

## SECTION 17050

### BASIC COMMUNICATIONS EQUIPMENT, MATERIALS, AND METHODS

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. Section describes the detailed technical requirements for the products and miscellaneous components furnished, installed, and tested to complement the Station Communications subsystems.

##### 1.02 GENERAL

- A. The provisions of this Section apply to all Division 17, Station Communications, except as otherwise specified.

##### 1.03 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
  - 1. C2 National Electrical Safety Code
- B. ASTM International (ASTM):
  - 1. A123 Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
  - 2. A153 Specification for Zinc Coating (Hot-Dipped) on Iron and Steel Hardware
  - 3. B3 Standard Specification for Soft or Annealed Copper Wire
  - 4. D2447 Standard Specification for Polyethylene (PE) Plastic Pipe, Schedule 40 and 80, based on outside diameter
  - 5. E84 Surface Burning Characteristics of Building Materials
  - 6. F512 Specification for Smooth Wall Polyvinyl Chloride (PVC) Conduit and Fittings for Underground Installation
  - 7. F593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- C. Consumer Electronics Association (CEA):
  - 1. 310 Cabinets, Racks, Panels, and Associated Equipment.
- D. California Building Code (CBC)
- E. California Electric Code (CEC)
- F. Electronic Industries Alliance (TIA/EIA):

1. 568-B.1-2 Commercial – Building Telecommunication Cabling Standard
  2. 606 Administration Standard for the Commercial Telecommunications Infrastructure
  3. J-STD-607 Commercial – Building Grounding and Bonding Requirements for Telecommunications
- G. International Building Code (IBC)
- H. National Electrical Contractors Association (NECA):
1. 1 Standard Practices for Good Workmanship in Electrical Construction
- I. National Fire Protection Association (NFPA):
1. 70 National Electrical Code (NEC)
  2. 130 Fixed Guideway Transit and Passenger Rail Systems
  3. 255 Standard Method of Test of Surface Burning Characteristics of Building Materials
  4. 703 Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Buildings
- J. National Electrical Manufacturers Association (NEMA):
1. 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
  2. ICS-1 General Standards for Industrial Control and Systems
  3. ICS-4 Terminal Blocks
  4. ICS-6 Industrial Controls and Systems Enclosures
  5. FB1 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
  6. LI1 Industrial Laminating Thermosetting Products
  7. VE1 Metallic Cable Tray Systems
  8. WC 7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
  9. WD 1 General Requirements for Wiring Devices
- K. State of California Public Utilities Commission (CPUC):

1. G.O. 128 Rules for Construction of Underground Electric Supply and Communications Systems
- L. Underwriters Laboratories (UL):
1. 5 Surface Metal Raceways and Fittings
  2. 6 Rigid Metal Conduit – Steel
  3. 50 Enclosures for Electrical Equipment – Nonenvironmental Considerations
  4. 50E Enclosures for Electrical Equipment – Environmental Considerations
  5. 94 Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
  6. 497 Standard for Safety Protectors for Paired Conductor Communications Circuits
  7. 508 Industrial Control Equipment
  8. 514A Metallic Outlet Boxes
  9. 514B Conduits, Tubing and Cable Fittings
  10. 651 Schedule 40 and 80 Rigid PVC Conduit and Fittings
  11. 969 Marking and Labeling Systems
  12. 1059 Terminal Blocks
- M. Uniform Building Code (UBC)

#### **1.04 SUBMITTALS**

- A. Submit Installation Work Plan including the following items:
1. Equipment layout, plan and elevation views
  2. Conduit installation from Communications Equipment Room (CER) and field Distribution Cabinets (DC)
  3. Wiring diagrams from CER to DC including all tagging identifiers
- B. Submit a complete bill of materials (BOM) and the corresponding data sheets for all equipment and accessories, which the Contractor intends to use for the project (as a part of the Preliminary and Final Design).
- C. Product Samples: Submit and demonstrate product samples when requested by the Engineer or when required.

- D. Calculations and Certifications:
  - 1. Calculations as listed in the Preliminary Design and Final Design. Refer to Section 17000, Basic Communications Technical Requirements.
  - 2. Copy of ISO certification for all proposed manufacturers.
- E. Software, Schedules, and Lists:
  - 1. Submit dedicated cable management software for Owner's use.
  - 2. Submit typed (printed) wiring interconnect schedules and schedule of conduits, wires and cables as specified to be produced by required dedicated cable-management software.
  - 3. Submit complete typed or printed list of cable, wire, and conduit identification tags for approval.
- F. Manufacturer Qualifications: Submit qualifications for any manufacturer differing from those specified herein and obtain Engineer's approval. Acceptability of the manufacturer shall be based on the manufacturer's experience, qualifications, and certifications (i.e. ISO-9001); equipment reliability; compliance with specified standards; and full compatibility with Caltrain's existing systems.
- G. As-Built Documentation: Submit complete As-Built documentation and drawings, as specified in Section 17000, Basic Communications Technical Requirements, for all Miscellaneous Components and Products.

#### **1.05 QUALITY ASSURANCE**

- A. Applicable Standards and Code:
  - 1. All equipment and methods shall comply with the applicable standards listed under Reference Standards.
- B. Material and Workmanship Requirements:
  - 1. All equipment provided under this Section shall be UL listed.
  - 2. All products specified herein shall be subject to Engineer's approval based on the Contractor's ability to demonstrate adherence to the specified requirement and approval of the manufacturer's quality process.
  - 3. Use no discontinued product models, refurbished equipment, or products scheduled for end-of-life, end-of-sale, or end-of-service within one calendar year of the installation date.
  - 4. All grounding shall be in accordance with NEC standards, and as specified for the Work except as modified herein. Ground each piece of equipment in accordance with the recommendations of the manufacturer.

## **PART 2 – PRODUCTS**

### **2.01 CIRCUIT BREAKERS, FUSES, AND FUSE CLIPS**

- A. Capacity:
  - 1. Fuses and circuit breakers shall be suitable for protection of the equipment and cabling connected.
- B. Fuse Type:
  - 1. Fuses shall be non-renewable time lag fusion type.
  - 2. Protective resistance shall be used in branch circuits.
- C. Fuse Clips:
  - 1. Positive contact pressure shall be applied to the fuses to ensure electrical continuity.

### **2.02 TAGGING**

- A. Cables, Wires and Conduits:
  - 1. Install cable identification tags at both ends of each cable, including wires, where they terminate on terminals, punch-down blocks, and connectors. Communications cable identifiers shall comply with standard TIA/EIA-606. This includes all electrical power wires and cable for communication facilities and equipment.
  - 2. Tag cables at the entrance and the exit of each manhole, pull-box, hand-hole, junction box, splice-box, cable trough, or fiber-slack enclosure.
  - 3. Tag conduits at the entrance and the exit of each manhole, pull-box, hand-hole, junction box, splice-box, cable trough, or fiber-slack enclosure.
  - 4. Use water-resistant identification tags with lamination over its designation for all conduits, cables, and wires. Permanently typed lettering shall be used.
  - 5. Use sleeve type non-metal tags where cable diameter permits.
  - 6. Use flat plastic tags for smaller cables (and all conduits): Two holes in the tag shall be provided for attachment with a dielectric tie.
  - 7. Furnish, use, and then submit to the Engineer a dedicated cable-management software, including software license, to provide Class 4 administration of the communication cables per standard TIA/EIA-606. Software shall be able to properly operate on Windows 2000, or latest revision of, operating system and be able to produce the following types of schedules:

- a. Typed wiring interconnect schedule for all external and internal wires and cables listing wire (cable) tag identification, To and From locations, To and From termination terminals, wire (cable) size and type, all conduit (raceway) tag identifications that wire (cable) is installed, all raceway size and type, and manhole (pull-boxes) that cable or wire is installed through.
  - b. Typed wiring interconnect schedule for each location and each facility for the entire project.
  - c. Typed schedule of conduits, wires, or cables to include quantity of each.
8. Cable, wire, and conduit identification tags: The tags shall follow the following sample format. Each cable, wire, and conduit shall have its own unique identification tag. If a wire is not terminated, then tag it "spare-1", "spare-2", "spare-3", and so forth.
- a. Sample tag scheme for External Cable, HIL-CER-FDP / BAS-CER-FDP-FS12-01; with:
    - i. HIL represents originating location "from" (Hillsdale)
    - ii. CER represents originating facility type (Communications Equipment Room)
    - iii. FDP represents originating termination cabinet/panel (Fiber Distribution Panel)
    - iv. / represents "to"
    - v. BAS represents ending location (Baysshore)
    - vi. CER represents ending facility type (Communications Equipment Room)
    - vii. FDP represents ending termination cabinet/panel
    - viii. FS12 represents cable type (Fiber Single-mode 12 strand)
    - ix. 01 represents cable number (01-99)
  - b. Sample tag Scheme for Station Distribution Cable: HIL-CER-FDP / DC1-FS02-01; with:
    - i. HIL represents Location "from"
    - ii. CER represents facility type
    - iii. FDP represents originating cabinet/panel
    - iv. / represents "to"

- v. DC1 represents ending distribution cabinet, panel, or equipment
  - vi. FS02 represents cable type (Fiber Single-mode 2 strand)
  - vii. 01 represents cable number (01-99)
- c. Sample tag Scheme for Internal Wires within the same CER or DC, FS01-01-FDP-SL4-14 / RTU-TB5-11; with:
- i. FS01 represents cable type (Fiber Single-mode 1 strand patch cord)
  - ii. 01 represents cable number (01-99)
  - iii. FDP represents originating cabinet/panel
  - iv. SL4-14 represents originating demarcation panel/card slot and port number
  - v. / represents "to"
  - vi. RTU represents ending cabinet, panel, or equipment
  - vii. TB5-11 represents ending termination block and termination terminal, jack, or port number
- d. Sample tag Scheme for External Conduits, HIL-CER / BAS-CER-PCO-01-3; with:
- i. HIL represents originating location area (Hillsdale)
  - ii. CER represents originating facility type
  - iii. / represents "to"
  - iv. BAS represents ending location area (Bayshore)
  - v. CER represents ending facility type
  - vi. PCO represents Pathway, such as "conduit"
  - vii. 01 represents conduit one (01-99)
  - viii. 3 inch represents 3 inch diameter conduit
- e. Sample tag Scheme for Internal Conduits, CER-FDP / PB01-PCO-01-0.75; with:
- i. CER represents originating facility type "from"
  - ii. FDP represents originating cabinet/panel

- iii. / represents "to"
- iv. PB01 represents ending pull-box, cabinet or equipment
- v. PCO represents Pathway, such as "conduit"
- vi. 01 represents conduit one (01-99)
- vii. 0.75 inch represents 0.75 inch diameter conduit

B. Equipment:

- 1. Label all terminal blocks, card cages, circuit cards, punch-down blocks, and jack fields. Communications equipment identifiers shall comply with TIA/EIA-606.
- 2. Use permanent lettering scheme.
- 3. Attach labels with a non-drying adhesive.
- 4. Show the correct communication equipment identifier on every respective equipment drawing and schematic.

**2.03 PUNCHDOWN BLOCKS**

A. Type:

- 1. Blocks shall be IDC-Type 50 pair punch-down blocks. Blocks shall be configured with two columns of 25 pairs of two termination clips. Clips shall accept No. 20 AWG - No. 26 AWG insulated wire, and No. 18 AWG - No. 19 AWG bare wire. Blocks used for data cable termination shall be rated at or higher than the rating of the cable being terminated.
- 2. Clips shall be pre-wired to an Amphenol type RJ21X connector socket or equal.
- 3. Blocks shall be equipped with a base, standoff bracket, cover, and bridging clips.

B. Base:

- 1. The base shall be impact resistant plastic.
- 2. Provide molded fanning strips on each side of the split blocks.
- 3. Apply permanent numbering to the fanning strips.
- 4. Provide a standoff of two inches from the mounting surface.
- 5. Provide a removable cover with circuit designations permanently applied.
- 6. Provide connector retention screws.



## **2.04 TWENTY-FIVE PAIR CONNECTORS**

- A. Type:
  - 1. Connectors shall be Amphenol-type RJ21X, or equal, with a self-extinguishing thermoplastic housing.
  - 2. A slide on cover shall protect the connector contacts.
  - 3. Provide retention screws.
  - 4. Connectors shall be non-reversible and shall be compatible in design and type (male/female) with the associated receptacles.
- B. Connector Contacts:
  - 1. Provide two (2) rows of 25 contacts.
  - 2. Contacts shall be insulation displacement type, designed to accept No. 22 and No. 24 AWG wire.

## **2.05 PROTECTED ENTRANCE TERMINALS**

- A. Design:
  - 1. Use protected entrance terminals at the input for all signal/communications circuits using metal cable and entering/exiting the facility (e.g. Communications Facilities and DC). Use connectorized protected entrance terminals in all applications unless specifically stated otherwise in this Section or on the Contract Drawings.
  - 2. Protected entrance terminals shall have a field splice line side connection stub pre-wired to three element (five pin) protector sockets. Connect the equipment side of the protectors via RJ21 connectors.
  - 3. Blocks shall be 110 Cat 5e/6 rated or Engineer approved equal.
  - 4. Protected entrance terminals shall include an integral splice chamber.
  - 5. Provide protected entrance terminals in 25, 50, and 100 pair sizes and fully populated with protector modules as per the application shown on the approved drawings.
- B. Protector Sockets: Protector Sockets shall be UL standard five pin sockets, with two-position (normal and detent) design. In the detent position, the protector shall be retained, the line side shall be disconnected, and the equipment side shall be protected. When fully inserted, the line and equipment side having the tip and ring pair shall be protected.

## 2.06 MULTI-PAIR PROTECTED TERMINAL BLOCKS

- A. Design:
1. Utilize multi-pair protected terminal blocks for applications requiring non-connectorized 25 pair or less terminal blocks, as specified on the Contract Drawings.
  2. Types and pair counts for terminal blocks shall be as shown on the approved drawings.
  3. Terminal blocks shall consist of pairs of brass binding posts imbedded in high impact plastic potted with a high dielectric polyurethane compound.
  4. Pre-wire binding posts to two element protector sockets. Wire the ground of all protector sockets to a common ground terminal.
  5. Equip binding posts with two brass nuts and washers. Size binding posts to accept up to two No. 14 AWG conductors.

## 2.07 PROTECTOR MODULES

- A. Three Element (5-Pin) Protectors: Protectors shall be solid-state modules with fuses or heat coils specifically designed for lightning protection.
1. Modules shall plug into 5-pin protected entrance terminal sockets.
  2. Each module shall protect both halves of a pair.
  3. Protector modules shall be UL 497 listed for primary protection.
  4. Modules shall have 2 ns to 5 ns response time.
  5. Modules shall protect for voltages over 230 Vdc.
  6. Modules shall protect for currents over 80 A.
- B. Two Element Protectors: Protectors shall be solid-state modules with fuses or heat coils specifically designed for lightning protection.
1. Modules shall plug or screw into protected terminal blocks.
  2. Protector modules shall be UL 497 listed for Primary protection.
  3. Modules shall have 2 ns to 5 ns response time.
  4. Modules shall protect for voltages over 230 Vdc.
  5. Modules shall protect for currents over 80 A.

**2.08 MAIN DISTRIBUTION FRAMES**

- A. Communications Facilities Main Distribution Frame (MDF): Each MDF shall consist of the following minimum equipment:
  - 1. A wall mounted 4 feet by 8 feet, 3/4-inch marine grade sanded and smooth surface plywood backboard for mounting equipment.
    - a. Fire Retardant Paint for Backboard: Paint shall comply with the requirements of ASTM E 84 (NFPA-255) and matching Federal Standard FS-595b, Color No. 27925, (Reference NFPA -255 and 703). Primer and paint shall be compatible with wood treatment.
  - 2. A minimum of two 100-pair connectorized protected entrance terminals (PET) fully equipped with protector modules for each active and inactive or unused circuit, as described in entitled Protected Entrance Terminals and Multi-Pair Protected Terminal Blocks herein. PET block shall be contained within a separate enclosure mounted on the MDF backboard. Enclosure shall have a fully removable cover in order to provide access to protected terminal blocks. (Mount on plywood backboard)
  - 3. A minimum of eight 110 Type CAT 5e/6 50-pair connectorized punch-down blocks (as described in Articles entitled Punchdown Blocks herein) utilizing 25 pair connectors per Article entitled Twenty-Five Pair Connectors as cross-connects. (Mount on plywood backboard)
  - 4. Provide binding post type terminal blocks as described in Article entitled Multi-Pair Protected Terminal Blocks herein and as shown on Contract Drawings. (Mount on plywood backboard)
- B. Outdoor Distribution Cabinet (DC) Local Distribution Frame (LDF):
  - 1. Each Outdoor DC or similar application shall consist of the following minimum equipment mounted to the Lexan panel mounted on the interior side panel of the DC:
    - a. One duplex 120Vdc UPS receptacle and back-box. Receptacles will be NEMA L5-30R (twist lock).
    - b. One duplex 120Vdc general purpose receptacle and back-box.
    - c. Multi-pair protected terminal blocks designed for a minimum of 24-pairs of PA speaker and microphone connections. Such protection blocks shall be specifically designed for PA applications.
    - d. Protection blocks for outdoor Category 5e/6 for Category 6 rated data wiring entering the facility or the cabinet.
    - e. Protection blocks for any other outside plant cabling containing conductive (metal) elements. Such protection blocks shall be designed specifically for use with the intended application.

## 2.09 CABLE TRAYS

- A. Cable trays shall be of open ladder type, aluminum, or other suitable material commercially available and providing support spacing and strength of material characteristics equal to or greater than the aluminum.
- B. The aluminum ladder type cable tray shall meet the following requirements:
  - 1. Ladder rung spacing shall be approximately 6 inches.
  - 2. Side stringer section shall be a minimum of 0.094 inches.
  - 3. Top and bottom flange section shall each be a minimum of 2 inches.
  - 4. Flange width shall be approximately 0.75 inches.
  - 5. Height of rail shall be approximately 3.375 inches.
  - 6. Rung thickness shall be a minimum of 0.062 inches.
  - 7. Rung bottom width shall be approximately 2.20 inches.
  - 8. Rung top width shall be approximately 0.75 inches.
  - 9. Plastic tray insert barrier to separate power and signal cables.
- C. Each cable tray shall be designed and fabricated with sufficient capacity to provide 50 percent of the cross-sectional area as free air space after the full number of cables and wires are installed. Sufficient overhead space must be available after installation to permit wires and cables to be inspected.
- D. Where practical, the tray shall be constructed in straight sections joined with Engineer approved couplers. Electrical continuity of the tray shall be maintained across sections by bonding straps.
- E. Using the manufacturer's standard, the tray shall be laid out using a minimum number of sections, but providing maximum continuous runs without gaps.
- F. All fittings, supports, and accessories shall be provided in accordance with the manufacturer's recommendations.
- G. Insofar as practical, cable trays shall be supported by cantilever type brackets in order that the cables can be laid into the tray without pulling.
- H. Where the width of the cable tray or the loading of cables is such that cantilever supports are impractical, other Engineer approved suspension methods may be used, but such application must be kept to a minimum.
- I. At least three supports shall be provided for each length of tray. Supports shall be evenly spaced insofar as possible; in no case shall the spacing between adjacent supports exceed five (5) feet.

- J. To prevent damage to cables, no metal edges of any description shall protrude and no sharp corners shall exist in the completed layout.
- K. Fiberglass support arms, where required to insulate the cable tray from the equipment racks, shall be flame retardant, reinforced polyester laminate Class "B" 130 degrees Celsius electrical sheet, meeting NEMA GPO-2 requirements specified in NEMA LI1.

## **2.10 OUTDOOR EQUIPMENT CABINETS**

- A. Outdoor equipment cabinets shall be floor mounted encasing an 19 inch EIA aluminum equipment mounting rack. Cabinets shall have an overall height of 48 inches, unless otherwise indicated on the Contract Drawings. The cabinets shall have CEA-310 standard 1 3/4 inches spaced single side drilled, tapped mounting holes.
- B. The cabinet base shall have a minimum depth of 30 inches. Cabinets shall have continuously welded seams and gasket front and rear doors.
- C. Obtain the approval of the Engineer to finish the outside of each cabinet. All cabinets shall be painted identically.
- D. Cabinets shall be equipped with screw clamp connection for grounding.
- E. Cabinets shall be grounded to the Chassis Grounding Buss-bar (CGB). Each cabinet rack shall have separate 'signal/communications' and 'power' grounding bars, which are connected to the Chassis Grounding Buss-bar (CGB) independently from each other and from other racks (where applicable).
- F. Cabinet shelves (both fixed and slide-out type) shall be provided as shown in the Contract Drawings.
- G. Cabinets shall be equipped with ac power strip, ground bus-bars, horizontal and vertical cable management, and other non-electronic type components as shown on the Contract Drawings.
- H. Cabinets shall be equipped with locking front and rear steel doors.
- I. Cabinets shall be equipped with louvered side panels.
- J. Cabinet design, furnish, and installation shall comply with Section 17160, Outdoor Communications Cabinets.

## **2.11 INDOOR COMMUNICATIONS CABINETS**

- A. Design:
  - 1. Where communication equipment cannot be housed in open equipment racks within controlled spaces dedicated for communications only, locked cabinets shall be used and designed for EMI shielding with the following features:
    - a. Continuously Welded Seams

- b. Gasket Front and Rear doors
  - c. Screened Ventilation Openings
  - d. Tested per Mil Std. 285
2. Cabinet construction and materials shall be as follows:
- a. 14 gauge or heavier steel frame.
  - b. 16 gauge or heavier panels.
  - c. 16 gauge or heavier struts.
  - d. 16 gauge mounting rails with CEA-310 rack mount standard spaced holes for equipment mounting widths of 19 inches and 23 inches.
  - e. Both front and rear doors shall be removable.
  - f. Locking front and rear removable doors shall be provided. All keys shall be alike and master keys shall be provided to the Engineer.
  - g. Communications House cabinets shall be installed on insulating sills as shown on Contract Drawings.
  - h. Cabinet shelves (both fixed and slide-out type) shall be provided as shown in the Contract Drawings.
  - i. Cabinets shall be equipped with AC power strip, power and communications ground bus-bars, horizontal and vertical cable management, and other non-electronic type components as shown on the Contract Drawings.
  - j. Cabinets shall be equipped with louvered top and side panels.
3. Finish:
- a. Obtain the approval of the Engineer to finish the outside of each cabinet. All cabinets shall be painted identically.
  - b. Finish inside of each cabinet in flat white enamel.
  - c. Racks or cabinets shall be grounded to the Main Grounding Buss-bar (MGB) as shown in the Contract Drawings.

## **2.12 MULTI-PAIR DISCONNECT MODULE TERMINAL BLOCKS**

- A. Design: Multi-pair disconnect module terminal blocks shall be 110 Type CAT 6 Rated or Engineer approved equal. Terminal blocks shall provide normally closed two-piece (line side and equipment side) insulation displacement contacts in 8 to

50 pair modules, as per the application shown on the Contract Drawings. Disconnection of the line side from the equipment side shall be by insertion of a disconnect plug.

- B. Performance:
  - 1. Contacts shall accept No. 20 AWG through No. 26 AWG insulated conductors.
  - 2. Contact resistance shall be less than  $1 \times 10^{-3}$  ohms.
  - 3. Insulation resistance shall be greater than  $50 \times 10^{12}$  ohms.
  - 4. Wire retention force shall be greater than or equal to 75 percent of wire breaking force.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION**

- A. General: All parts of the specifications pertaining to miscellaneous components and products shall be installed as specified in this specification and in accordance with the Contract Drawings.
- B. Twenty-Five Pair Connectors:
  - 1. Cable Attachment Tool: Twenty-five pair connectors that are attached to cables in the field shall be made-tip utilizing an Engineer approved connector attachment.
  - 2. Testing: Test twenty-five pair connectors that are attached in the field, utilizing an Engineer approved tester that detects opens, shorts and crosses. Also, verify color code.
- C. Terminal Blocks:
  - 1. Make connections to terminal blocks in accordance with the Engineer approved connection details. Utilize twisted pair jumper wire for cross-connections.
  - 2. Neatly bundle all wiring on terminal blocks and restrain to prevent tracing wires by pulling.
  - 3. Utilize tags and labels to identify the terminal block designation and the pair number terminated on each terminal.
  - 4. For protected terminal blocks, ground protected terminal blocks with No. 6 AWG minimum ground wire to the cabinet communications ground.
  - 5. Test all protector modules prior to installation on terminal blocks.

- D. Main Distribution Frames:
1. Backboard Mounting in Communications Facilities.
    - a. Secure plywood backboard to the wall in such a manner that it will adequately support the weight of all equipment and cables that are attached to it. Cable termination and management devices shall be provided and subject to the Engineer's approval.
    - b. Prime and apply fire retardant paint to the backboard to all exposed sides prior to installation of any equipment.
    - c. Floor conduit stub-ups shall be extended to 2 feet above finished floor as shown on the Contract Drawing.
  2. MDF and miscellaneous equipment mounting in Distribution Cabinets (DC) shall be as shown on Contract Drawings.
  3. Wiring:
    - a. Wire each MDF in accordance with an approved cross-connect and wire termination plan.
    - b. Utilize tags and labels to identify the cross-connect module designation and the pair number terminated on each quick-clip. All tag and label designations shall be transferred to the as-built drawings. Method of tagging and labeling shall be in accordance with Article entitled Tagging herein.
    - c. Neatly bundle cables and cross-connect wiring and restrained using Velcro ties.
    - d. Individually ground each distribution frame, equipment rack or cabinet, protected terminal block, or cable tray section, to the Communications Equipment Room (CER) Main Grounding Bus-bar (MGB) with No. 6 AWG ground wire and lugs as shown on the Contract Drawings.
- E. Cable Tray:
1. Attachment: Each cable tray section shall be attached to the Communications Facility ceiling utilizing expansion fasteners required for the ceiling material. Fasteners shall be rated for a pull-out load equal to at least 150 percent of the maximum rated load for each cable tray section.
  2. Cable trays shall be attached horizontally to 19" racks to provide neat and secure mounting of equipment cables.
  3. Grounding: Cable tray shall be grounded to the Communications Facility MGB utilizing No. 6 AWG minimum ground wire. Electrical continuity of the cable tray shall be maintained between sections utilizing No. 6 AWG



minimum ground wire and attachment hardware, as recommended by the manufacturer.

4. Installation of Cable:
  - a. Cables shall be laid into the tray, rather than pulled, wherever possible, so as to eliminate twisting. Cables shall be attached to the tray utilizing dielectric ties so as to maintain straight runs and adequate separation of cables. Cables carrying ac and dc power shall be separated from audio and data cables to the maximum extent possible.
  - b. Fiber optic distribution cables will be encased in 1 inch inner-duct and attached to the tray utilizing dielectric ties. Fiber and inner-duct shall be separated from copper cables. Inner-duct will run the full length of the cable tray to the Fiber Distribution Panel (FDP) opening.
  - c. Fiber Optic patch cables shall not be installed with bend diameters less than those specified by the vendor.

F. Internal Wiring and Cabling:

1. Internal wiring shall be installed in wiring harnesses or cable trays.
2. Wire and cable shall be secured within ducts or open wire ways to prevent chafing movement.
3. Strain relief shall be provided where needed.
4. Wire or cable splices will not be permitted.
5. All wires and cables shall be fully protected against any contact with any surface other than that designed specifically to support or protect them.
6. Wires and cables shall be laid in place with sufficient slack at the bends so that wires and cables will clear the inside bend surface of the wire way, thereby preventing the insulation from being crushed.
7. All wire and cable shall be free of kinks and insulation damage. Wire installation shall not be subject to accumulations of moisture or foreign matter.
8. Wire and cable dress shall allow for sufficient slack to provide for shock and vibration induced movements, movement of sliding racks, equipment shifting, alignment, cover removal, and component replacement.
9. All wire and cable bends shall conform to the manufacturer recommended wire/cable specific minimum bend radius. All wire and cabling harness and dress arrangements shall also account for this requirement.

10. Wiring and cabling dress in harness arrangements shall be tied with a high strength approved Velcro type wire-tie.
11. For rack wiring, utilize rack's cable management hardware for routing and securing of the wires and cables.
12. All wires and cables shall be free from metal edges, bolt heads, and other interference points, and shall have electrical clearance from the covers, regardless of the insulation properties of covers or doors.

**END OF SECTION**