

DIVISION 27 – COMMUNICATIONS

270000 – COMMUNICATIONS GENERAL

Part 1 - General

1.1 Related Sections

- A. This specification section provides general conditions for all division 27 specifications. All contractors working with in the division 27 specification shall adhere to this specification.
- B. Section 270528 Communication Infrastructure Systems
- C. Section 271000 Structured Cabling System
- D. Section 272000 Network Electronics
- E. Section 273000 Telephone System
- F. Section 274040 Assistive Listening System
- G. Section 274200 Classroom Amplification System
- H. Section 277000 Intercom-Clock-PA System
- I. Section 279000 Intrusion Alarm
- J. Section 279010 CCTV Surveillance

1.2 Statement of Work

- A. This document describes the requirements for the contractors, products and installation relating to furnishing and installing Structured Cabling and Communications Systems.
- B. Contractor will provide a bid including all labor, materials, tools and equipment required for the complete installation of work called for on the Construction Drawings and described in this Document. It is the responsibility of the Contractor to provide all material necessary to provide a complete and operable system. If the contractor feels that the system described is incomplete they must address this in writing to the Owner/Owner's Representative before providing a bid.
- C. All questions concerning non-specified product and services will be address to the Owner's Representative before Contactor provides a bid. Owner expects that by accepting the Contractor's bid proposal that the Contractor has provided a competent bid for a complete solution.
- D. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of devices, typical installation details, and mounting details will be provided as an attachment to this document. The successful vendor shall meet or exceed all requirements for the systems described in this document.
- E. 271000 contractor shall be complete with work including all testing and labeling prior to 272000 contractor work start. Also the district requires minimum of 10 days to review test documents prior to network start up.
- F. 272000 contractor will require that 271000 is complete prior to work start. 272000 will need minimum of five day burn in of network equipment prior to turnover to district.

1.3 Existing cabling and systems equipment

- A. Demolition of cabling systems per NEC 800.2
 - 1. The owner shall be given "first right of refusal" for all decommissioned equipment and removed cable.
 - 2. The owner may wish to keep, recycle or destroy these items. If the items are refused by the owner the contractor may keep, recycle or destroy these items.
 - 3. Owner will establish a location for all materials it wishes to keep, recycle or destroy.

1.4 Regulatory References

- A. Contractor will comply will all Federal, State, Local Codes/Regulations and Industries Standards.
1. Federal:
 - National Electric Code(NEC) 2008 or latest approved
Chapter 8: "Communications Systems"
Article 250: "Grounding"
 - NFPA 70 - National Electric Code(NEC)
 - FCC - Part 15, Part 68
 - ADA – Americans with Disabilities Act
 2. State of California:
 - CCR Part 2 - California Building Code.
 - CCR Part 3 - California Electrical Code
 - Occupational Safety and Health Act (OSHA).
 - Title 24, Building Standards, State of California.
 - Title 19, California Code of Regulations.
 - Title 8, Electrical Safety, State of California
 3. ANSI Standards
 - ANSI C2-2001 National Electrical Safety Code.
 - ANSI C80.3 Specification for Zinc-coated Electrical Metallic Tubing.
 - ANSI/UL 797 Electrical Metallic Tubing.
 - ANSI/ICEA S-83-596-2001 - Fiber Optic Premises Distribution Cable Technical Requirements.
 4. Industry Standards:
 - Telecommunications Industry Associations/Electronics Industry Association (TIA/EIA)
 - TIA/EIA-568-C Commercial Building Telecommunications Cabling Standard
 - TIA/EIA-568-C.1 General Requirements
 - TIA/EIA-568-C.2 Balanced Twisted Pair Cabling Components Standard
 - TIA/EIA-568-C.3 Optical Fiber Cabling Components Standard
 - TIA/EIA-569-A Commercial Building Standard for Telecom Pathways and Spaces
 - TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - TIA/EIA-607 Commercial Building Grounding/Bonding Requirements
 - TIA/EIA-758 Customer-Owned Outside Plant Telecommunications Cabling Standard
 - TIA/EIA-758-1 Addendum No. 1 to TIA/EIA-758, Customer-Owned Outside Plant Telecommunications Cabling Standard
 - National Electrical Manufacturer's Association (NEMA)
 - Institute of Electrical and Electronic Engineers (IEEE)
 - 802.3 (Ethernet)
 - 802.3ab (Gigabit Ethernet over 4-pair Category 5e, 6 & 6A or higher)
 - 802.3Z (Gigabit Ethernet over optical fiber)
 - Underwriters Laboratories Inc. (UL)
 - International Organization for Standardization/International Electromagnetic Commission (ISO/IEC) ISO 11801 Generic Cabling for Customer Premises
 - Building Industry Consulting Services International (BICSI)
Telecommunications Distribution Methods Manual (TDMM 12th Edition or latest).
 - ASCII - American Standard Code for information Interchange
 - ASTM - American Society for Testing and Materials
- B. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current

releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

- C. This document does not replace any code, either partially or wholly. The contractor must be aware of and comply with all local codes that may impact this project.

1.5 Safety/Contractor Qualifications/Quality Assurance

A. Safety and Indemnity

1. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of persons and property during performance of work.
2. The Contractor shall ensure that all personnel working in or anywhere on the site shall be provided a hard hat, safety shoes, a face shield or safety goggles, etc. for their protection.
3. No act, service, drawing review or construction observance by the owner's representative or any other party employed by the campus is intended to include review or approval of adequacy of the Contractor's safety measures, in, on or near the construction site.

B. Contractor Qualifications

1. Each low voltage contractor/sub-contractor shall submit their qualifications to the district prior to award of contracts.
2. Contractor shall have been in business for no less than five (5) years and have installed of a minimum of 3 projects of similar size and scope.
3. A *Manufacture Certified Installer* contractor shall complete the System installation. The contractor shall have completed standards based product and installation training. ***A copy of the Contractor's Manufacture Certified Installer certificate shall be submitted with their submittal.***

4. Sub-Contractor Qualifications

- All Contractors shall submit a list of at least three (3) projects of similar dollar volume completed within the past 24 months for reference purposes.
- The Contractor shall compile detailed information relating to similar work completed, including corporate references sufficient to enable the Owner to evaluate and agree to the Contractors' responsibility, experience and capacity to perform the work.
- Each Contractor to perform telecommunications work on this project shall possess a C-10 or C-7 (formerly C-61) Limited Specialty License for Telecommunications and must be certified for the installation, termination, splicing, and testing of copper cables, fiber optic cable, riser cable, and inside wiring. The appropriate contractor's license for underground construction and conduit installation is also required.
- An on-site Contractor superintendent must be available at all times. Contact can be by person or telephone.

5. Contractors who do not meet the minimum specified requirements will not be accepted.

C. Quality Assurance

Contractors are required to comply with the following without exception:

1. The winning Contractor will assign this project to a competent Project Manager who has demonstrated their ability to supervise a telecommunications project of the same size and scope.
 - The contractor will make this person available to the Owner/Owner's Representative before the start of this project for an interview. This person must be deemed acceptable by the Owner and/or their Representative before work can begin.
 - Project Manager will be required to be available for scheduled on site project meetings at no additional cost to the Owner.
 - Project Manager will be required to be available to meet on site with the Owner/Owner's representative with a minimum of 24 hours' notice for non-

- emergency issues, and a minimum of 4 hours for emergency issues at no additional cost to the Owner.
2. All material and equipment to be installed on this project shall be "new". If the Owner/Owner's Representative discovers that "used" material or equipment has been installed on this project the Contractor will be required to replace said materials and/or equipment with "new" products at no additional cost to the Owner.
 - "New" - Materials and products manufactured within one (1) year prior to installation, and meet or exceed the latest published specifications of the manufacture. Also these materials and equipment may not have been in use before installation on this project unless directed otherwise in the project documents.
 3. Contractor must warranty all materials, equipment and labor for a minimum of one (1) year from the Owner's acceptance of the work.
 - Warranty will provide repair/replacement of all defective or improperly installed materials at no additional cost to the Owner (including Labor, drive time, shipping, taxes, etc.).
 - Contractor is required to keep in stock replacement parts for all items covered in this specification and provide a competent service technician to be on site to repair/replace defective items no later than 24hours after receiving trouble call.
 - Warranty will cover normal Business hours, 8am – 5pm, Monday thru Friday. All calls received on a Friday or the day before a holiday will be held until the following regular business day.

1.6 Submittal Documentation

- A. The successful contractor shall provide their submittal package in accordance with the Section 01 20 00 1.06 Submittal Schedule
- B. The successful contractor shall provide three (3) copies of their submittal package.
- C. The Submittal Package will include:
 1. All documentation given will be in a Bond Cover or in a Three (3) Ring Binder.
 2. A coversheet on the Contractor's Company Letterhead including:
 - Contractor's Name
 - Contractor's License Number
 - The Project Name
 - The Specification Number and Description
 - The date documentation was submitted.
 3. A spreadsheet with a full material list of products and equipment included in the Contractor's bid price. Spreadsheet will provide:
 - Manufacture Name
 - Part Number
 - Description
 - Quantity to be installed for each part.
 4. A legible copy of the Manufacture's Catalog Cut sheet for each part included in the Contractor's bid.
 - The Catalog Cut sheets shall be placed in the same order as shown on the spreadsheet.
 5. Copies of the Manufacture's Certification for a minimum of the Project Forman and 50% of the installation crew.
 6. Sample of Labeling Scheme. Contractor will provide a sample for each identifier to be used on this project.
- D. LEED/CHIPS/HPSA (when applicable to project provide additional submittal information)
 1. Recycled content, segregated by pre- and post-consumer percentages.
 2. Rapidly renewable material content.

3. VOC content
4. Distances from site to follow material process locations.
 - Raw material harvest, collection or extraction
 - Product or component fabrication
 - Final material manufacture, if different than component fabrication

1.7 Equivalent Products

- A. Pre-Approved Equals:
 1. All pre-approved products shall be listed in the relevant specification section.
- B. Contractors wishing to approve a system other than those specified in this document will be required to perform the following:
 - Provide System specifications and cut sheets for all system components for the proposed new system(s).
 - Provide an itemized comparison to each of the system functions as described in this specification. Include in that document how the proposed system compares to the specified system described in this document on a line by line basis, using one of the following three criteria: "exceeds"/"matches"/ "unequal".
- C. All other products than those specifically address in the bid document that the Contractor is seeking approvals for must be **received** by the Owner's Representative **no later than 5 business days before the bid date**. All Approved Equals will be published in addendum form prior to the bid date.
- D. Failure to received written approval for product installed that deviates from the products called for in this specification and/or on the project drawings will result in the contractor having to replace the unapproved materials and equipment with the originally specified products at no additional cost to the Owner.
- E. All proposed system documentation must be sent to the Owner's Representative via one of the following; mail, fax or email. The Contractor will include the project name, their contact information, and the specification section number that the proposed system is comparable to.

1.8 Acceptance and Warranties

- A. Project Acceptance
 1. The Owner and the Contractor shall accept the project as complete based on the following criteria:
 - Before executing any performance testing, the Contractor shall present a test plan to the Project Engineer for their approval.
 - The Contractor has completed all testing and delivered copies of all test results to the owner's representative.
 - All test results have been examined and approved by the Contractor and the Project Engineer.
 - Copies of all documentation required by this section have been delivered to the Project Engineer.
 - All punch list items are completed to the satisfaction of the Inspector-of-Record.
 - Manufacturer Warranty Certification Certificates are provided to the Owner.
 2. Following completion and/or compliance with the requirements listed above, the Contractor shall issue a Notice of Completion confirming that the project is complete. A 45-day acceptance period shall begin immediately following the issuance of the Notice of Completion.
 3. Minor failures shall be responded to at the Owner's discretion or within one business day.
- B. Manufacture Warranties
 1. The installed 271000 structured wiring (as applicable for given cable media) system, including both inter-building and intra-building sub-systems, shall be warranted by a manufacturer for a 20-year period or greater.

2. The warranty certified systems will be a complete system comprised of products from a single manufacturer for the entire channel (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.). The Manufacturer shall administer a follow on program through the Vendor to provide support and service to the purchaser. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.
3. The Contractor shall be responsible for correcting any problems and malfunctions that are warranty-related for the entire warranty period. In the event that a Contractor should not be in business at the time of an issue, the manufacturer shall be responsible for all corrections, if deemed the responsible party.
4. Copies of any extended material warranties shall be passed through to the Owner.
5. During the installation and up to the date of final acceptance, the Contractor shall protect all finished and unfinished work against damage and loss. In the event of such damage or loss, the Contractor shall replace or repair such work at no cost to the Owner or any other Trade Partnership working on the project.

END OF SECTION

270528 – COMMUNICATIONS INFRASTRUCTURE SYSTEM

Part 1 - General

1.1 Statement of Work

- A. This document describes the requirements for the contractors, products and installation relating to furnishing and installing Underground Ducts and Raceway systems. All systems described herein shall be governed by the Division 16000 specifications, should these two documents be in conflict the more stringent shall prevail.
- B. The locations of vaults and pull boxes on the drawings are approximate and reflect the best information available. The Contractor is responsible for locating all existing utilities within the areas to be excavated prior to excavation. Final location of all trenches, communications utility vaults, and pull boxes must be verified and signed off on by the Owner/Owner's Representative.
- C. The contractor shall furnish and install all work necessary to make complete systems, whether or not such details are mentioned in these specifications or shown on the drawings, but which are necessary in order to complete working systems, excepting those portions that are specifically mentioned therein or plainly marked on the accompanying drawings as being installed or supplied by others.

1.2 Contractor Qualifications/Quality Assurance

- A. **Safety and Indemnity**
 - 1. Contractors will submit the necessary documentation to demonstrate their compliance with Section 270000 "1.5 A. Safety & Indemnity".
- B. **Contractor Qualifications**
 - 1. Contractors will submit the necessary documentation to demonstrate their compliance with Section 270000 "1.5 B. Contractor Qualification".
- C. **Quality Assurance**
 - 1. Contractor shall comply with all requirements as specified in Section 270000 "1.5 C. Quality Assurance".
- D. **Warranty**
 - 1. Contractor shall comply with all requirements as specified in Section 270000 "1.8. Acceptance & Warranties".

1.3 Submittal Documentation

- A. The successful contractor shall provide their submittal package in accordance with the Section 01 20 00 1.06 Submittal Schedule, and Section 270000 "1.6 Submittal Documentation".

1.4 Equivalent Products

- A. All Products described and Part Numbers given in this Specification are those of Leviton, Superior Essex, and Cooper B-Line unless otherwise noted.
- B. Pre-Approved Equals:
 - 1. Utility Vault Company, Christy Concrete, BES
 - 2. Hoffman, B-Line, Circle AW
 - 3. CARLON, Allied Tubing, MaxCell
 - 4. RANDL Inc , Thomas & Betts, Bridgeport, Appleton, Erico, Minerallac
 - 5. Wiremold, Hubbell
- C. Contractors wishing to approve a system other than those specified in this document shall do so in accordance with Section 270000 "1.7 Equivalent Products".

Part 2 - Products

2.1 Pathways & Fittings

A. Communication Underground Boxes

1. Communication Pull Boxes

- Provide separate pre-cast concrete pull boxes, with lids labeled "communications" (for TV, telephone, data, security).
- Type equal to "Christy N16, N30, N40, N44" steel reinforced solid concrete box, concrete lid & 12" extension box shall be used. See project drawings for locations & additional requirements.
- Shall be constructed out of 3000 PSI steel reinforced concrete.
- Install on 6" gravel pad and provide drain. See project details for more info.
- Pull boxes in traffic areas and along roads shall be designed and installed for H20-44 loading.
- Pull boxes shall be located and provided with grade rings as necessary to ensure that water is drained from conduits.
- Pull boxes shall be installed to minimize surface drainage entry as follows:
 1. Pull boxes should not be located in paths or streets. If such location cannot be avoided, pull boxes should not be located in low spots or drainage channels.
 2. Pull boxes not located in paths or streets should be installed so that the top is approximately 2" above final grade.
- All pull boxes shall be installed with a mow strip minimum of 6".
- Non-slip lids shall be provided for pull boxes in sidewalk areas. Use concrete or fiberglass-no metal lids in sidewalks.
- **Quantity:** Contractor will provide pull boxes and covers in the sizes and quantities as shown on the drawings.

2. Communication Vaults

- Provide separate pre-cast concrete vault, with lids labeled "communications" (for TV, telephone, data, intrusion alarm).
- Vaults shall be equipped with a cable racking on the long walls suitable to support large copper cables as called for on the design documents.
- Vaults shall include; Anchorage, Lifting Inserts and Racking Devices.
- All Vaults shall be equipped with traffic-rated lids with a locking mechanism. All lids shall have the identification marking of "Communications" permanently affixed to the cover.
- All pull boxes shall be installed with a mow strip minimum of 12".
- **Quantity:** Contractor will provide vaults and covers in the sizes and quantities as shown on the drawings.
- **Standard Vault** size 24"x36"x36" equal to Old Castle 2436-STD
- **Large Vault** size 36"x60"x36" equal to Old Castle 3660-STD

3. Communication Vault Accessories

UNDERGROUND CABLE RACK HOOKS

Lite Duty Extension

- Formed from 3/16 inch steel
- Hot dipped galvanized per ASTM A123 / A153
- Smooth top surface to protect cables from damage
- Insulator 11A31 fits these hooks
- Part numbers Inwesco or equal

Catalog No.	Extension From
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	Face of Rack (Inches)
10A35	4
10A36	7-1/2
10A37	10
10A38	14
10A39	18

Heavy Duty Extension

- Formed from 10 ga. steel
- Hot dipped galvanized per ASTM A123 / A153
- Unique design locks hook into rack
- Part numbers Inwesco or equal

Catalog No.	Extension From Face of Rack (Inches)
10C38	14

J-Hook Cradle

- Curved design to cradle cable
- Available in fusion bonded epoxy coated steel
- Available in injection molded ABS plastic
- Steel used is 1/4 inch thick x 15/16 inch wide
- ABS plastic hooks are 1-3/8 inch wide
- ABS plastic hooks furnished with locking tab
- Part numbers Inwesco or equal

Catalog No.	Type	Diameter Of Curve (Inches)
10A60	Coated Steel	2-1/2
10B60	Plastic	2-1/2
10A61	Coated Steel	5
10B61	Plastic	5

4. Surface-Mounted Entrance Cabinets Type 1 & 12

- The Contractor shall provide a minimum of a NEMA 1 type enclosure that meets the UL 50, File No. E27567: Type 1 NEMA/EEMAC Type 1 CSA, File No. LL42184: Type 1 IEC 60529, IP30 standards for indoor applications.
- The Enclosure shall be constructed from 16 awg galvanized steel, with a drip shield top and seam free side, front and back.
- The Enclosure shall have a "slip-on" removable front cover held in place with steel screws.
- Enclose shall incorporate pre-punched knockouts for standard trade size conduits up to 1".
- The size of cabinets mounted on an outside wall to serve a smaller building shall be as indicated on the construction plans.
- **Quantity:** Contractor will provide boxes in the sizes and quantities as shown on the drawings.

5. Surface-Mounted Entrance Cabinets Type 3R and 4X
 - The Contractor shall provide a minimum of a NEMA 3R type enclosure that meets the UL 50 for outdoor applications.
 - The Enclosure shall be constructed from 16 awg galvanized steel, with a drip shield top and seam free side, front and back.
 - The Enclosure shall have a "slip-on" removable front cover held in place with steel screws.
 - Enclosure shall incorporate pre-punched knockouts for standard trade size conduits up to 1".
 - The size of cabinets mounted on an outside wall to serve a smaller building shall be as indicated on the construction plans.
 - **Quantity:** Contractor will provide boxes in the sizes and quantities as shown on the drawings.

B. Metallic Pull Boxes and Terminal Cans

1. NEMA Type 1 – Screw Cover Cans
 - Used for indoor use only
 - NEMA/EEMAC Type 1, IEC 60529, IP30
 - UL 50, 50E Listed; Type 1; File No. E27525, cUL Listed per CSA C22.2 No 40; Type 1; File No. E27525
 - 16, 14 or 12 gauge steel or plated steel
 - ANSI 61 gray polyester powder paint finish inside and out.
 - Minimum size 6x6x4
 - Pre-Approved Sizes
Hoffman ASE6X6X4, ASE10X10X4, ASE12X12X4, ASE18X12X4, ASE18X18X4
Hoffman ASE6X6X6, ASE10X10X6, ASE12X12X6, ASE18X12X6, ASE18X18X6, ASE24X18X6, ASE24X24X6
 - Provide "NK" for No Knock-Outs as required.
 - Provide "AFE" Flush Covers as required.
 - Provide "AFDF" Flush Doors on all cans in user accessible areas IE; Data Closets, Electrical Rooms, Janitor Rooms, and Mechanical Rooms.
 - Provide "ACLFDF" Lock Kits for all cans in student areas.
2. NEMA 3R Terminal Cans
 - Used for outdoor use under-eave, breezeway or parapet
 - NEMA/EEMAC Type 3R, IEC 60529, IP32
 - UL 50, 50E Listed; Type 3R; File No. E27567, cUL Listed per CSA C22.2 No 94; Type 3R File No. E27567
 - 16 gauge galvanized steel
 - ANSI 61 gray polyester powder paint finish inside and out over galvanized steel.
 - Minimum size 12x12x6
 - Hoffman A12R126HCR, A18R186HCR, A20R208HCR, A30R308HCR
3. NEMA 4 Terminal Cans
 - Used for outdoor use vertical or Horizontal under-eave, breezeway or parapet
 - 16 or 14 gauge steel (see table)
 - Seams continuously welded and ground smooth
 - Stainless steel door clamps on three sides of door
 - ANSI 61 gray polyester powder paint finish inside and out over galvanized steel.
 - Minimum size 16x16x6
 - Hoffman A16H16ALP, A20H20ALP, A24H24ALP, A36H24ALP

C. Conduit

1. Rigid Steel Conduit

- Rigid steel conduit shall comply with Underwriter's Laboratories UL-6 Specification, ANSI C80.1 and Federal specification WW-C-581E or latest revisions. Conduit shall be hot dip galvanized on the exterior, with zinc or enamel on the interior.
- Couplings, locknuts, and all other fittings shall be galvanized or sheardized, waterproof and threaded type only. Rigid conduit shall terminate with two locknuts; one outside and one inside enclosures and specified bushings. No running threads or chase nipples shall be issued without approval.
- Bushings shall be non-metallic for 1 inch and smaller and insulated metallic for conduits larger than 1 inch.
- **Galvanized rigid steel conduits (GRC)** may be used in all locations. For underground runs in direct contact with earth, conduit shall be wrapped in 10mil PVC tape or shall be factory PVC-over-GRS conduit.
- **Intermediate metallic conduit (IMC)** may be used indoor and outdoor locations, not underground.

2. Electrical Metallic Tubing (EMT)

- EMT conduit shall comply with Underwriter's Laboratories UL 797, ANSI C80.3 and Federal Specification WW-C-563 or latest revision. EMT shall be galvanized or sheardized.
- Couplings and connectors for EMT shall be galvanized or cadmium plated and shall be of the compression type requiring the tightening of a nut on a gland ring. No die cast type shall be allowed. All connections shall have permanent insulated throats.
- **Electrical metallic conduit (EMT)** may be used indoor and outdoor locations, not underground, not in areas subject to physical damage, not in concrete slabs, not in hazardous areas, not in masonry walls.

3. Schedule 40 PVC:

- The minimum conduit trade size allowed for this project will 2". Contractor will increase to the next higher trade size if conduit fill ration will exceed 40%.
- Conduit shall be Carlon or equal, rated for use with 90° C conductors, UL Listed or approved equal. Material shall comply to NEMA Specification TC-2 (Conduit), TC-3 (Fittings) and UL 651 (Conduit) and 514b (Fittings).
- Conduit and fittings shall carry a UL label (Conduit - on each 10 foot length; Fittings - stamped or molded on each fitting).
- Conduit and fittings shall be identified for type and manufacturer and shall be traceable to location of plant and date manufactured. The markings shall be legible and permanent.
- The Conduit shall be made from polyvinyl chloride compound (recognized by UL) which includes inert modifiers to improve weatherability and heat distortion. Clean rework material, generated by the manufacturer's own conduit production, may be used by the same manufacturer, provided the end products meet the requirements of this specification.
- The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar conductors or Cables.
- Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity.
- Testing and Acceptance Criteria: Conduit and fittings shall be tested in accordance with the testing requirements defined in NEMA TC-2, NEMA TC-3 and UL-651 and 514. The acceptance criteria shall be given in the same standards.

- All conduit and fittings shall be solvent cemented in applications in accordance with instructions from the manufacturer.
 - Conduit Spacers
 - High impact spacers shall be used in all multi-conduit duct banks (five or more conduits). The spacers shall conform to NEMA TC-2, TC-6, TC-8, and ASTM F 512.
 - Spacers shall be installed and secured following the manufacturer's suggested guidelines, the BICSI CO-OSP Manual, or TIA/EIA 578, whichever is more stringent.
4. Pipe hangers for individual conduits shall be factory made, consisting of a pipe ring and threaded suspension rod. The pipe ring shall be malleable iron, split and hinged, or shall be interlocked with the suspension rod socket.
 5. Pipe racks for a group of parallel conduits shall be galvanized structural steel preformed channels of length as required, suspended on threaded rods and secured thereto with nuts above and below the cross bar. All offsets shall be in the same plane and shall be parallel.
 6. Factory made pipe straps shall be one-hole malleable iron or two-hole galvanized clamps.
 7. Manufacturer: Appleton, Crouse-Hinds, B-Line, Unistrut, T&B, or an approved equivalent product.
 8. Conduit Terminations and Plugs
 - All conduits entering a vault or pullbox shall be equipped with a bell-end securely attached to the structure.
 - All metal conduits shall be equipped with a bushing or end collar to protect cable during placement.
 - All unused conduits placed on this project or cleaned and modified by the Contractor shall be equipped with reusable rubber or plastic expansion seal plugs in all utility vaults/pull boxes and within all buildings.
 - Conduit Flexible Type
 - **Flexible conduit** "Steel Flex or Aluminum Flex" may only be used for attic j-box to device connection, where specified in the project drawings or with consent of the owner/consultant representative.
 - **Liquidtight flexible conduit** may only be used where specified in the project drawings or with consent of the owner/consultant representative.
 - GRC & IMC fittings shall be galvanized rigid steel threaded type. Provide insulated grounding bushings at all enclosures.
 - EMT fittings shall be die cast or steel set screw type for dry locations, die cast or steel compression type for wet locations. Provide insulated grounding bushings at all enclosures.
 - PVC fittings shall be schedule 40 or schedule 80, provide adapters at all enclosures and transitions to GRC, IMC or EMT conduits.
 - Flexible fittings shall be die cast or steel type.
 - Liquidtight fittings shall be steel compression type.
 - Provide insulated screw on bushings on all conduit connections.
 - Provide insulated push on bushings for all stubb-out conduits.
 - **Quantity:** Contractor will provide conduits in the sizes and quantities as shown on the drawings.
 9. Textile Innerduct - MaxCell
 - Made from White Polyester and Nylon resin polymer
 - Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
 - Detectable Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb

polyester flat woven pull tape, and a solid copper, polyvinyl color coated conductor (19AWG minimum) for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the textile sleeve.

- Indoor Textile Innerduct (Riser-listed): Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
- Plenum-Listed Textile Innerduct: Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.
- Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.: 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
- Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
- Pull Tape: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.
- Duct Water Seal: products suitable for closing underground and entrance conduit openings where innerduct or cable is installed, to prevent entry of gases, liquids, or rodents into the structure.
- Approved Textile Innerduct #'s
MXC4003, MXR4003
MXC3456, MXP3456, MXR3456
MXC2003, MXP2003, MXR2003
MXC2002, MXP2002, MXR2002

D. Duct Bank Locating Cable (Detectable Warning Tape)

1. Warning tape

- Warning Tape shall be a minimum of 3" wide, orange in color, 4 mils thick, and shall have an imprint as follows:
 - "Caution Telephone Cable Buried Below" or,
 - "Caution Fiber Optic Cable Buried Below"

E. Inter-duct

1. Plenum

- White or orange Kynar PVDF Resin, a fluoropolymer compound.
- Plenum rated flexible optical fiber/communication raceway.
- Provide wire management in a building for fiber optic and data and communications cabling.
- Recognized per NEC Articles, 770 and 800 for Plenum, Riser and General Purpose Raceway for optical fiber, and telecommunications cables.
- UL Listed
- Meets UL 910 standards for Plenum Optical Fiber/Communications raceways.
- Provide all fittings to form a complete integrated raceway system.
- Extrude raceway from precision extruded PVDF resin
- 1"-2" diameter raceway shall have a 1/4" wide 1250 lb. tensile pull tape preinstalled.
- Shall be available in 3/4" through 2" diameters.
- Footage shall be sequentially marked.
- Threaded Aluminum Coupling: Molded Aluminum fitting which connect two pieces of corrugated tubing equipped with threaded ends.

- Quick-Connect Couplings: Molded Part which allows two pieces of 1" diameter corrugated tubing to be quickly snapped together. Available only in 1" diameter.
 - Quick-Connect Threaded Male Adapters: Molded fitting which quickly snaps onto a 1" diameter piece of corrugated tubing to produce a threaded end. Available only in 1" diameter.
 - Quick-Connect Male Snap-In Adapters: Molded fitting which snaps onto a 1" diameter piece of corrugated tubing to connect to an outlet or switch box. Available only in 1" diameter.
 - Metallic Terminal Adapters: Molded metal part which allows a piece of corrugated tubing to connect to metallic conduit and metallic boxes.
 - **Spool Length: Varies**, contractor shall field verify prior to ordering.
 - **Color: Orange**
 - **Part #: Carlon**
 - ¾" CE4X1-1000
 - 1" CF4X1C-1000
 - 1-1/4" CG4X1C-900
 - 1-1/2" CH4X1C-1200
 - 2" CJ4X1C-1400
2. Riser
- Orange polyvinyl chloride (PVC)
 - Riser rated Flexible Optical Fiber/Communication Raceway.
 - Provides wire management for fiber optic and data and communications cabling in Riser applications and/or General Purpose applications within a building or for direct burial or concrete encasement.
 - Recognized per NEC Articles, 770 and 800 for Plenum, Riser and General Purpose applications for optical fiber, and telecommunications cables.
 - UL Listed
 - Listed under UL 1666 - Standard for Riser Application for Optical Fiber Raceway.
 - Provide all fittings to form a complete integrated raceway system.
 - Fabricate Raceway from precision extruded PVC resin.
 - Kevlar_ pull tape can be preinstalled in the 1" through 2" diameter.
 - The footage shall be sequentially marked.
 - Shall be available in ¾" through 2" diameters.
 - Threaded Aluminum Coupling: molded Aluminum fitting which connect two pieces of corrugated tubing equipped with threaded ends.
 - Quick-Connect Couplings: Molded Part which allows two pieces of corrugated tubing to be quickly snapped together. Available only in ½"-1" diameter.
 - Quick-Connect Threaded Male Adapters: Molded fitting which quickly snaps onto a piece of corrugated tubing to produce a threaded end. Available only in ½"-1" diameter.
 - Quick-Connect Male Snap-In Adapters: Molded fitting which snaps onto a piece of corrugated tubing to connect to an outlet or switch box. Available only in ½"-1".
 - Metallic Terminal Adapters: Molded metal part which allows a piece of corrugated tubing to connect to metallic conduit and metallic boxes.
 - Schedule 40 Fittings: Molded fitting that is solvent cemented to the raceways. Schedule 40 fittings are commonly used with PVC Schedule 40 rigid conduit.
 - **Spool Length: Varies**, contractor shall field verify prior to ordering.
 - **Color: Orange**

- **Part #: Carlon**
 - ¾" DE4X1-1000
 - 1" DF4X1C-1000
 - 1-1/4" DG4X1C-900
 - 1-1/2" DH4X1C-1200
 - 2" DJ4X1C-700
- 3. General Purpose for use in Underground Conduit
 - Orange polyvinyl chloride (PVC)
 - General Purpose is nonmetallic flexible raceway for use in General Purpose applications only. It is UL Listed and available with tape pre-installed.
 - General Purpose raceway is listed to UL 2024 in accordance with the National Electrical Code per Articles 725, 770, 800 and 820 for General Purpose and other cabling optical fiber/telecommunication applications.
 - For use in General Purpose areas per Articles 725, 770, 800 and 820 of the NEC.
 - Available in sizes 3/4" through 2"
 - Pull tape can be factory pre-installed in 1" through 2"
 - Outside Diameters meet IPS Dimensions
 - Footage sequentially marked
 - **Spool Length: Varies**, contractor shall field verify prior to ordering.
 - **Color: Orange**
 - **Part #: Carlon**
 - 1" BF4X1B-8000
 - 1-1/4" BG4X1B-5600
 - 1-1/2" BH4X1B-4500
 - 2" BJ4X1B-8000

F. Outlet Boxes

1. Outlet boxes (voice, data and audio visual)
 - All boxes shall be 5 in. Square x 2.875 in. Deep Metal Box with Cable Management minimum. As required provide 4-11/16" square by 2-1/8" deep.
 - Volume: 64 in³ (1050 cm³)
 - Side Knockouts: (1) 1" & (1) 1-1/4" each side
 - Listing: C ETL US; for use on Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits only.
 - Provide ****varied depth**** mud ring as required to allow no more than 1/8" gap between wall materials.
 - Any unused outlet or j-box shall be equipped with a blank cover.
 - Approved Outlet box shall be RANDL Inc. T-55 series or Hubbell HBL260/263 Large Capacity Wall Boxes
2. Outlet boxes (wall phone, microphone and other devices)
 - All boxes shall be 4-11/16" square by 2-1/8" deep minimum.
 - Provide ****varied depth**** mud ring as required to allow no more than 1/8" gap between wall materials.
 - Any unused outlet or j-box shall be equipped with a blank cover.
3. Junction boxes
 - All boxes shall be 4-11/16" square by 2-1/8" deep minimum.
 - Provide ****varied depth**** mud ring as required to allow no more than 1/8" gap between wall materials.
 - Any unused outlet or j-box shall be equipped with a blank cover.
4. Surface Mount boxes

- base has rectangular KO to enable extension from existing single-gang flush wall box and 1/2" and 1" trade size concentric KOs.
- Accepts NEMA Faceplates
- one-gang - 4 3/4" H x 3" W x 2 3/4" D equal to Wiremold # 2344
- two-gang - 4 3/4" H x 4 7/8" W x 2 3/4" D equal to Wiremold # 2344-2

G. Floor Boxes

1. Floor boxes provide the interface between power and communication cabling in an on-grade or above-grade concrete floor where power and communication services are required. Boxes shall provide flush or recessed device outlets that will not obstruct the floor area.
2. Provide floor boxes approved for use in concrete floor construction. Boxes shall be approved for above grade (stamped steel) and on grade (cast iron) applications. Floor boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet UL514A and shall bear the appropriate label. Floor boxes shall conform to the standard set in the National Electrical Code. Multi-compartment box shall have been evaluated by UL to meet the applicable U.S. safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
3. Boxes shall be available in one-, two-, or three-gang configurations or a single unit with four independent wiring compartments and available in stamped steel and cast iron versions. Boxes shall be rectangular in shape and available in deep and shallow versions. Boxes shall provide pre- and post-pour adjustments. Multiple gang boxes shall also provide a removable barrier between the individual compartments for greater capacity when required.
4. Multi-Compartment Boxes: Floor boxes shall be manufactured in stamped steel or cast-iron. Box shall be available in shallow version for stamped steel or cast-iron types and deep version for stamped steel type only. Box shall have four independent wiring compartments that allow up to 4 duplex receptacles and/or communications services.
 - Boxes shall permit a tunneling feature that will allow internal wiring to various compartments. The box shall provide various size conduit openings.
 - Boxes shall be fully adjustable, providing a maximum of 1-7/8 inch pre-pour adjustment, and a maximum of 3/4 inch post-pour adjustment.
 - Boxes shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate connectivity outlets and modular inserts. Where indicated, provide connectivity outlets and modular inserts by Wiremold/Ortronics or approved equal.
 - Activation covers shall be die-cast aluminum. Cover finish shall be one of the following, as selected:
 - a. textured aluminum finish.
 - b. Powder coat finish, color shall be Black.
 - c. Powder coat finish, color shall be Brass,
 - Activation covers shall be available in flanged or flangeless versions as selected. Covers shall be available with options for tile or carpet inserts, blank covers, or covers with one or two 1 inch liquid tight openings for furniture feed applications as applicable.
 - Pre-Approved Floor boxes shall be equal to **Wiremold RFB-4 & RFB-9** series boxes or equal Hubbell System One.
 - Contractor shall provide all required entrance fittings & adapter plates for scope of work depicted.

H. Surface mount raceway "SMR"

1. Non-metallic raceway is an enclosed pathway used for surface distribution of branch circuit electrical wiring, and cabling for voice, data, multi-media, low voltage, and optical fiber. Raceway is typically installed in existing building structures, or after construction is complete. A complete raceway system includes raceway, covers, mounting hardware, various fittings, and outlet boxes installed at specific locations. Specific codes and standards apply to electrical wires and telecommunications cables that are deployed within non-metallic raceway. Codes that are enforced by the local Authority Having Jurisdiction (AHJ) must be observed during construction.
 - Assembly and disassembly of raceway base, cover, and fittings shall require no special tools.
 - Installed fittings shall be designed to overlap the raceway junction to cover exposed or uneven edges.
 - Security caps shall provide enhanced tamper protection by installing over the assembled raceway in desired locations.
 - Raceway shall be designed to accept inline device boxes with either horizontal or vertical faceplate orientations.
 - Device boxes shall have a removable knockout portion to permit raceway entry and exit. Device boxes shall serve as an extension box by removing a single knockout.
 - Device boxes shall be available in standard NEMA single, double, and 3-gang versions. Device box color shall match raceway color.
 - Device boxes shall accommodate various faceplates that accept modular connector inserts or bezels for balanced twisted pair, fiber optic, coaxial, multi-media, and other low voltage cabling connectors.
 - Faceplates for device boxes shall accommodate pre-printed labels for proper electrical identification, or telecommunications port identification according to ANSI/TIA/EIA-606-A.
 - Faceplates shall be available in colors that match the device box and raceway.
 - Category rated communications jacks installed in surface box faceplates shall have provisions for snap-in icons for further identification.
2. 5400 Series
 - The raceway shall be a two-piece design with a base and snap-on covers. The raceway base shall accept both a single cover that spans the entire base or two individual TwinSnap™ covers. Total width shall be 5.25" [133mm] by 1.75" [44.5mm] deep with an approximate thickness of .095" [2.4mm]. The base and cover shall be available in 8' [2.4m] lengths. The raceway shall be available with two (5400TB) or three (5400TBD) wiring channels.
 - The 5400TB Series Base shall have two wiring channels separated by one integral barrier. Each channel must be large enough to accept standard power and communication devices without restricting capacity of the adjacent channel. The 5400TBD Series Base shall have three wiring channels separated by two integral barriers forming 1/2, 1/4, and 1/4 compartments. One channel must be large enough to accept standard power and communication devices without restricting capacity of the other channels. The 5400C Series Cover shall span the entire width of the base concealing all of the wiring channels. The 5400TC Series Cover shall have flanges for snapping onto the base side walls and center barrier. The cover shall span one-half the width of the base, providing independent access to services.
 - A complete line of full capacity corner elbows and tee fittings must be available to maintain a controlled 2" [51mm] cable bend radius which

meets the specifications for Fiber Optic and UTP/STP cabling and exceeds the TIA / EIA 569-A requirements for communications pathways. They shall be manufactured of a rigid PVC compound. A full complement of fittings must be available including, but not limited to tees, entrance fittings, cover clips, and end caps. They shall be manufactured of a rigid PVC compound. The fittings shall have a matte texture, in ivory or white colors to match the base and cover. They shall overlap the cover and base to hide uneven cuts. All fittings shall be supplied with a base where applicable to eliminate mitering. A transition fitting shall be available to adapt to other Wiremold series raceways.

- Device brackets shall be available for mounting standard devices in-line or offset from the raceway. A device bracket shall provide up to three single-gang openings at one location. Faceplates shall be 5507 Series that match and fit flush in the device plate. They shall be manufactured of rigid PVC compound.
- The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP, STP (150 ohm), fiber optic, coaxial and other cabling types with faceplates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons, as well as write-on station identification labels shall be available.

I. Cable Tray Systems

Provide cable tray system to route power and communications cable distribution for utility needs. Cable tray system shall consist of cable tray and appropriate fittings for a complete installation.

1. Cable tray is to be utilized in locations only as covered in Article 392 of the National Electric Code, as adopted by the National Fire Protection Association and as approved by the American National Standards Institute.
2. Trays shall be constructed of 6063 T6 and T5 aluminum alloys and shall utilize center lines to indicate all areas where after field cutting of tray, new holes need to be drilled or screws inserted (Center Spine, Twin Spine, Ladder Style and Wall Mounted Trays).
3. Ladder Tray: Cable tray shall be constructed to form an open and accessible compartment to hold the necessary cables. The tray shall be constructed of two components, (1) two longitudinal support rails (side rails) and (2) the rungs. The rail shall be a single aluminum extrusion with extending flanges that provide rung support. The rungs shall have 7/8 inch cable laying surface and be attached with sheet metal screws to the two side rails on 6 inch, 9 inch or 12 inch centers, creating a cable laying area between the rails.
4. Wall Mounted Cable Tray: Cable tray shall be constructed to form an open and accessible compartment to hold the necessary cables which also enables full viewing of the compartment. The tray shall be wall mounted allowing cable lay-in where applicable.
 - Trays shall be constructed with two components, (1) the main support which is the spine and (2) the rungs. The spine shall be a single aluminum extrusion designed with a lower cavity which has extending wings and provides rung support.
 - Rungs shall have a 1 inch cable laying surface, and be attached on 6 inch, 9 inch or 12 inch centers, and protrude from the spine only on one side. The end of the rungs shall be bent upward to the height of 3 inches, 4 inches or 6 inches as applicable forming a 90 degree angle. This creates a cable laying area between the spine and the vertical portion of the rung. The rung shall be designed with a center screw groove along its length to provide a direct

- connection for rung mounted accessories. The ends of all rungs shall be fitted with a plastic cap to prevent damage to the cable and injury to the installer.
- For multi-tier wall mounted trays, the lower rungs shall be mounted through the entire vertical distance of the spine and project down, be bent outward, then up from one side only, forming a 'J' hook shape. These rungs shall be fixed in place with a sheet metal screw through the top of the spine which allows for replacement or expansion of the tray area.
 - Top and bottom rungs shall form two or three tiers of cable tray, one above the other, attached to one single support member or spine.
 - Tray shall not have side rails and shall offer an open view of the cables.
5. A full complement of fittings for the cable tray shall be available including, but not limited to, 45 and 90 degree flat, vertical inside and outside elbows, tee and cross fittings, couplings for joining sections of the tray, hangers, end blanks, field-installed dividers and all other components necessary to make the system perform as intended. The fittings and accessories shall be of a compatible material.
6. Ladder Rack Cable Runway
- Stringers shall be fabricated from ASTM A513 Steel tubing.
 - Rungs shall be fabricated from 3/8"x1 1/2" steel channel welded
 - Rungs shall be spaced at 12.0" center to center
 - Ladder Rack shall have a powder coat finished.
 - Ladder Rack shall be individually boxed
 - Ladder rack shall be apart of a total system that includes: manufacture bends, wall supports, joining hardware, etc.
 - Ladder Rack shall be grounding per the TIA/EIA 607-A.
 - Ladder Rack shall be UL listed- File number E60548
 - **Color:** Ladder Rack will be **BLACK**
 - **Quantity:** See Drawing for quantity and installation details.
 - **Part#:** Cooper B-Line Ladder Rack, PN# SB17U12BFB or equal by CPI
7. Wire Basket Cable Runway
- Wire mesh cable tray shall be manufactured from round carbon steel wires that are 5 mm and 6 mm in diameter. Wires shall be welded at intersections to form a 2" x 4" grid pattern. The tray shall be U-shaped with equal height sidewalls.
 - Individual tray sections shall be 10' long and 4", 6", 8", 12", 16", 18", 20", or 24" wide. Sidewalls shall be 4" high, as specified below.
 - Wire mesh cable tray shall be zinc electroplated after fabrication, galvanized before fabrication (pre-galvanized) or painted black with powder coat paint, as specified below.
 - Wire mesh cable tray that is 6" wide or wider shall be UL Classified for suitability as an equipment grounding conductor only. Pre-galvanized trays shall be UL Classified in the United States. Painted tray shall be UL Classified in the United States.
 - Ladder Rack shall be grounding per the TIA/EIA 6A07-A.
 - **Color:** Zinc Electroplate
 - **Quantity:** See Drawing for quantity and installation details.
 - **Part#:** Equal to Chatsworth Products OnTrac
 - Part Number 34821-504, 4" High x 4" Wide x 10' Long.
 - Part Number 34821-506, 4" High x 6" Wide x 10' Long.
 - Part Number 34821-508, 4" High x 8" Wide x 10' Long.
 - Part Number 34821-512, 4" High x 12" Wide x 10' Long.
 - Part Number 34821-516, 4" High x 16" Wide x 10' Long.
 - Part Number 34821-518, 4" High x 18" Wide x 10' Long.

- Part Number 34821-520, 4" High x 20" Wide x 10' Long.
 - Part Number 34821-524, 4" High x 24" Wide x 10' Long.
- Provide all installation hardware required for installation whether shown on the plans or not. Some of the supports may require design build application and shall be included by the contractor without notice.
 - OnTrac Standard Splice Kit
 - OnTrac Splice Bar
 - OnTrac Splice Washer & Bolt Kit
 - OnTrac Spring Splice Kit
 - OnTrac Clamp Washer
 - OnTrac Carriage Bolt Hardware Kit
 - OnTrac 90° Splice Bar Kit
 - OnTrac Rack-Mount Hook
 - OnTrac Pedestal Clamp Bracket
 - Split Bolt Grounding Clamp
 - OnTrac Cable Tray Divider
 - OnTrac Cover
 - OnTrac Cable Tray Bottom Insert
 - OnTrac Cable Tray Liner
 - OnTrac Tool-Less Radius Drop
 - OnTrac Large Radius Drop
 - OnTrac Vertical Radius Bracket
 - OnTrac Electrical Box Bracket
 - OnTrac Conduit Bracket
 - OnTrac Auxiliary Side Bracket
 - OnTrac Section Support Bracket
 - OnTrac Label Holder
 - OnTrac Cable Tray Cutting Tool
 - Threaded Rod, 3/8-16
 - Threaded Rod Coupling Kit, 3/8-16
 - Threaded Rod I-Beam Clamp, 3/8-16
 - Hex Nut, 3/8-16
 - Split Lock Washer, 3/8"
 - Washer, 3/8"
 - Hex Lag Screw, 3/8-7 x 2" Long
 - Hex Lag Screw, 1/4-10 x 2" Long
 - Split Lock Washer, 1/4"
- Provide all support systems required for installation whether shown on the plans or not. Some of the supports may require design build application and shall be included by the contractor without notice.
 - OnTrac Wire Mesh Cable Tray System Supports
 - OnTrac Ceiling Center Support Bracket
 - OnTrac Ceiling Edge Hanger
 - OnTrac Ceiling Trapeze Support Bracket
 - OnTrac Wall/Ceiling C-Support Bracket
 - OnTrac Wall L-Support Bracket
 - OnTrac Wall Triangle Support Bracket
 - OnTrac Wall-Mount Angle
 - OnTrac Under Floor Support
 - OnTrac Under Floor C-Bracket
 - OnTrac Pedestal Clamp Bracket Kit

J. Cabling Support System
1. Telco Backboards

- Backboards shall be 4' x 8' x .75" void free plywood (ACX Plywood with the "A" side turned out).
 - The plywood shall be painted with two coats of white fire retardant paint.
 - Cut full size sheet to required size for application type, minimum 6" larger than equipment installed.
2. J-Hooks
- Cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
 - Cable supports shall have flared edges to prevent damage while installing cables.
 - Cable support system shall provide fasteners that allow them to be mounted to wall, concrete, joist, tee-bar wire, treaded rod, beams and raised floor supports.
 - Fasteners shall have the ability to either be factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 - Fastener to with one non-continuous cable support, factory or jobsite assembled.
 - **Color:** NA
 - **Quantity:** Contractor will provide quantities of j-hooks and hanger accessories in the amount necessary to support all horizontal cabling every 4-5 feet.
 - **Part#:** ERICO CAT425, Cooper B-Line BCH12, BCH21, BCH32, BCH64 and accessories.

K. Pull Rope

1. Pulling Ropes (Mule tape)
- Pull ropes shall be 1/2" flat tape with a minimum tensile strength of 1200 lbs.
 - Ropes shall be pre-lubricated, woven polyester or aramid fiber tape made from low friction, high abrasion resistant yarns providing a low coefficient of friction. Tape shall be printed with sequential footage markings for accurate measurements.
2. Empty Conduits
- Pull rope shall be new 1/4" polypropylene over polyester rope with a minimum 1200 lb. tensile strength.
 - Every empty conduit shall be equipped with a pull rope secured to the duct plug at each end.
3. Installed with Cables:
- Pull rope shall be new 1/8" polypropylene string with a minimum 750 lb. tensile strength.
 - Contractor will be required to install a pull string into every conduit that they pull cabling.

2.2 Fire Stop Systems

A. General

1. Sleeves shall be 2", 3" or 4" EMT or smaller. All cables penetrating walls must be sleeved.
2. Sleeves shall maintain a 40% conduit fill ratio.
3. Sleeves must be supported or attached at walls by apparatuses meant to do so. All sleeves shall be rigidly and properly supported.
4. Sleeves must extend past inaccessible areas.
5. Sleeves must be protected by a U.L. rated system at all firewalls designated on the construction drawings.
6. Fire stopping shall be a material, or combination of materials, to retain the integrity of time-rated construction by maintaining an effective barrier against the

spread of flame, smoke, and gases. It shall be used in specific locations as follows:

- Duct, cables, conduit, piping, and cable tray penetrations through floor slab and through time-rated partitions or fire walls.
 - Openings between floor slab and curtain walls, including inside hollow curtain walls at the floor slab.
 - Penetrations of vertical service shafts.
 - Openings and penetrations in time-rated partitions of fire walls containing fire doors.
 - Locations where specifically shown on the drawings or where specified in other sections of the Standards.
7. Fire stopping materials shall be asbestos free and capable of maintaining an effective barrier against flame, smoke, and gasses in compliance with requirements of ASTM E 814, and UL 1479. Only listed fire stopping material acceptable to State, County, and City codes shall be used.
8. The rating of the fire stops shall in no case be less than the rating of the time rated floor or wall assembly.
9. All Fire stopping Locations (FSL) shall be labeled within 12" of the fire stopping material on each side of the penetrated fire barrier. The format for the Fire stopping Location identifier shall display the Telecom Room floor number, the Fire stopping Location number, and the hour rating of the fire rating system (e.g. 1-FLS001 (2)). Each fire stopping location shall be identified with a fire stopping warning label. The label shall include the manufacturer of the product, the installer and company name, the UL number for the product, the rating of the material, the installation date, and the number and type of cables passing through the opening. The fire stopping warning label can include the fire stopping location identifier, eliminating the need for a separate label. Penetration modifications requiring the repair/re-installation of the fire stopping material require the addition of a new fire stopping warning label. No previous fire stopping warning labels shall be removed or obscured by new labels. In the event the penetration is completely cleaned of existing fire stopping material, and new material is installed, the previous label shall be removed or obscured completely.
10. Manufacturers; Specified Technologies Inc., 3M & Hilti
- SSS - intumesant sealant
 - SSP - putty and putty pads
 - SSAMW - mineral wool
 - IC 15WB+ - intumesant sealant
 - CP 25WB+ - intumesant sealant
 - Fire Barrier Moldable Putty+ - putty and putty pads
 - FS-ONE - intumesant sealant
 - CP 618 - putty and putty pads.

B. Single Entry System

- The fire stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure.
- Fire stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall use the proper fire stop equipment.

- Fire stop systems shall be UL Classified to ASTM E814 (UL 1479).
 - **Quantity:** See Drawing for quantity and installation details.
 - **Part#:** Equal to STI, PN# SSS100
- C. Re-Enterable Fire Stop System
- The re-enterable fire stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure.
 - No additional fire stopping material shall be required to obtain proper fire stopping.
 - The system shall offer full fire resistance whether it is empty or 100% visually filled.
 - The system shall be self-contained, and shall automatically adjust to differing cable loads.
 - The system shall allow add, moves, and changes without additional materials.
 - All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate re-enterable fire stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall use the proper fire stop equipment.
 - Fire stop systems shall be UL Classified to ASTM E814 (UL 1479).
 - The system shall be gang-able using wall plates for additional capacity.
 - **Quantity:** See Drawing for quantity and installation details.
 - **Part #:** Equal to STI
STI PN# EZDP33FWS
STI PN# EZDP33WR

2.3 Grounding/Bonding Systems

- A. Grounding and Bonding Equipment
1. Telecommunications Main Grounding Busbar (TMGB)
 - Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
 - The buss bar shall be 4" (100 mm) high and 12" (300 mm) long and shall have 18 attachment points (two rows of 9 each) for two-hole grounding lugs.
 - The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 15 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 - The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
 - The busbar shall be UL Listed as grounding and bonding equipment.
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Telecommunications Main Grounding Busbar: Part Number 40153-012, 12" x 4" (300 mm x 100 mm) Telecommunications Main Grounding Busbar, UL Listed.
 2. Telecommunications Grounding Busbar (TGB)
 - Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
 - The busbar shall be 2" (50 mm) high and 10" (250 mm) long and shall have 7 attachment points (one row) for two-hole grounding lugs.

- The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 4 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 - The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
 - The busbar shall be UL Listed as grounding and bonding equipment.
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Telecommunications Grounding Busbar:
Part Number 13622-010, 10" x 2" (250 mm x 50 mm) Telecommunications Grounding Busbar, UL Listed.
3. Horizontal Rack Busbar
- Horizontal rack-mount busbar shall be constructed of 3/16" (4.7 mm) thick by 3/4" (19.1 mm) high hard-drawn electrolytic tough pitch 110 alloy copper bar.
 - Bar shall be 19" EIA or 23" rack mounting width (as specified below) for mounting on relay racks or in cabinets.
 - Bar shall have eight 6-32 tapped ground mounting holes on 1" (25.4 mm) intervals and four 0.281" (7.1 mm) holes for the attachment of two-hole grounding lugs.
 - Each bar shall include a copper splice bar of the same material (to transition between adjoining racks) and two each 12-24 x 3/4" copper-plated steel screws and flat washers for attachment to the rack or cabinet.
 - Bar shall be UL Listed as grounding and bonding equipment.
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Horizontal Rack Busbar: Part Number 10610-019, Ground Bar for 19" Rack.
4. Two Mounting Hole Ground Terminal Block
- Ground terminal block shall be made of electroplated tin aluminum extrusion.
 - Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
 - The conductors shall be held in place by two stainless steel set screws.
 - Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
 - Ground terminal block shall be UL Listed as a wire connector.
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Two Mounting Hole Ground Terminal Block:
Part Number 40167-001, Two Mounting Hole Ground Terminal Block, 1 each
 - Compression Lugs
 - Compression lugs shall be manufactured from electroplated tinned copper.
 - Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
 - Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
 - Compression lugs shall be UL Listed as wire connectors.
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Compression Lugs:
Part Number 40162-901, Compression Lug, #6 Awg, 5/8" (15.8 mm) hole spacing, 1 each.
Part Number 40162-903, Compression Lug, #6 Awg, 1" (25.4 mm) hole spacing, 1 each.

- Part Number 40162-904, Compression Lug, #2 Awg, 5/8" (15.8 mm) hole spacing, 1 each.
 - Part Number 40162-907, Compression Lug, #2 Awg, 1" (25.4 mm) hole spacing, 1 each.
 - Part Number 40162-909, Compression Lug, 2/0 Awg, 1" (25.4 mm) hole spacing, 1 each.
 - Part Number 40162-911, Compression Lug, 4/0 Awg, 1" (25.4 mm) hole spacing, 1 each.
5. Antioxidant Joint Compound
- Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Antioxidant Joint Compound:
 - Part Number 40168-101, Antioxidant Joint Compound, Copper-to-Copper Connections, .5 oz, 1 each.
 - Part Number 40168-801, Antioxidant Joint Compound, Copper-to-Copper Connections, 8 oz, 1 each.
 - Part Number 40166-101, Antioxidant Joint Compound, Aluminum-to-Aluminum or Aluminum-to-Copper Connections, .5 oz, 1 each.
 - Part Number 40166-801, Antioxidant Joint Compound, Aluminum-to-Aluminum or Aluminum-to-Copper Connections, 8 oz, 1 each.
 - Part Number 40168-150, Antioxidant Joint Compound, Copper-to-Copper Connections, .5 oz, 50 each.
 - Part Number 40168-812, Antioxidant Joint Compound, Copper-to-Copper Connections, 8 oz, 12 each.
 - Part Number 40166-150, Antioxidant Joint Compound, Aluminum-to-Aluminum or Aluminum-to-Copper Connections, .5 oz, 50 each.
 - Part Number 40166-812, Antioxidant Joint Compound, Aluminum-to-Aluminum or Aluminum-to-Copper Connections, 8 oz, 12 each.
6. C-Type, Compression Taps
- Compression taps shall be manufactured from copper alloy.
 - Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool
 - Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0, as stated below.
 - Compression taps shall be UL Listed.
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Compression Taps:
 - Part Number 40163-001, Compression Tap, #6 AWG Solid Run to #6 AWG Solid Tap, 1 each.
 - Part Number 40163-007, Compression Tap, 2/0 Stranded Run to 2/0 Stranded Tap, 1 each.
7. Pipe Clamp With Grounding Connector
- Pipe clamp shall be made from electroplated tinned bronze. Installation hardware will be stainless steel.
 - Pipe clamp shall be sized to fit up to two conductors ranging in size from #6 to 250 MCM; conductors must be the same size.
 - Pipe clamp installation hardware shall be sized to attach to pipes, sizes 1" to 6" (.75" to 6.63" in diameter), as stated below.
 - Pipe clamp shall be UL Listed as grounding and bonding equipment.

- Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Pipe Clamps:
 - Part Number 40170-002, Pipe Clamp, for 1" to 1-1/4" pipe, 1 each.
 - Part Number 40170-003, Pipe Clamp, for 1-1/2" to 2" pipe, 1 each.
 - Part Number 40170-004, Pipe Clamp, for 2-1/2" to 3" pipe, 1 each.
 - Part Number 40170-005, Pipe Clamp, for 3-1/2" to 4" pipe, 1 each.
 - Part Number 40170-006, Pipe Clamp, for 5" to 6" pipe, 1 each.
8. Equipment Ground Jumper Kit
- Kit includes one 24"L insulated ground jumper with a straight two hole compression lug on one end and an L-shaped two hole compression lug on the other end, two plated installation screws, an abrasive pad and a .5 ounce tube of antioxidant joint compound.
 - Ground conductor is an insulated green/yellow stripe #6 AWG wire
 - Lugs are made from electroplated tinned copper and have two mounting holes spaces .5" to .625" apart that accept 1/4" screws.
 - Jumper will be made with UL Listed components
 - Design Make shall be:
 - Chatsworth Products, Inc. (CPI),
 - Equipment Ground Jumper Kit:
 - Part Number 40159-010, Equipment Ground Jumper Kit, 1 each.

B. Communications raceways, backboards and rack systems

1. The conduit system must be permanently and effectively grounded, in accordance with Title 24 of the California Code of Regulations, California Electric Code #250, and National Electric Code or as required by local AHJ. If in confusion or conflict the most stringent specification shall apply.
2. Provide as a minimum a #1/0awg THHN conductor in conduit from the main building grounding point to a 1/4" x 4" x 5.25" telecommunications grounding bus bar(TGB) at every backboard.
3. Provide as a minimum #6awg green THHN conductor from each equipment rack, cable tray or wall mounted equipment to a TGB.

2.4 Concrete for Telecom Systems

A. All Concrete

1. Refer to Section 03xxxx Concrete; all concrete shall be governed by this specification.
2. Furnish to the AHJ a mix design showing the proposed weights of water, aggregate and cement per cubic foot of concrete a minimum of 7 days prior to beginning placement.
3. Proportion the cement, water and aggregate to obtain concrete with good workability.
4. Use Type I Portland Cement for slurry mix and Type II for riprap grout. according to ASTM C 150.

B. Concrete Slurry

1. Fine aggregate for concrete slurry shall completely pass the 3/8" sieve with no more than 5% passing the No. 100 sieve. The fine aggregate shall contain no silt, loam, clay or organic particles.

C. Concrete RipRap Grout

1. Fine aggregate for riprap grout shall completely pass the No. 4 sieve with no more than 5% passing the No. 100 sieve.

- D. Ensure that the concrete slurry develops a 12-hour compressive strength of 500 psi and a slump of 7 inches, +/- 1 inch for concrete slurry; the riprap

grout requires a 28-day minimum strength of 3000 psi and a slump of 4 inches +/- 1 inch. Furnish concrete for specimens.

- E. Concrete shall be placed as nearly as practical to its final position to avoid flow causing segregation of the aggregate. Concrete should not be dropped more than 5 feet vertically without the use of a tremie or similar device. Do not place concrete in a manner that will cause the pipe to float. Vibrate or rod the concrete as necessary to remove voids.

Part 3 - Execution

3.1 General

A. Permits and Licensing

1. Contractor is responsible to procure all necessary permits before the commencement of their work to the city or state agencies as required. It is the contractor's responsibility to provide all documentation to the AHJ.
2. Contractor is responsible to procure all necessary licenses for the city or state they are commencing the work in, before the commencement of their work begins.
3. Contractor to procure all encroachment permits as it pertains to the work described in these documents.
4. No person may access or enter in any way, an underground vault or confined space without the training, staff, and safety equipment defined on the confined space permit. Accessing these spaces without a valid permit or without the required support services will be cause for an order to stop work until all violations are resolved and may result in a fine or suspension of the workers involved.

B. Safety

1. All federal (OSHA), state, and local safety rules, will be enforced at all times during the duration of the project. It is the responsibility of the Contractor to conduct frequent inspections of the job site to ensure compliance.

3.2 Installation

A. INTRA-BUILDING PATHWAYS

A. COMMUNICATION VAULTS

1. Site Access
 - The general contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete units.
2. Installation
 - Precast concrete units shall be installed to the lines and grades shown in the contract documents or otherwise specified.
 - Precast concrete units shall be lifted by suitable lifting devices at points provided by the precast concrete producer.
 - Precast concrete units shall be installed in accordance with applicable industry standards. Upon request, the precast concrete producer shall provide installation instructions.
 - Field modifications to the product shall relieve the precast producer of liability regardless if such modifications result in the failure of the precast concrete unit.
3. Water tightness

- Where water tightness is a necessary performance characteristic of the precast concrete unit's end use, watertight joints, pipe-entry connectors and inserts should be used to ensure the integrity of the entire system.

B. CONDUIT

1. All conduit shall be routed parallel or perpendicular to walls.
2. All conduit shall be installed in accordance with NEMA "Standard of Installation" and shall meet applicable local and national building and electrical codes or regulations.
3. Conduit runs shall not exceed 100 feet or contain more than two 90 degree bends without utilizing appropriately sized pull boxes. No conduits may enter a pull box at a 90 degree angle. They are not to be installed into the side of a pull box. All conduits must enter the ends of the pull box.
4. All conduits entering a building from outside shall be plugged with reusable stoppers to eliminate the entrance of water or gases into the entrance room. Building entrance conduits shall slope downward away from the building to reduce the potential of water entering the building. All building penetrations are to be sealed from wall to wall and on the outside and inside of the penetrations.
5. All conduits penetrating a fire or smoke barrier shall be fully sealed between the conduit and the actual penetration following manufacturer's recommendations. Contractor shall label each fire stop location with the manufacturer's identification number of the product used and shall provide the inspector copies of each products system configuration.
6. No communications outlet boxes shall be "daisy-chained." Each communications outlet shall be served by a separate 1-inch (minimum) conduit.
7. In rooms with a drop or false ceiling, communications outlets shall be served by a 1-inch conduit stubbed six inches above the false ceiling, angled toward the cable tray or open access area, and be equipped with a compression fitting and plastic bushing. All stubs shall be marked "Comm".
8. All conduit shall be equipped with an approved water or barrier seal in building access points.
9. No communications conduit shall contain more than 180 degrees of bend without the use of a pullbox. Pullboxes must be approved by Engineer of Record to ensure proper sizing and conduit entry placement.
10. In areas where hard lid ceilings are in place, all conduits are to run to accessible location or to cable tray.
11. Provide labels at both ends of conduits to identify location of far end.

C. STATION CABLE SUPPORT SYSTEM

1. All station cable support systems shall be braced for zone four seismic activity.
2. In suspended ceiling and raised floor areas where duct, cable trays, or conduit are not available, station cables shall be bundled with Velcro straps at appropriate distances.
3. Velcro straps shall not be over tightened to the point of deforming or crimping the cable sheath.
4. Velcro straps shall be UL listed, rated for low smoke, and certified for use in a plenum environment.
5. The station cable support system components shall be firmly attached to the existing building structure and installed not more than five feet apart.
6. The station cable support system components shall be installed to provide at least three (3) inches of clear vertical space between the cables/optics and the ceiling tiles.
7. The station cable support system components shall be spaced to prevent the cables/optics from sagging or buckling.
8. No more than eighteen (18) Category 6 cables shall be supported by a J - hook.
9. No more than thirty (30) Category 6 cables shall be supported by triangular galvanized metal bracket.

10. The station cable support system shall be clearly and neatly labeled per TIA/EIA 606-A, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- D. Raceways
1. All dual channel raceway shall be installed with a complete end-to-end channel for future power service installation.
 2. The raceway shall be stubbed above the false ceiling space and capped so that each section of raceway can be connected to a power service in the future without a requirement to add raceway to visible portions of the system. If no false ceiling space is available, the power channel is to be stubbed up and capped next to the point at which the communication services enter the room.
- E. Cable Tray
1. The Contractor will be responsible for placement of the cable tray in concert with other trades, allowing sufficient room for the cable installers to gain access to all portions of the tray system. Cable tray location shall be coordinated with open ceiling areas, access panel locations, and feeder conduit positions to provide an accessible cable pathway throughout the facility.
 2. All metallic trays must be grounded and may be used as a ground conductor. Provide #2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component. Trays used as an equipment grounding conductor must be clearly marked.
 3. Trays shall be bonded end-to-end.
 4. Trays shall enter distribution rooms a minimum of six inches into the room, then utilize a drop out to protect station cables from potential damage from the end of the tray.
 5. Cable trays shall be placed a minimum of six (6) inches from any overhead light fixture and twelve (12) inches from any electrical ballast. A minimum of eight (8) inches of clearance above the tray shall be maintained at all times. All bends and T-joints in the tray shall be fully accessible from above (within 1 foot). Trays shall be mounted no higher than twelve (12) feet above the finished floor and shall not extend more than eight (8) feet over a fixed ceiling area.
 6. A separate conduit sleeve (minimum of four inches) must be provided as a pathway through any wall or over any obstruction (such as a rated hallway) from the cable tray into any room having a communications outlet.
 7. The Contractor shall fire stop around the tray and, after installation of the cables, within the tray using removable pillow-style products following manufacturers' guidelines. Sound deadening material shall be provided and installed after installation of cable.
 8. In rooms without a drop ceiling (open to the structure), the cable shall be mounted as high as possible to provide the greatest clearance above the finished floor, but within the limits in (e) above.
- F. Wire Mesh Cable Tray
1. Provide all components of the tray system (tray, supports, splices, fasteners, and accessories) from a single manufacturer.
 2. Wire mesh cable tray shall be secured to the structural ceiling, building truss system, wall or floor using manufacturer's recommended supports and appropriate hardware as defined by local code or the authority having jurisdiction (AHJ).
 3. When the pathway is overhead, wire mesh cable tray shall be installed with a minimum clearance of 12" (300 mm) above the tray. Leave 12" (300 mm) in between the tray and ceiling/building truss structure. Multiple tiers of wire mesh cable tray shall be installed with a minimum clearance of 12" (300 mm) in between the trays. When located above an acoustical drop ceiling, wire mesh cable tray shall be installed a minimum of 3" (75 mm) above the drop ceiling tiles.

4. When installed under a raised floor, wire mesh cable tray shall be installed with a minimum 3/4" (19 mm) clearance between the top of the tray and the bottom of the floor tiles or floor system stringers, whichever are lower in elevation. Maintain a 3" (75 mm) clearance between trays wherever trays cross over.
 5. Wire mesh cable tray shall be supported every 6' (1.8 m) of span or less. Support wire mesh cable tray within 2' (0.6 m) of every splice and intersection. Support intersections on all sides. Support wire mesh cable tray on both sides of every change in elevation/direction. The weight of the load on the cable tray must not exceed the stated limits per span in the manufacturer's published load table. Use additional supports where needed.
 6. Secure wire mesh cable tray to each support with a minimum of one fastener. Follow the manufacturers' recommended assembly, splice and intersection-forming practices.
 7. Use installation tools and practices recommended by the manufacturer to field fabricate wire mesh cable tray intersections and changes in elevation. Use side-action bolt cutters with an offset head to cut wire mesh cable tray.
 8. Wire mesh cable tray shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the wire basket tray and a minimum #6 grounding wire or as recommended by the AHJ. Follow UL Classified splicing methods recommended by the manufacturer, ground the tray per NEC requirements and verify bonds at splices and intersections between individual cable tray sections. Cable pathway should be electrically continuous through bonding and attached to the TGB.
 9. The quantity of cables within the tray will not exceed a whole number value equal to 50% of the interior area of the tray divided by the cross-sectional area of the cable. Cable fill will not exceed the depth of the cable tray's side rail [2" (50 mm), 4" (100 mm) or 6" (150 mm)].
 10. The combined weight of cables within the tray will not exceed stated load capacity in manufacturer's specifications.
 11. Separate different media type within the tray. Treat each type of media separately when determining cable fill limits.
 12. When pathways for other utilities or building services are within 2' (0.6 m) of the wire mesh cable tray, cover the tray after cables are installed.
- G. Pull boxes
1. Pull boxes shall be installed in easily accessible locations.
 2. Pull boxes installed as part of a horizontal cabling pathway shall be installed immediately above suspended ceilings, where possible.
 3. Pull boxes shall not be used for splicing cable.
 4. Pull boxes shall be placed in conduit runs that exceed 100 feet or which require more than two 90 degree bends. The pull boxes shall be located in straight sections of conduit and must not be used for a right angle bend. Installation shall allow cable to pass through from one conduit to another in a direct line.
 5. Pull boxes must have a length at least 12 times the diameter of the largest conduit.
- B. EXISTING OUTLET BOXES, RACEWAYS, AND CONDUITS
- A. Existing recessed boxes and concealed station conduits may only be re-used as a pathway for a new outlet per the criteria below:
1. Existing recessed single-gang box with a 3/4 inch diameter station conduit: One new voice or data outlet (1 cable maximum).
 2. Existing recessed single-gang outlet with a 1 inch diameter station conduit: One new voice/data outlet or one new voice/data/fiber outlet. (3 cables maximum) (Only acceptable in offices and classrooms where wire cannot be fished in existing walls.) For outlets with fiber cable terminations, faceplates must be

equipped with a spool to provide for a maintenance loop per manufacturer's specifications.

C. GROUNDING AND BONDING SYSTEMS

A. Grounding and bonding - GENERAL

1. Installation: The Contractor shall provide grounding and bonding in accordance with the requirements of NFPA 70, IEEE 142, TIA/EIA 568, TIA/EIA 607, state and local codes, the campus standards and to requirements specified herein. Codes shall be complied with as a minimum requirement, with these specifications prevailing when they are more stringent.
2. Bonding
 - (a) Metallic conduits, wireways, metal enclosures of busways, cable boxes, equipment housings, cable racks and all non-current carrying metallic parts of the installed telecommunications services shall be grounded with #6 AWG copper wire. The metallic conduit system shall be used for equipment and enclosure grounding but not as a system ground conductor.
 - (b) All metallic conduit stub-ups shall be grounded, and where multiple stub-ups are made within an equipment enclosure, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.
 - (c) Each metallic raceway, pipe, duct and other metal object entering the buildings shall be bonded together. The Contractor shall use #6 AWG bare copper conductors.
 - (d) The Contractor shall bond telecommunications equipment and busbars separately.

B. Signal Reference Grounding and Bonding

1. Each identified telecommunications space within a building shall have a common signal reference ground. The signal reference ground shall conform to the following:
 - (a) Within the building, all communication spaces shall be separately bonded to each other and connected to the primary building ground in accordance with the provisions of TIA/EIA 607. The communication ground shall not ground any other equipment or be connected to any potential high voltage source. All racks, frames, drain wires, and all installed communication equipment shall only be grounded to this common reference ground with a minimum size #6 AWG copper wire.
 - (b) The Contractor shall provide, as a minimum, a continuous #3/0 AWG green electrical conductor connected to a 1/4" x 4" x 5.25" telecommunications grounding bus bar (TGB) 6" AFF on the plywood backboard of each IDF (or telecommunication space) to terminate chassis and other equipment grounds.
 - (c) The ground wires from each individual IDF shall be routed directly to the Building Distribution Frame (BDF), terminated and bonded together via a telecommunications main grounding bus bar (TMGB) of minimum 1/4" x 4" x 12" dimensions. This point of single reference for all closets in a building shall in turn be grounded with a minimum #3/0 AWG ground conductor to the main building ground. If a main building ground is unavailable, the ground wire from the BDF shall be grounded to the nearest electrical panel ground bus bar. The building ground for signal reference shall be the building service entrance ground.
2. Riser/Tie Cable Bonding
 - (a) There shall be no bonding between the entry cable and the inside riser or distribution cable.

- (b) All riser and tie cable shields shall be bonded into a single continuous path end-to-end and grounded on each floor in which pairs leave the sheath. Cable shields shall be grounded to the signal reference ground provided in each telecommunication space.
- C. Grounding and Bonding Testing and Inspection Procedures
 - 1. As an exception to requirements that may be stated elsewhere in these documents, the Inspector of Record shall be given five (5) working days' notice prior to each test. The Contractor shall provide all test equipment and personnel and shall provide written copies of all test results.
 - 2. Grounding and bonding system conductors and connections shall be inspected for tightness and proper installation.
 - 3. The Contractor shall provide personnel and test equipment for point-to-point resistance tests before connecting equipment. Perform point-to-point tests in each building to determine the resistance between the main grounding system and all BDF/IDF ground bus bars. Investigate and correct point-to-point resistance values that exceed 0.5 ohm. The Contractor shall record resistance measurements at all test point locations.
- D. INFORMATION OUTLETS
 - A. GENERAL REQUIREMENTS
 - 1. Station outlets shall be mounted securely at work area locations.
 - 2. Station outlets shall be located so that the cable required to reach the desktop equipment is no more than 10 feet long.
 - 3. Station outlets should not be "daisy-chained."
 - 4. Outlets shall be mounted as follows:
 - (a) Wall phone: 48 inches above the finished floor.
 - (b) Standard voice/data outlet: 15 inches above the finished floor.
 - (c) Wall-mounted video outlet: 78 inches above the finished floor.
 - (d) Counter top: 6 inches above the counter top.
 - B. MODULAR FURNITURE TELECOMMUNICATIONS OUTLETS
 - 1. The Contractor shall provide and install all components and labor necessary to completely install, test, and document voice and data telecommunications outlets at each modular furniture workstation location.
 - 2. Category 6 station cable shall be placed from the BDF, through the riser sleeves, through the cable tray system into the conduit, ceiling or floor poles, etc. into the furniture to be served.
 - 3. The Contractor shall coordinate the telecommunications and electrical installation so that the modular furniture is served from the joint signal/power floor monuments or joint power pole in a consistent manner. The Contractor shall provide and install all fittings, flex conduit, adapter plates, and telecommunications cable and components necessary to install Category 6 station cable from the consolidation point box, through the ceiling or floor monument or pole, into the furniture raceway, and to the final user outlet location (including jacks, adapters, and faceplates).
 - 4. The telecommunications installers shall coordinate with the electrical drawings for the number and location of user voice and data outlets.
 - 5. Labels shall be numbered according to a scheme developed in consultation with the owner's representative.
- E. GROUNDING AND BONDING
 - 1. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor.

2. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.
3. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB).
4. The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.
5. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.
6. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape.
7. All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.
8. Wall-Mount Busbars
 - Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
 - Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
 - Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
 - The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
9. Rack-Mount Busbars and Ground Bars
 - When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount horizontal or vertical busbar or ground bar to the rack or cabinet. The rack-mount busbar or ground bar provides multiple bonding points on the rack for rack and rack-mount equipment.
 - Attach rack-mount busbars and ground bars to racks or cabinets according to the manufacturer's installation instructions.
 - Bond the rack-mount busbar or ground bar to the room's TMGB or TGB with appropriately sized hardware and conductor.
10. Ground Terminal Block
 - Every rack and cabinet shall be bonded to the TMGB or TGB.
 - Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
 - Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.
11. Pedestal Clamp
 - At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the TMGB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed according to the manufacturer's recommendations.

- If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the TMGB or TGB and bond each rack and/or cabinet to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.
 - Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
 - Remove insulation from conductors where wires attach to the pedestal clamp.
12. Pipe Clamp
- Bond metal pipes located inside the data center computer room with a minimum #6 AWG conductor to the TMGB or TGB using a pipe clamp sized to fit the pipe and the conductor and installed according to the manufacturer's recommendations.
 - Remove paint between the pipe and pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the bond.
 - Remove insulation from conductors where wires attach to the pipe clamp.
13. Equipment Ground Jumper Kit
- Bond equipment to a vertical rack-mount busbar or groundbar using ground jumper according to the manufacturer's recommendations.
 - Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or groundbar to help prevent corrosion at the bond.

F. FIRE STOP SYSTEM

1. The fire stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure.
2. Fire stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
3. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall use the proper fire stop equipment.
4. Fire stop systems shall be UL Classified to ASTM E814 (UL 1479).

3.3 System Closeout and As-built Documentation

- A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Owner's Representative/Engineer for approval. One (1) to be a hardcopy and two (2) to be electronic copies. Documentation shall include the items detailed in the sub-sections below.
- B. Documentation shall be submitted within ten (10) working days of the completion of each construction phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 calendar days of the completion of each testing phase. At the request of the Owner's Representative/Engineer, the telecommunications contractor shall provide copies of the original test results.
- C. The **As-Built** drawings are to include conduit routes, utility vault/pull box locations, surface mount enclosure locations, PVC to GRC transition points and the approved labeling identifiers. Numbering, icons, and drawing conventions used shall be

consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD 2008) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.

END OF SECTION