:
  - a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
  - b. Clamp type, with insulated throat.
- 4. Liquid-tight flexible metal conduit fittings:
  - a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  - b. Only steel or malleable iron materials are acceptable.
  - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 5. Direct burial plastic conduit fittings:
  - a. Fittings shall meet the requirements of UL 514C and NEMA TC3.
  - b. As recommended by the conduit manufacturer.
- 6. Surface metal raceway fittings: As recommended by the raceway manufacturer.
- 7. Expansion and deflection couplings:
  - a. Conform to UL 467 and UL 514B.
  - b. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

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- c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
- d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
  - 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
  - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
  - 3. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
  - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
  - 1. UL-50 and UL-514A.
  - 2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
  - 3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
  - 4. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.
- G. Warning Tape: Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters, and imprinted with "CAUTION BURIED COMMUNICATIONS CABLE BELOW"

**PART 3 - EXECUTION**

**3.1 PENETRATIONS**

- A. Cutting or Holes:
  - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Resident Engineer prior to drilling through structural sections.
  - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Resident Engineer as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as

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specified in Section 07 92 00, JOINT SEALANTS.

**3.2 INSTALLATION, GENERAL**

**A. Install conduit as follows:**

1. In complete runs before pulling in cables or wires.
2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
5. Mechanically continuous.
6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough-in Stage to prevent entry of debris, until wires are pulled in.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
12. Unless otherwise indicated on the drawings or specified herein, All conduits shall be installed concealed within finished walls, floors and ceilings.

**B. Conduit Bends:**

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

**C. Layout and Homeruns:**

Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Resident Engineer.

**3.3 CONCEALED WORK INSTALLATION**

**A. In Concrete:**

1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only when the following occurs:
  - a. Where shown on the structural drawings.
  - b. As approved by the Resident Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.

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- a. Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
- b. Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
- c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (3/4 inch) of concrete around the conduits.
- 5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.
- B. Furred or Suspended Ceilings and in Walls:
  - 1. Conduit for conductors above 600 volts:
    - a. Rigid steel or rigid aluminum.
    - b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
  - 2. Conduit for conductors 600 volts and below:
    - a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
  - 3. Align and run conduit parallel or perpendicular to the building lines.
  - 4. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
  - 5. Tightening set screws with pliers is prohibited.

**3.4 EXPOSED WORK INSTALLATION**

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for conductors above 600 volts:
  - 1. Rigid steel or rigid aluminum.
  - 2. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
- C. Conduit for Conductors 600 volts and below:
  - 1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- D. Align and run conduit parallel or perpendicular to the building lines.
- E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- F. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- G. Surface metal raceways: Use only where shown.
- H. Painting:
  - 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
  - 2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (two inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

**3.5 EXPANSION JOINTS**

- A. Conduits 75 mm (3 inches) and larger, that are secured to the building

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structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.

C. Install expansion and deflection couplings where shown.

D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

**3.6 CONDUIT SUPPORTS, INSTALLATION**

A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.

2. Existing Construction:

a. Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.

b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).

c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts are permitted.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.

L. Vertical Supports: Vertical conduit runs shall have riser clamps and



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supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

#### **3.7 BOX INSTALLATION**

- A. Boxes for Concealed Conduits:
  - 1. Flush mounted.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Stencil or install phenolic nameplates on covers of the boxes Identified on riser diagrams; for example "SIG-FA JB No. 1".

#### **3.11 COMMUNICATION SYSTEM CONDUIT**

- A. Install the communication raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings
- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.
- F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- G. Where drilling is necessary for vertical conduits, locate holes so as Not to affect structural sections such as ribs or beams.
- H. All empty conduits located in communication closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- I. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

Sizes of Conduit	Radius of Conduit Bends
Trade Size	mm, Inches
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

- J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in Section 06 10 00, ROUGH CARPENTRY on the wall of

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communication closets where shown on drawings . Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.

K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).

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**SECTION 27 11 10**

**VOICE AND DIGITAL TELECOMMUNICATION DISTRIBUTION CABLE EQUIPMENT AND SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. This Section specifies the furnishing, installing, certification, testing, and guaranty of a complete and operating Voice and Digital Cable Distribution System (here-in-after referred to as "*the system*"), and associated equipment and hardware to be installed in the VA Medical Center here-in-after referred to as "*the Facility*". The system shall include, but not be limited to: interface enclosures, and relay racks; necessary combiners, outside plant cabling, fiber optic and copper backbone and horizontal station cabling; and necessary passive devices such as: splitters, couplers, cable "patch", "punch down", and crossconnector blocks or devices, voice and digital distribution sub-systems, and associated hardware.

**1.2 RELATED WORK**

- A. SECTION 01 33 23
- B. SECTION 26 05 11
- C. SECTION 27 05 33
- D. SECTION 26 27 26
- E. SECTION 27 05 26

**1.3 QUALITY ASSURANCE**

A. The Contractor shall show written proof of contractual relationship or technical certification by the OEM, and shall be authorized by the OEM to pass through the OEM's certification and equipment warranty to VA. Additionally, the OEM and Contractor shall accept complete responsibility for the design installation, certification, and support for the system. The Contractor, including all subcontractors (if any) shall have a MIN proven three year track record for LEC and FTS coordination, EPBXs and associated equipment, data networks, cabling projects involving UTP Category 6 service certification, optical fiber, and analog cable telecommunication distribution systems. This record, along with the Contractor/OEM certifications must be provided in writing as a part of the Contractor's technical submittal.

**1.4 SUBMITTALS**

- A. Manufacturers Literature
- B. Samples: TCO Wall Outlet Box w/ cover plate. CAT 6 cable.
- C. As-Built Drawings

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only. Except for a specific date given the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date the system's submittal is technically approved by VA, shall be enforced.
- B. JOINT COMMISSION ON ACCREDITATION OF HEALTH CARE ORGANIZATION (JCAHO) comprehensive Accreditation Manual for Hospitals
- C. NATIONAL AND LOCAL LIFE SAFETY CODES(S)  
The more stringent of each listed code
- D. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

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1. No. 69: National Electrical Safety Code
  2. No. 70: National Electrical Code (NEC)
  3. No. 75: Protection of Electronic Computer/Data Processing Equipment
  4. No. 77: Static Electricity
  5. No. 99: Standard for Health Care Facilities
  6. No. 101: Life Safety Code
  7. No. 1221: Public Fire Service Communication Systems
- E. UNDERWRITERS LABORATORIES, INC. (UL) STANDARD FOR SAFETY PUBLICATIONS
1. All supplies and materials shall be listed, labeled, or certified by UL or a nationally recognized testing laboratory where such standards have been established for the supplies, materials, or equipment. See paragraph MIN Requirements Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL) and the guidelines listed in Paragraph 1.2.
  2. The active electronic and passive distribution equipment required by the OEM's and Contractor's system design and approved technical submittal must conform with each UL standard in effect for the equipment with appropriate label (s) affixed to each item of system equipment, as of the date of the technical submittal was issued. Where a UL standard is in existence for equipment to be used in completion of this contract, a test must be conducted to certify the equipment meets the UL standard. This test must be conducted by UL, which makes periodic inspections of the production of equipment. The Contractor shall provide, with the technical submittal, certification and listing documents supplied by UL or the testing laboratory for each piece of equipment to be furnished for this project, that indicate the items conform to UL standards, where such standards exist.
  3. The Following are the MIN UL Requirements for the System:
    - a. No. 65: Wired Cabinets
    - b. No. 96: Lightning Protection Components
    - c. No. 96A: Installation Requirements for Lightning Protection System
    - d. No. 467: Grounding and Bonding Equipment
    - e. No. 497/497A/497B: Protectors for Paired Conductors/Communications Circuits/Data Circuits
    - f. No. 884: Under Floor Raceways and Fittings
    - g. No. 1198: Distress Signaling
    - h. No. 1459: Telephone Equipment
- F. ANSI/EIA/TIA PUBLICATIONS
1. TIA-568-1: Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
  2. TIA-568-2: Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components.
  3. TIA-568-3: Optical Cabling Components Standard
  4. TIA-569: Commercial Building Standard for Telecommunications Pathways and Spaces
  5. TIA-598: Optical Fiber Cable Color Coding
  6. TIA/EIA-606: Administration Standard for Commercial Telecommunications Infrastructure
  7. J-STD-607: Commercial Building Grounding (Earthing)

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- and Bonding Requirements for Telecommunications
- 8. TIA-758: Customer-owned Outside Plant Telecommunications Infrastructure Standard
- 9. TIA-526-7: Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant OFSTP-7
- 10. TIA-526-14: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant OFSTP-14
- G. AMERICAN TELEPHONE AND TELEGRAPH COMPANY  
Document 900-200-318 Outside Plant Systems Engineering Handbook
- H. CONSULTATIVE COMMITTEE FOR INTERNATIONAL TELEPHONE AND TELEGRAPH (CCITT)
  - 1. Standard for asynchronous dial-up communications at the speed given.
  - 2. Standard for asynchronous dial-up communications.
- I. FEDERAL INFORMATION PROCESSING STANDARDS (FIPPS) PUBLICATIONS
- J. FEDERAL COMMUNICATIONS COMMISSION (FCC) PUBLICATIONS  
Standards for telephone equipment and systems.
- K. UNITED STATES AIR FORCE  
Technical Order 33K-I-100 Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide
- L. COMMERCIAL STANDARDS
  - 1. ISBN 0-13-083379-7 (025): Broadband Network Technology
  - 2. ISBN 0-02-415431-8: Business Data Communications
  - 3. ISBN 0-13-083387-8: Broadband Coding, Modulation, And Transmission Engineering
- M. BICSI - Telecommunications Distribution Methods Manual.

**PART 2 - PRODUCTS**

**2.1 EQUIPMENT AND MATERIALS**

- A. General. All equipment to be supplied under this specification shall be new and the current model of a standard product of an OEM or record.
- B. Product Delivery, Storage and Handling
  - 1. Delivery: Deliver materials to the job site in OEM's original unopened containers clearly labeled with the OEM's name and equipment model and serial identification numbers. The RE may inventory equipment.
  - 2. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the RE.
- C. Equipment Standards and Testing
  - 1. The system has been defined herein as connected to systems identified as Health Care Support Functions. Therefore, at a MIN, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.

**2.2 OUTSIDE PLANT TELEPHONE SYSTEM COPPER CABLING**

- A. Cables:
  - 1. Quantity of pairs as indicated on the Drawings.
  - 2. Provide cables suitable for installation in underground conduits.
  - 3. 22 AWG solid copper.
  - 4. Color coded foam-skin insulation meeting telephone industry

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standards.

5. Pairs assembled into 25 pair groups with unique identifiers.
  6. Expanded thermal plastic rubber filling compound.
  7. Aluminum shield.
  8. Flooding compound sealing the shield interfaces against water entering the cable.
  9. Black polyethylene jacket with periodic identification of:
    - a. Product code number.
    - b. Pair size
    - c. Date
    - d. Length
- B. Building Entrance Protector:
1. Pair capacity equal to the cable pairs entering the building.
  2. Internal splice chamber.
  3. 110 type connector blocks on input and output.
  4. Grounding lug for #6 AWG ground wire.
  5. Protector modules:
    - a. Five pin
    - b. Solid state type.
    - c. Self resetting current limiters for sneak current protection.
    - d. Coordinate voltage with equipment being served.

**2.3 OUTSIDE PLANT FIBER OPTIC CABLING SYSTEM**

- A. Fiber Optic Cables:
1. General:
    - a. Strand types and quantities as indicated on the Drawings.
    - b. Provide cables suitable for installation in underground conduits and innerducts.
    - c. Provide cables which maintain optical transmission reliability in excess of 20 years.
    - d. Provide cables which exhibit stable performance subjected to building environmental fluctuations and which resist aging including micro cracking and yellowing of the fiber coating material.
    - e. Dielectric strength element.
    - f. Minimum rated short term tensile load 200 lbs.
    - g. Minimum rated long term tensile load 100 lbs.
    - h. Minimum bending radius:
      1. 20 times diameter during installation.
      2. 10 times diameter after installation.
- B. Indoor/Outdoor plenum rated type:
1. Color coded loose tube fibers.
  2. Coating diameter 250  $\mu\text{m}$ .
  3. Dry water blocking system.
  4. OFNP fire resistance listing.
- C. Singlemode fiber:
1. Core diameter 8.3  $\mu\text{m}$ .
  2. Cladding diameter 125  $\mu\text{m}$ .
  3. Maximum attenuation:
    - a. 1.0 dB/km at 1310 nm.
    - b. 0.75 dB/km at 1550 nm.
- D. Multimode fiber:

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1. Core diameter 62.5  $\mu\text{m}$ .
2. Cladding diameter 125  $\mu\text{m}$ .
3. Minimum bandwidth:
  - a. 200 MHz km at 850 nm.
  - b. 500 MHz km at 1300 nm.
4. Maximum attenuation:
  - a. 3.5 dB/km at 850 nm.
  - b. 1.0 dB/km at 1300 nm.
- E. Loose Tube Fiber Optic Break Out Kits:
  1. Provide break out kits for loose tube fiber strands.
  2. Color coded buffer tubes.
- F. Rack Mounted Enclosures
  1. Shall be Leviton Opt-x 1000 rack mount enclosures or equal. Enclosures shall be provided with 12 ST connectors for termination of 12 multimode fibers or 12 ST connectors for termination of 12 single mode fibers.
  2. Fiber optic jumpers will be provided by others.
- G. Fiber Optic Connectors:
  1. General:
    - a. Ceramic ferrule.
    - b. Epoxy connected.
  2. Singlemode:
    - a. ST type
    - b. Maximum connector loss of 0.30 dB at 1310 or 1550 nm.
    - c. Maximum 0.20 dB insertion loss increase at 1310 or 1550 nm after 1000 matings.
    - d. Minimum return loss of 20 dB.
  3. Multimode:
    - a. ST type
    - b. Maximum connector loss of 0.30 dB at 850 or 1300 nm.
    - c. Maximum 0.20 dB insertion loss increase at 850 or 1300 nm after 1000 matings.
    - d. Minimum return loss of 20 dB.
- H. Flexible Innerduct
  1. Acceptable manufacturer: Carlon or approved equal.
  2. General:
    - a. Provide flexible HDPE innerducts for fiber runs throughout the building from building termination to communication closet rack.
    - b. Provide flexible HDPE innerducts in ducts and conduits as indicated on the Drawings.
- I. Completed fiber optic cable plant must pass testing to the following TIA-568-C.3 standards
  - 0.75 dB maximum loss for each mated pair of connectors
  - 0.3 dB maximum loss for each splice
  - 3.5 dB/km loss for multimode fiber at 850nm
  - 1.5 dB/km loss for multimode fiber at 1300nm
  - 1.0 dB/km loss for singlemode fiber in indoor cable (both wavelengths)
  - 0.5 dB/km loss for singlemode fiber in outdoor cable (both wavelengths)
  - TIA-568-C.0 requires testing each link in only a single direction.

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**2.4 DISTRIBUTION EQUIPMENT AND SYSTEMS**

A. Distribution Cables. Each cable shall meet or exceed the following specifications for the specific type of cable. Each cable reel shall be sweep tested and certified by the OEM by tags affixed to each reel. The Contractor shall turn over all sweep tags to the RE or FACILITY Contracting Officer. Additionally, the Contractor shall provide a 2' sample of each provided cable, to the RE and receive approval before installation. Cables installed in any outside location (i.e. above ground, under ground in conduit, ducts, pathways, etc.) shall be filled with a waterproofing compound between outside jacket (not immediately touching any provided armor) and inter conductors to seal punctures in the jacket and protect the conductors from moisture.

1. Telephone

a. The system cable shall be provided by the Contractor to meet the MIN system requirements of **Category 5e service**. The cable shall interconnect each part of the system. The cable shall be completely survivable in areas where it is installed.

b. Technical Characteristics

Length	As required, in 1K reels MIN
Cable	Voice grade <b>category 5e</b>
Connectors	As required by system design
Size	22 AWG, MIN, Outside 24 AWG, MIN, Inside
Color Coding	2-White
Bend radius	10X the cable outside diameter
Impedance	120 Ohms +/- 15%, BAL
Shield Coverage	As required by OEM specs

**Attenuation**

<b>Frequency in mHz</b>	<b>dB per 1,000' , MAX</b>
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
62.0	52.0
100.0	68.0

2. Data Multiconductor

a. The cable shall be multi-conductor, unshielded cable with stranded conductors. The cable shall be able to handle the power and voltage used over the distance required. It shall meet **Category 6 service** at a MIN.

b. Technical Characteristics

**Standards Compliance ISO/IEC 11801 TIA/EIA-568-B.2-1**

**Conductor**

**Size 23AWG x 4pairs**

**Construction Solid Bare Copper**



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Conductor Diameter 1.0 / 0.570±0.008mm

Insulation

Ave. Thick. 0.178mm

Min. Thick 0.153mm

Diameter 1.00±0.01mm

Material HDPE

Color Codes

1. Orange x White/Orange

2. Blue x White/Blue

3. Brown x White/Brown

4. Green x White/Green

Jacket

Ave. Thick 0.58mm

Min. Thick 0.46mm

Diameter 20±0.20mm

Material PVC

Electrical & Physical Properties

Item 23AWG x 4pairs

Rating 75°C, 300V

Conductor Resistance 89.2Ω/km/20°C max

Mutual Capacitance 56pF/m max

Dielectric Strength AC 1.5kV/min

Spark Test 2.5kV

Flame Retardant Test CM

Characteristic Impedance 100±15Ω @ 1 ~ 550MHz

Structural Return Loss 8.6dB min at 550MHz

Propagation Delay 536nS/100m max @ 550MHz

Delay Skew 30nS/100m max at 1 ~ 550MHz

**Cat6 Cable must be tested to exceed the following standards  
Frequency at 100 MHz**

**Attenuation aka Insertion Loss (Min@100MHz) Cat6 - 19.8 dB**

**Characteristic Impedance Cat6 - 100 ohms ± 15%**

**NEXT (Min. at 100 MHz) Cat6 - 44.3 dB**

**PSNEXT (Min. at 100 MHz) Cat6 - 42.3 dB**

**ELFEXT (Min. at 100 MHz) Cat6 - 27.8 dB**

**PSELFEXT (Min. at 100 MHz) Cat6 - 24.8 dB**

**Return Loss (Min. at 100 MHz)**

**Cat6 - 20.1 dB**

**Delay Skew (Max. per 100 m)**

**Cat6 - 45 nS**

B. Patch Panels shall be Leviton eXtreme 106 QuickPort or equal.

C. Racks will not be filled more than halfway with patch panels.

Additional racks will be added if additional patch panels are required.

D. Telecommunication Outlet (TCO)

1. The TCO shall consist of two telephone multipin jack and two data multi pin jacks mounted in a steel outlet box. A 4" x 4" x 2.5" steel outlet box with labeled stainless steel cover plate will be used.

2. All telephone multipin connections shall be RJ-45/11 compatible female types. All data multipin connections shall be RJ-45 female

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types.

3. The TCO shall be fed from the appropriate CCS located in the respective TC in a manner to acquire a uniform and balanced distribution system.
4. Interface of the data multi pin jacks to appropriate patch panels (or approved "punch down" blocks) in the associated TC, is the responsibility of the Contractor.
5. The wall outlet shall be provided with a UL approved grey cyclac plastic cover plate to fit the telephone multipin jack, data multi pin jacks and the outlet box provided (4" x 4" for single and 4" x 8" for dual outlet box applications).

**2.5 LABELING**

- A. Provide a complete labeling system for all cables, verify exact nomenclature and termination at both ends with owner.
- B. Provide permanent cable labels that are neat and legible.

**PART 3 – EXECUTION**

**3.1 INSTALLATION**

- A. System Installation.
  1. After award of contract, and within the time period specified in the contract, the Contractor shall deliver the total system in a manner that fully complies with the requirements of this specification. The Contractor shall make no substitutions or changes in the system without written approval from the RE and PM.
  2. The Contractor shall install all equipment and systems in a manner that complies with accepted industry standards of good practice, OEM instructions, the requirements of this specification, and in a manner which does not constitute a safety hazard. The Contractor shall insure that all installation personnel understands and complies with all the requirements of this specification.
- B. Conduit, Cables and Wiring, Cable Tray, Raceways, Etc.
  1. General
    - a. The Contractor shall employ the latest installation practices and materials.
    - b. All cables shall be installed in conduit and/or cable tray. Conduits shall be in accordance with Section 27 05 33, Raceways and Boxes for Communication Systems.
    - c. Cable runs shall be splice free.
    - d. Cables shall be installed and fastened without causing sharp bends (10 times diameter after installation) or rubbing of the cables against sharp edges. Cables shall be fastened with hardware that will not damage or distort them.
    - e. Cables shall be labeled with permanent markers at the terminals of the electronic and passive equipment. The lettering on the cables shall correspond with the lettering on the as installed diagrams.
    - f. Cable shall be grouped and shall not change position throughout the cable run.
    - g. Completely test all of the cables after installation and replace any defective cables.
    - h. Wiring scheme used for cat 6/5e cabling shall be 568 B.
  2. Conduits
    - a. The Contractor shall provide conduit, junction boxes, connectors,

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- sleeves, weatherheads, pitch pockets, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed.
- b. Conduit (including GFE) fill shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit.
3. Distribution System Signal Wires and Cables
- a. Wires and cables shall be able to withstand any adverse environmental conditions in their respective location without deterioration. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels shall open and close without removing or disturbing the wires and cables.
- b. Each wire and cable shall terminate on an item of equipment by direct connection. Spare or unused wire and cable shall be provided with appropriate connectors (female types) that are installed in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.
- c. Routing and Interconnection
- (1) Wires or cables between consoles, cabinets, racks and other equipment shall be in conduit, wireway, raceway, innerduct, or cable trays that are secured to solid building structures. The Contractor shall enforce strict adherence to NEC Article 517, NFPA 99, and 101 standards for isolation and separation of all parts of the emergency systems.
- (2) Wires and cables shall be insulated to prevent contact with signal or current carrying conductors. Wires or cables used in assembling consoles, panels, equipment cabinets and racks shall be formed into harnesses that are TIED supported. Harnessed wires or cables shall be combed straight, formed and dressed in either a vertical or horizontal relationship to equipment, components or terminations.
- (3) Harnesses with intertwined members are not acceptable. Each wire or cable that breaks out from a harness for connection or termination shall have a TIED provided at that harness or bundle point, and be provided with a 10 foot minimum neatly formed service loop.
- (4) Wires and cables shall be grouped according to service. Wires and cables shall be neatly formed and shall not change position in the group throughout the conduit run. Wires and cables in cable ducts, trays, or wireways shall be neatly formed, bundled, TIED in 20 to 30 inch lengths and shall not change position in the group throughout the run. Concealed splices are not allowed.
- C. Outlet Boxes and Faceplates
1. Outlet Boxes. The Contractor as required by the system design, onsite inspection, review and verification of the contract drawings shall provide signal, power, interface, connection, distribution and junction boxes.
2. Faceplates (Or Cover Plates). Faceplates shall be of a standard type, MIN stainless steel construction and provided by the Contractor

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for each identified system outlet location. Connectors and jacks appearing on the faceplate shall be clearly and permanently marked. Audio, voice, data send or receive, microphone, and control cable ground connections shall be isolated from the faceplate.

D. Connectors. Circuits, transmission lines, and signal extensions shall have continuity, correct connection and polarity. A uniform polarity shall be maintained between all points in the system. Each connector shall be designed for the specific size cable being used and installed with the OEM's approved installation tool. Typical system cable connectors include; but, are not limited to: Audio spade lug, punch block, "F", "UHF", "N", "BNC", "KS", "XL", "RCA" and "ST".

E. Cables

1. Telephone Copper Cabling System:

a. Cable:

- (1) Install per the manufacturer's published installation instructions.
- (2) Install in conduits as indicated on the Drawings.
- (3) Terminate all cable pairs at the building entrance protector.
- (4) Ground cable sheath.

b. Building entrance protector:

- (1) Install per the manufacturer's published installation instructions.
- (2) Install in locations as indicated.
- (3) Install protector modules for each pair.
- (4) Ground protector.

2. Fiber Optic Cabling System:

a. Innerducts:

- (1) Install per the manufacturer's published installation instructions.
- (2) Install in conduits as indicated on the Drawings.

b. Fiber optic cabling:

- (1) Install per the manufacturer's published installation instructions.
- (2) Install cabling unspliced.
- (3) Do not exceed recommended pulling tensions.
- (4) Do not exceed recommended bend radius.

c. Fiber termination enclosures:

- (1) Use rack or wall mounted enclosure for data fibers in  
Get with owner to verify termination points.

**3.2 LABELING**

- A. Provide permanent labels on both ends of cables.
- B. Provide permanent labels on fiber termination enclosures.
- C. Coordinate labeling scheme information with owner.

**3.3 TESTING**

A. General:

1. Test all cabling and connections.
2. Complete certified testing report.

B. Fiber Cable Testing:

1. OTDR test all fibers on each reel prior to installation:
  - a. Test singlemode fibers at both 1310 nm and 1550 nm in one direction.

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- b. Test multimode fibers at both 850 nm and 1300 nm in one direction.
    - c. Provide hard copy trace of each test.
  2. After installation and termination, test all fibers with an optical loss test set:
    - a. Test all fibers in one direction from the fiber termination enclosure.
    - b. Test singlemode fibers at both 1310 nm and 1550 nm.
    - c. Test multimode fibers at both 850 nm and 1300 nm.
    - d. Provide hard copy of each test:
      - (1) Indicate fiber identification matching the cable label.
      - (2) Indicate the fiber number.
      - (3) Acceptance test criteria:
        - (a) Within 5% of manufacturers loss specification.
        - (b) Within 5% of losses specified.
  3. If any tested fiber fails:
    - a. Re-terminate both ends of fiber and re-test.
    - b. If re-test fails, replace cable at no additional cost to the Owner.
  4. Perform final functional tests in presence of the Owner's representative.
  5. Certify system is complete and functional.

**3.4 SYSTEM GUARANTY**

A. Contractor's Responsibility. The Contractor shall guarantee that all installed material and equipment will be free from defects, workmanship, and will remain so for a period of one year from date of final acceptance of the system by VA. The Contractor shall provide OEM's equipment warranty documents, to the RE or Facility Contracting Officer if the Facility has taken possession of the building(s), that certifies each item of equipment installed conforms to OEM published specifications.

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