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*Board of Commissioners*

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October 27, 2020

**ADDENDUM NO. 4**

Board of County Commissioners  
ITB 2020-108  
Construction of Program Space  
Barstow, Calvert County, Maryland

To Prospective Bidders:

Following is an addendum to the referenced specifications. Please acknowledge receipt of this addendum by executing the signature block provided below. This signed addendum must be included with your proposal. Failure to do so may subject bidder to disqualification. This Addendum forms a part of the specifications and supplements and modifies them as indicated below:

**Section 271500, Remove and Replace**

Remove Section 271500 in its entirety and replace with revised Section 271500 attached to this Addendum No. 4.

**Drawings, Delete and Replace**

Delete all references to Cat6A and replace to read: "Provide 350MHZ Cat5e cabling per ANSI/TIA/EIA-568-B requirements."

CONTRACTOR'S LEGAL BUSINESS NAME: \_\_\_\_\_

AUTHORIZED SIGNATURE: \_\_\_\_\_ DATE: \_\_\_\_\_

Mailing Address: 175 Main Street, Prince Frederick, Maryland 20678  
Maryland Relay for Impaired Hearing or Speech: 1-800-735-2258

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SECTION 271500 - DATA, VOICE AND VIDEO SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS SUMMARY

- A. This section is subject to General provisions of the Contract including General and Supplementary Conditions and Division 1 specifications, apply to this section.
- B. Drawing and general provisions of the contract including General and Supplementary Conditions, apply to this section.
- C. Provide a complete system of wired voice and data, and projector AV outlets, suitable for distribution and utilization of data/voice network and AV signals from the Calvert County supplied telephone systems and computer data networks.
- D. The data network wiring shall be suitable for a minimum 1000 Mega-Bits per second (Mb/s) data network.
- E. The Customer's Cable Infrastructure Project requires an AMP NETCONNECT Systems structured cabling system, or equivalent single-manufacturer solution. The Category 5e portion of the cabling system shall comply with the link and channel performance requirements of ANSI/TIA/EIA 568-B.2-1 "Performance Specifications for 4-pair 100 Ohm Category 5e Cabling". The cabling system shall be backed by a 25-Year System Warranty. The system warranty shall be facilitated by the Contractor and be established between the Customer and the cabling system Manufacturer.
- F. The successful Contractor is required to furnish all labor, supervision, tooling, miscellaneous mounting hardware and consumables for each cabling system installed. The Contractor shall maintain current status with the warranting manufacturer, including all training requirements, for the duration of the Cable Infrastructure Project. The Contractor shall staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the 25-Year System Warranty requirements. After installation, the Contractor shall submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, and to apply for said warranty on behalf of the customer. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

1.2 SCOPE

- A. This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, etc. for telecommunications system supporting voice and data. The intent of this document is to provide all pertinent information to allow the vendor to bid the labor, supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any and all items required for a complete system if not identified in the BOM attached to this specification.
- B. The Data and Voice Structured Cabling and Outlet System shall include, but is not necessarily limited to:

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- a. Category 5e Unshielded Twisted Pair (UTP) Data Cable
  - b. Category 5e Unshielded Twisted Pair (UTP) Voice (Telephone) Cable
  - c. Workstation Jacks
  - d. Workstation Multi-Jack Outlets
  - e. Wall mounted swing patch panel racks or stand-alone data cabinets/racks
  - f. Type 66S and 100 wiring punchblocks
  - g. Complete system testing in accordance with accepted industry standard test means and methods.
- C. Cable television and video outlets, wiring and associated work shall be in strict accordance with the requirements of Comcast and Verizon cable TV standards and coordinated with Physical Facilities Electronics Shop.

1.3 APPLICABLE DOCUMENTS

- A. The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The documents below are incorporated by reference.
- 1. This Technical Specification and Associated Drawings.
  - 2. ANSI/TIA/EIA-568-B, *Commercial Building Telecommunications Cabling Standard*
  - 3. ANSI/TIA/EIA 568-B.2-1, *Performance Specification for 4-Pair 100 Ohm Category 5e Cabling*
  - 4. TIA/TSB-140, *Additional Guidelines For Field-Testing Length, Loss And Polarity Of Optical Fiber Cabling Systems*
  - 5. ANSI/TIA/EIA-569-A, *Commercial Building Standard for Telecommunications Pathways and Spaces*
  - 6. ANSI/TIA/EIA-606-A, *Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*
  - 7. ANSI/J-STD-607-A, *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*
  - 8. Building Industries Consulting Services International (BICSI) *Telecommunications Distribution Methods Manual* (TDMM) – 10th edition
  - 9. National Fire Protection Agency (NFPA) – NFPA 70, *National Electrical Code* (NEC) - 2011
  - 10. AMP NETCONNECT Design and Installation Contractor Agreement (current)
- B. If a conflict exists between applicable documents, then the order in the list above shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity, and is therefore enforceable as law by a local, state or federal inspection agency.
- C. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents; the vendor is responsible to determine and adhere to the most recent release when developing the proposal for installation.

1.4 RELATED WORK SPECIFIED ELSEWHERE

- A. The work in this section is related to the work specified in the following section: Division 26 Sections General Electrical Requirements and Basic Electrical Materials and Methods.

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- B. All work under this section is subject to the General Conditions and any Special Requirements for the entire Contract.

1.5 SUBMITTALS:

- A. General: Submit the following according to Division 26 Specification Sections.
- B. Product Data and Shop Drawings: Submit these items, and the Certifications specified below, as a complete package. Submittal will not be reviewed if it is incomplete.
  - 1. A complete schedule of equipment and materials that are to be furnished for the work. Accompanying the schedule shall be manufacturer's specifications or cut sheets for each major component. Original specification sheets or clear copies of same shall be submitted on all items. Manufacturers name, make and model number shall appear on each sheet. Submittals shall be bound in booklet form with cover sheet and index, and presented in a neat and logical order in a binder. Submittals shall contain installation, operation and programming manuals of the system to provide the Owner and Engineer complete information as to system features, functions and capabilities.
  - 2. A schedule/count of data, phone, wireless and other low voltage cabling/jacks for each closet must be submitted after the bids are issued so that a proper network design can be performed. This information is required so that the correct number of network switches can be designed and ordered for the project. This information must be provided to the Owner Network Support Services Manager.
  - 3. Complete drawings of equipment racks and special assemblies. Each drawing shall show all equipment with its manufacturer and model number.
  - 4. Complete drawings detailing installation locations of equipment, cable quantities and types with terminal block or patch panel locations. Submit Shop Drawings of each proposed system indicating the proposed system configuration and all specified requirements. Shop Drawing shall indicate proposed cable routing, detail installation locations of equipment, cable quantities, cable types, and terminal block locations. All Shop Drawings shall be Contractor's original drawings. Submission of Engineer's Contract Drawings as Shop Drawings is not permitted. Clear and detailed sets of floor plans for the complete building shall be furnished showing the locations of all equipment and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. The layout of all telecommunications system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.
  - 5. Submit dimensional outline drawing of systems control cabinet(s) and racks showing relative position and size of all major components and equipment involving dimensions, elevations, and terminations. Each drawing shall indicate all equipment with its manufacturer and model number shown.
  - 6. Submit wiring diagrams showing typical connections for all systems and equipment. Include detailed one-line drawings of each system. Each system drawing shall show proposed circuit numbers for all cables and terminal connections. Provide typical wiring termination details for all devices.

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7. The Contractor shall submit a certificate with the RCDD signature, registration number, and seal verifying the completeness and accuracy of the design and installation. All distribution designs shall be submitted with the RCDD signature, registration number, and seal.
- C. Provide Operation and Maintenance Manuals, as specified in Division 1 and Division 26, for work specified in this Section. Include complete service information, including schematics, prints of the Special System Drawings, interconnecting diagrams for this particular project, and parts lists to permit quick and efficient maintenance and repair of the equipment by a qualified technician. Provide a separate binder with copies of all system test reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. The installing contractor shall submit proof of having installed at least six (6) similar Data and Voice Structured Cabling And Outlet Systems. These systems shall have been in service for a minimum of three (3) years. These systems must have been within a fifty (50) mile radius of the project location. Included with this proof shall be the customer name, customer contact and telephone number, and, if applicable, the architect and electrical engineer on the project. The Architect and Owner retain the right to reject any installing contractor who, in their sole judgment, has not met the above criteria or has received a less than favorable reference from any of the submitted references OR from any other customer for which the installing contractor has performed similar installations, whether or not such customer has been listed on the submittal.
2. In order to assure full compliance with all codes and regulations, the installing contractor must have on its regular staff a Master Electrician licensed within the jurisdiction in which the installation occurs. Proof of such licensing must be included with the original submittal.
3. The Contractor shall make application for all necessary permits, licenses and inspections as required by the Authority Having Jurisdiction, and shall pay all fees and charges appurtenant thereto.
4. The installing contractor must be certified by the manufacturer of the Cabling System being proposed for installation. Proof of such certification must be included with the original submittal.

- B. Manufacturer Qualifications: Materials proposed for use on this project shall be provided by a manufacturer experienced in manufacturing components listed and labeled under EIA/TIA-568A and who comply with these Specifications.

1.7 WARRANTY

A. Special Warranty Requirements:

1. The proposed Systems will be covered by a two part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow-on program through the Vendor to provide support and service to the purchaser.

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2. The first part is an assurance program which provides that the certified system will support the applications for which it is designed, during the 15 year warrantee of the certified system.
3. The second portion of the certification is a fifteen-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.)
4. In the event that the certified system ceases to support the certified application(s), whether at the time of cut-over, during normal use or when upgrading (e.g. ATM), the manufacturer and vendor shall commit to promptly implement corrective action.

**PART 2 – PRODUCTS**

**2.1 TELECOMMUNICATIONS SYSTEM REQUIREMENTS**

- A. Facilities Description: Provide outlets in configuration as detailed on the drawings. Where both voice and data jacks are indicated to be provided in the same outlet, the voice jack shall be located at the upper left position. Horizontal data cables shall be terminated on rack-mounted Category 5e patch panels. Horizontal data circuits shall be connected to LAN electronics within each Telecommunications Room or MDF/IDF (Main Distribution Facility/ Intermediate Distribution Facility).
- B. Provide twelve strand single-mode (8/125 micron) fiber optic backbone, 25 pair Cat 5e CMP riser cables for data and voice. Within the data (MDF), backbone fiber strands shall be terminated and housed in rack mounted fiber optic distribution (LIU) enclosures. Backbone copper pairs shall be terminated on wall-mount 110 or 66S Cross-Connect termination frames as indicated on the drawings.
- C. Acceptable manufacturers for cables, connectors, patch panels and patch cords include the following:
  1. AMP
  2. Hubbell
  3. Leviton
  4. Ortronics
  5. Superior Essex
  6. Corning

Data jacks, patch panels and cabling shall be a product of one manufacturer or supported by multiple manufacturers as one system.

Unshielded twisted pair cable connecting hardware shall comply with EIA/TIA-568A, TSB 40, insulation displacement connector (IDC) type, using modules designed for use with punch-down caps or tools. IDC terminal block modules shall be integral with connector bodies, including plugs and jacks where indicated. Jacks and jack assemblies for unshielded twisted pair cable shall be modular, color-coded, RJ-45 receptacle units with integral IDC type terminals.

**2.2 HORIZONTAL DISTRIBUTION SUBSYSTEM**

- A. Telecommunications Outlets: Each telecommunications outlet (TO) location, unless otherwise noted, shall be provided with four Category 5e cables. Each Category 5e cable shall be terminated on an 8-position, 8-conductor Category 5e modular jack to the T568B wiring code. The TO faceplates, unless otherwise noted, shall be mounted to double gang boxes, surface mount boxes and/or floor boxes as required.

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- B. **Modular Jacks for Data Circuits:** Modular jacks shall be unkeyed, unshielded, 4-pair, RJ-45. Modular jacks shall terminate using 110-style pc board connectors, color-coded for both T568A and T568B wiring. Each modular jack shall be wired to T568B. The 110-style insulation displacement connectors shall be capable of terminating 22-24 AWG solid or 24 AWG stranded conductors. The insulation displacement contacts shall be paired with additional space between pairs to improve crosstalk performance. Modular jacks shall utilize a secondary PC board separate from the signal path for crosstalk compensation. Each modular jack shall meet the TIA/EIA-568-C.2, Category 5e performance standards.

Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination. Each jack shall incorporate an integral, hinged dust cover. Modular jacks shall be UL Listed under file number E81956. Modular jacks shall be equivalent of AMP SL series. Icons shall be AMP Data Icon, or approved equal. Blank covers shall be AMP White Blank Dust Cover, or approved equal.

Data jack cabling, inserts and other system components shall be color coded as follows:

1. All data jacks terminated on data receptacles shall be blue color with matching icon for uniformity
  2. All data jacks terminated on video surveillance camera receptacles shall be black with matching icon for uniformity.
  3. All data jacks terminated on wireless access point receptacles shall be purple/violet.
  4. All data jacks for emergency/alarms shall be red with matching icon for uniformity.
- C. **Modular Jacks for Voice Circuits:** shall be identical to data circuits, terminated at 110 blocks, unless noted otherwise. Where voice is noted as analog (for 911 hot line, etc) terminate directly onto type 66S terminal block. Voice jacks and cabling shall be gray in color. 911 hot line jacks and cabling shall be red in color. Wall mounted voice outlets shall be provided with stainless steel wall plate with wall telephone instrument mounting lugs.
- D. **Wall Faceplates:** Work area wall outlets shall be constructed utilizing 110Connect double gang 4-Port high-impact modular white or ivory ABS plastic faceplates 4.5" X 4.5" X .75" in size. Mounting shall be semi-flush, unless otherwise noted. All unused spaces shall be equipped with a blank insert. Data/voice outlets shall be loaded with modular jacks as described in 3.1, and as detailed on the Drawings. Label jacks "voice" or "data" as appropriate to use. Provide facilities for insertion of machine printed jack identification label behind clear plastic cover. Install machine printed labels at each jack location.
- E. **Telecommunications Outlet Installation:** All outlets shall be installed in the following manner. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. No more than 12" of slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack may be neatly coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable. In addition, each cable type shall be terminated as indicated below. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B document, manufacturer's recommendations and/or best industry practices. Pair untwist at the termination shall not exceed 0.5 inch for Category 5e connecting hardware. Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable. The cable jacket shall be maintained as close as possible to the termination point. Modem jacks shall be considered the last voice jack in the sequence. Data jacks shall occupy the top position(s) on the faceplate. Data jacks in horizontally

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oriented faceplates shall occupy the left-most position(s). Verify jack termination scheme with Calvert County Department of Technology (contact Network Support Manager) prior to termination.

- F. Horizontal Distribution Cable Product Specifications: Horizontal Cabling for Data Circuits -- Horizontal cabling shall be 23 AWG, 4-pair UTP, NEC/NFPA CMP rated and be independently verified for compliance. Cable shall exceed all TIA/EIA and ISO Category 5e/Class E.
- G. Cable performance shall be independently verified and characterized to 350 MHz. Cable jacketing shall be color as directed by owner and shall be lead-free. Independent verification for flammability compliance shall be to NEC article 800 and NFPA 70; CMP (NFPA 262, UL 910).
- H. Horizontal Distribution Cable Installation: Cable shall be installed in accordance with manufacturer's recommendations and best industry practices. Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type. Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document. Where cable splices are allowed, they shall be in accessible locations and housed in an enclosure intended and suitable for the purpose. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of four-foot intervals - at no point shall cable(s) rest on acoustic ceiling grids, concrete block, brick or panels. Horizontal distribution cables shall be bundled in groups of not greater than 40 cables (cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle). Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware. The cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices. Cables shall not be attached to ceiling grid or lighting support wires. Where light support for drop cable legs is required, the Contractor shall install clips to support the cabling. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate. Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cables outside diameter (4 X cable O.D.) at any point in the run. Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle.
- I. Horizontal Cross-Connect Termination Hardware Product Specifications: Horizontal Cross-Connect for Data Circuits - Horizontal cross-connect shall consist of Category 5e patch panels, which shall be 2U high and provide 48 modular jack ports, wired to T568B. Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination. The front of each 6-port module shall be capable of accepting 9mm to 12mm labels. Each port shall be capable of accepting an icon to indicate its function. Patch panels shall terminate the building cabling on 66S-style insulation displacement connectors. The installed system shall comply with the Category 5e performance characteristics.

The horizontal cross-connect for data circuits shall consist of patch cords from the horizontal Category 5e termination panels to the network equipment within the same or adjacent racks. The horizontal data cross-connect shall be contained in 19" x 7" rack(s). All equipment racks shall be augmented with horizontal and vertical cable management hardware, both front and rear, to properly dress horizontal cables and patch cords. Patch panels shall be 3.5 inches high and provide 48 modular jack ports, wired to T568B. Patch panel modular jacks shall be configured as 6-port, replaceable modules. Each patch

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panel shall be separated vertically on the rack by a 2U (for 2U patch panels) horizontal finger duct cable management panel. Patch panels must be UL Listed under file number E81956. Patch panels shall be AMP 5375015-1 with hinged management panels with inserts (color as directed by the owner), or an approved equivalent. Patch panels shall be identically numbered by the connection to respective jack and shall be arranged in sequential ascending order from left to right and top to bottom. Provide quantity of patch panels as required to match outlet quantity, plus 20% spare capacity, minimum 15 (fifteen) empty ports for future expansion. Provide the appropriate number of patch cables to allow all jacks to be patched down to Owner supplied network switches and stations. Patch cables of the connection from patch panel to network switch are to be 7 feet long. Patch cables for connection from station jack to end device shall be 14 feet long. All patch cables shall be Cat 5e. Horizontal and vertical patch cord management shall be AMP 137525-1 for side and 1375259-1 for center mounting.

- J. Horizontal Cross-Connect Installation: Copper termination and management hardware shall be installed in the following manner. Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-B document, manufacturer's recommendations and/or best industry practices. Pair untwist at the termination shall not exceed 0.5 inch for Category 5e connecting hardware. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable. Cables shall be neatly bundled and dressed to their respective panels or blocks. Only Velcro cable ties should be used to bundle and dress cables. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame. The cable jacket shall be maintained as close as possible to the termination point. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cable labels shall not be obscured from view.

#### 2.3 CROSS-CONNECT CABLE ASSEMBLIES:

- A. Each (MDF/IDF) shall require cable assemblies to cross-connect between the horizontal data patch panels and network equipment. The total quantity of cable assemblies required in each (MDF/IDF) shall be 2 foot through 9 foot length of cable for each port in Patch Panel as required for the installation. One patch cord per user outlet shall be provided. The phone cords shall be provided by the owner. Voice cable assemblies at each workstation shall be provided by the Owner. Voice cable assemblies used at the voice cross connect shall be factory-assembled by the manufacturer of the cabling system. In the (MDF) fiber optic cable assemblies shall be provided to cross-connect between the backbone data fiber LIU enclosures and network equipment. Optical fiber cable assemblies shall be 5 meters in length. SC Duplex, LC duplex or Hybrid fiber optic cable assemblies shall be provided depending upon LAN electronic interface.

#### B. Product Specifications

Cable Assemblies for Backbone Data Circuits: Backbone data cable assemblies shall be optical fiber assemblies, factory-terminated to match the fiber optic backbone cable. Fiber optic patch cords shall be UL 1666 approved. The duplex cables shall utilize SC Duplex plugs at one end, LC duplex plug on the other end, or as required. Fiber couplers shall be AMP 504640-3 Mating Couplers or approved equal. Optical fiber patch cables shall be 5 m in length.

#### 2.5 TELECOMMUNICATIONS SPACES

- A. The telecommunication closets shall house racks, voice termination fields and required cable routing hardware. Racks shall have sufficient capacity for termination/patch panels, cable management

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panels, hubs, switches, UPS, fiber optic distribution enclosure, etc. as required. Provide 50% spare capacity in rack for owner hardware. Provide a rack mounted shelf at the MDF data termination rack for Owner's router. Racks shall be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side. If one mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 6" to the wall to allow room for vertical management. Where there is more than one rack, the racks shall be ganged with vertical management hardware to provide interbay management. Ganged rack frames will be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly. In all closets the racks shall be on the opposite side of the room from the voice termination fields. Voice termination fields shall be mounted on 4' x 8' x .75" virgin fire retardant plywood, unless otherwise noted in drawings, and shall be on the opposite side of the room from the room entrance. Backbone termination fields shall be mounted to the left of the horizontal voice fields. Conduits with 4" minimum diameter shall be used in all closets. Conduits for data backbone shall be located adjacent to the racks and conduits for voice shall be located adjacent to the voice termination fields. The Contractor shall provide innerduct for all backbone fiber runs. Contractor shall provide required ladder and wall-mount management rings to properly support and dress cables from conduits to racks and frames.

- B. Installation Specifications: Racks shall be installed in the following manner. Racks shall be securely attached to the concrete floor using 3/8" hardware. All racks shall be grounded to the telecommunications ground bus bar. Rack mount screws (#12-24) not used for installing fiber panels and other hardware shall be bagged and left with the rack upon completion of the installation. Voice backbone termination fields shall be mounted on 4' x 8' x .75" virgin plywood, painted "BLACK" with fire retardant paint, that is mounted vertically at 12" A.F.F.

#### 2.6 FIRESTOP SYSTEMS

- A. Composition: A firestop system is comprised of the item or items penetrating the fire-rated structure, the opening in the structure and the materials and assembly used to seal the penetrated structure. Firestop systems comprise an effective block for fire, heat, vapor and a pressurized water stream. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to "through" penetrations (complete penetration) and "membrane" penetrations (through one side of a hollow, fire-rated structure). Any penetrating items (i.e., riser slots and sleeves, cables, conduit, cable tray, raceways, etc.) shall be properly firestopped.
- B. Product Specifications: Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed. A drawing showing the proposed firestopped system, stamped by the cognizant PE, shall be provided to the owner's technical representative prior to installing the firestop system(s).
- C. Firestop System Installation: All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cabling system acceptance.
- D. Provide Specified Technologies, Inc (STI) EZ Path Cable Pathway sleeves at all cable penetrations through walls in the telecommunications rooms (MDF and IDF rooms). Provide multiple Series 33 and Series 44 as needed to serve cabling being installed plus 100% spare capacity.

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2.7 GROUNDING AND BONDING

- A. 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 for acting as a current-carrying conductor. The TBB shall be installed independently of the building electrical ground and of the building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607-A Telecommunications Bonding and Grounding Standard.
- B. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB). 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.
- C. Product Specifications: All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TC or ER shall be grounded to the TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors. Where metallic panels attached to the rack do not have sufficient metal to metal contact to provide an adequate path to ground, they shall be bonded to the rack using a minimum #14 AWG copper conductor. The copper conductor size shall be upgraded based on the largest power conductor feeding any rack-mount equipment. The conductor shall be continuous, attaching all isolated components in a daisy chain fashion from top to bottom and bonded to the rack using an appropriate compression connector. All wires used for telecommunications grounding purposes shall be identified with green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the System Documentation Section of this specification.
- D. Ground System Installation: The TBB shall adhere to the recommendations of the ANSI/TIA/EIA-607-A standard, and shall be installed in accordance with best industry practices. Installation and termination of the main bonding conductor to the building service entrance ground, at a minimum, shall be performed by a licensed electrical contractor.

PART 3 – EXECUTION

3.1 EXAMINATION:

- A. Examine pathway elements to receive cable. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. Wiring Methods:

- 1. Install station cables to individual outlets in raceway within walls.
- 2. Install horizontal runs of station cables exposed above finished ceilings. Provide “J” hooks or other suitable cable management devices at intervals not to exceed 4'-0" on center.

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- B. Install components as indicated, according to manufacturers' written instructions. Use techniques, practices, and methods that are consistent with the Category 5e rating of the components and that assure Category 5e performance of completed and linked signal paths, end-to-end.
- C. Install cable without damaging conductors, shield, or jacket.
- D. Do not bend cable in handling or installation to smaller radii than minimums recommended by manufacturers.
- E. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
  - 1. Pull cables simultaneously where more than one is being installed in the same raceway or cable run.
  - 2. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation.
  - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- F. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
- G. Secure and support exposed cable at intervals not exceeding 30 inches and not more than 6 inches from boxes, cable trays, fittings, racks, frames, and terminals.
- H. Separation of Wires: Comply with EIA/TIA-569 rules for separation of unshielded copper voice and data system cables from potential EMI sources, including electrical power lines and equipment.
- I. Make splices, taps, and terminations only at outlets, terminals, and cross-connect and patch panels.
- J. Use splice and tap connectors compatible with media types.

**3.3 CABLE ROUTING**

- A. Wiring for the voice/data/video system shall be supported by J hooks, above accessible ceilings. Exposed wiring run in the, mechanical rooms, and other rooms where there is no drop ceiling shall be installed in EMT conduit above 10'-0" AFF and in surface metal raceway below 10'-0" AFF. EMT conduit in mechanical rooms may be installed in EMT conduit below 10'-0" AFF.
- B. All voice and data horizontal cables shall not exceed 90 m (295 ft) from the telecommunications outlet in the work area to the horizontal cross connect. The combined length of jumpers, or patch cords and equipment cables in the telecommunications closet and the work area should not exceed 10m (33 feet) total, including 3 m(10 feet) at the station and 6 m (20 feet) at the closet. Every effort will be made to route cables so as not to exceed 90 meters in length. Contractor will identify any cable runs exceeding 90 meters from proposed MDF/IDF location and shall provide solution to meet the 90-meter requirement.
- C. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation. Cable bends shall be no less than four (4) times the cable outer diameter or 1.00".

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- D. In open ceiling cabling, cable supports shall be provided by means that are structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 760 mm (30 inches) apart and not more than 150 mm (6 inches) from boxes, cable trays, fittings, racks, frames and terminals.
- E. Telecommunications pathways, spaces and metallic cables which run parallel with electric power cables or lighting cables shall be installed with a minimum clearance of 300 mm (12 inches). Communication cables shall not be run parallel with electric power cables for more than 10 m (33 feet) if their separation is less than 300 m (12 inches).
- F. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 75 mm (3 in) above the ceiling grid supporting the tiles.
- G. Cables run exposed above accessible ceilings shall be run in bundles of a size for installation. Bundle by use of cable ties, taking care not to cinch cables. Cable shall be supported from roof structures, joists and other appropriate structural members by means of J hooks. In no case shall any cable be supported from below by contact with the ceiling system. The data, telecommunication and video cabling systems shall be separated into bundles and separated by a minimum of 12". Provide cable ties to secure cables to each "J" hook. Avoid cinching cables.
  - 1. All voice and data telecommunications cable installed above suspended ceilings shall be supported by 2" "J" hooks. For support of high density (>50 cables) bulk cable where 48" spacing results in the bowing of cable, the Contractor shall divide bulk cable into smaller parallel streams or decrease the spacing of the "J" hooks sufficiently to adequately support the cable.
  - 2. Where voice and data telecommunication wiring is supported by "J" hooks, wire shall be run neatly bundled with tie wraps. Tie wraps shall be spaced randomly between 6" and 10" apart, 8" on the average. Tie wraps shall be snug, but capable of being easily rotated about the cable bundle so as to secure the cable without binding, deforming or damaging it. Cable deflection shall be less than 5" between "J" hooks.
  - 3. "J" hooks shall be supported directly by the building structure. "J" hooks shall be supported on minimum 3/8" threaded rod anchored to the side hallway walk, or to the slab above. "J" hooks shall *not* be attached to or supported by ceiling supports, piping or piping supports, or duct work or duct work supports.
  - 4. Install cabling below or to the side of the duct work, just above the suspended ceiling. Extend "J" hooks down to support the cabling at that level.
- H. Where wire and cable penetrate walls or other structural elements or pass above inaccessible areas of the building, install EMT sleeves sized to accept sizes of run, as follows (in no case shall sleeves exceed 40% fill ratio):

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<b>IPS/TRADE SIZE</b>	<b>NUMBER OF CABLES</b>
0.75-inch	2
1.00-inch	4
1.25-inch	8
1.50-inch	11
2.00-inch	18
2.50-inch	27
3.00-inch	41
3.50-inch	55
4.00-inch	71

**3.4 INSTALLATION AT EQUIPMENT ROOMS AND WIRING CLOSETS**

- A. Provide adequate length of conductors and cables. Train the conductors to terminal points with no excess. Provide ten (10) foot service loop for each copper cable within Equipment Room. Use cable management system to restrain cables, to prevent straining connections, and to prevent bending cables to radii smaller than allowed.
- B. Mount voice backbone punchblocks, terminal strips, and other connecting hardware on plywood backboards, except as otherwise indicated. Provide additional 3/4-inch fire retardant treated plywood backboards where required for mounting of equipment.
- C. Mount data patch panels in floor or wall mounted electronic racks, with cable management. Do not fill racks to more than 50% capacity to allow spare room for Owner furnished equipment. Provide additional racks, to match existing, where required to maintain rack space.
- D. Group connecting hardware for cables into separate logical fields.
- E. Communication grounding / earthing and bonding shall be in accordance with applicable codes and regulations. It is recommended that the requirements of IEC 1000-5-2, ANSI/TIA/EIA-607, or both, be observed throughout the entire cabling system. Provide 12" ground bus bars and #6 solid copper ground wires from the ground bus bars to the building ground. Provide #6 ground from the ladder cable rack to the ground bus bars.

**3.5 SLACK**

- A. In the work area, a minimum of 300 mm (12 in) should be left at outlets, while 1 m (3 ft) should be left at the backboard or rack, and 6 m (20 feet) in the closet area.

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- B. In telecommunications rooms a minimum of 6 m (20 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types. “All cable types” includes all voice/data/video backbone cables and fiber optic backbone cables.
- C. All unused cables shall be properly terminated, as specified, with 10 m (33 feet) extra cable neatly coiled and tie-wrapped at the workstation end of cable in the ceiling space.
- D. Where wireless access point devices are installed, provide a minimum of 3 m (10 feet) of cable coiled, tie-wrapped, and supported in the ceiling space.

#### 3.6 SYSTEM DOCUMENTATION

- A. The following section describes the installation, administration, testing, and as-built documentation required to be produced and/or maintained by the Contractor during the course of the installation.
- B. Cabling System Labeling: The Contractor shall develop and submit for approval a labeling scheme for the cable installation. Voice and Data outlets and cables shall be labeled the using the same labeling scheme. Customer will negotiate an appropriate labeling scheme with the successful Contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cable origin and destination and a unique identifier for each cable within the system. Racks and patch panels shall be labeled to identify the location within the cabling system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
- C. Product Specifications: The labeling shall be machine-generated and affixed to the cable, faceplate, patch panel, rack or other hardware.
- D. Labeling Software: Labeling software shall be easily useable and run on Microsoft Windows® 95, 98, ME, NT, 2000 and XP operating systems. Labeling software shall be compliant with TIA/EIA-606-A and shall be able to produce complex unique identifiers of up to 12 independent segments. Labeling software shall be capable of inserting symbols as well as use any standard True Type Font as well as capable of saving individual build information and of fine tuning print adjustments. Labeling software shall be compatible with AMP NETCONNECT products and shall be [Microsoft Word®, Microsoft Excel® or purchased directly from Silver Fox, Ltd. at: <http://www.silfox.com/eshop/viewproduct.php?id=149>].
- E. Faceplate Labeling: Labeling for faceplates at each work station shall be white [perforated card stock compatible with inkjet and laser printers or pre-cut self-adhesive polyester compatible with laser printers]. Labels shall be 1.98” x 0.373” in size and be divided 72 labels per sheet with each sheet being 8.5” x 11”. Work area outlet labels shall be AMP NETCONNECT part number [1375356-X or 1375357-X (X denotes packaging, see Table-30)].

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Description	Labels per Sheet	Sheets per Pack	Labels per Pack	Part Number
Card Stock Self-adhesive	72	5	360	1375356-1
	72	100	7200	5-375356-1
	72	5	360	1375357-1
Polyester	72	100	7200	5-1375357-1

Table-30

Faceplate Label Part Numbers

- F. Patch Panel Labels: Patch Panel labels shall be white [perforated card stock compatible with inkjet and laser printers or pre-cut self-adhesive polyester compatible with laser printers]. Labels shall be [3.10" x 0.50" (for patch panels without icons) or 3.30" x 0.25" (for patch panels with icons)] in size and be divided [36 or 72] labels per sheet with each sheet being 8.5" x 11". Patch panel labels shall be AMP NETCONNECT part number [1375351-X, 1375352-X or 1375353- X (X denotes packaging, see Table-31)].

Description	Labels per Sheet	Sheets per Pack	Labels per Pack	Part Number
Card Stock	36	5	180	1375351-1
	36	100	3600	5-1375351-1
	36	5	180	1375352-1
Self-adhesive	36	100	3600	5-1375352-1
Polyester	72	5	360	1375353-1
	72	100	7200	5-1375353-1

Table-31

Data Patch Panel Label Part Numbers

- G. Cross-Connect Labels: Cross-connect labels shall be [perforated card stock compatible with inkjet and laser printers or pre-cut self-adhesive polyester compatible with laser printers] [and be color coded per the labeling scheme in paragraph 10 (card stock)]. Labels shall be 7.90" x 0.48" in size and be divided 18 labels per sheet with each sheet being 8.5" x 11". Cross-connect labels shall be AMP NETCONNECT part number [1375354-X or 1375355-X (X denotes color and packaging, see Table-32)].

Description	Labels per Sheet	Sheets per Pack	Labels per Pack	Color	Part Number
Card Stock	18	5	90	White	1375354-1
				Blue	1375354-2
				Green	1375354-3
				Purple	1375354-4
				Red	1375354-5
				Brown	1375354-6
				Yellow	1375354-7
				Orange	1375354-8
				Gray	1375354-9



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			White	5-1375354-1
			Blue	5-1375354-2
			Green	5-1375354-3
			Purple	5-1375354-4
	100	1800	Red	5-1375354-5
			Brown	5-1375354-6
			Yellow	5-1375354-7
			Orange	5-1375354-8
			Gray	5-1375354-9
Self-adhesive Polyester Table-32	18	5	90	White
	100		1800	White
				1375355-1
				5-1375355-1

Voice Cross-Connect Label Part Numbers

- H. Cable Labels: Cable labels shall be self-adhesive, self-laminating, pre-cut and laser-printer compatible. Labels shall be used with [4-pair horizontal UTP cable and/or 25-Pair backbone UTP], be [0.984" x 1.496" (4-Pair) and/or 0.984" x 2.480" (25-Pair)] in size and be divided [48 (4-Pair) and/or 24 (25-Pair)] labels per sheet with each sheet being 8.5" x 11". Cable labels shall be AMP NETCONNECT part number [1479002-X and/or 1479003-X (X denotes packaging, see Table-33)].

Description	Labels per Sheet	Sheets per Pack	Labels per Pack	Part Number
Card Stock	18	5	90	1479002-1
		100	1800	5-1479002-1
Self-adhesive Polyester	18	5	90	1479003-1
		100	1800	5-1479003-1

Table-33

Twisted Pair Cable Label Part Numbers

- I. Icons: Icons shall be used to indicate the function of each port on a work area outlet. Icons shall be provided with each faceplate kit and be colored to match the faceplate. Icons shall be used in each TR for horizontal or backbone patch panels and enclosures.

3.7 LABELING REQUIREMENTS

- A. Identify system components in compliance with the following specifications:
- B. Follow EIA/TIA recommendations and Owner's standards for identification of voice and data jacks, cables and terminations.
- C. Workstation: Label cables within outlet boxes. Label each jack with a unique identifying nomenclature.

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Type of Closet <b>D = Data</b> <b>V = Voice</b> <b>C = Video</b>	Room #	Rack	Patch Panel (1 to 10, depending on Qty. of racks 1 = denotes top of rack CATV trunk cable	Data Port #/Cable TV Tap number
D	029	A	01	43

- D. Wireless access point cabling/cabling terminated above a ceiling must have the jack label applied to the ceiling grid, as well as the end termination point to allow for quick visual inspections by field network technicians for future troubleshooting. Preference is to have the wireless outlets terminated into a faceplate mounted to the ceiling tile where the wireless access points can be mounted directly to the faceplate.
- E. Distribution Racks and Frames: Label each unit and field within that unit.
- F. Within Connector Fields, in Wiring Closets and Equipment Rooms: Label each connector and each discrete unit of cable-terminating and connecting hardware.
- G. Cables, Generally: Label each cable within 4 inches (100 mm) of each termination and elsewhere as indicated.
- H. Exposed Cables and Cables in Cable Trays: Label each cable at intervals not exceeding 15 feet (4.5 m)
- I. Cable Schedule: Post at a prominent location in each IDF Room and equipment room. List incoming and outgoing cables and their designations, origins, and destinations. Protect with a rigid frame and clear plastic cover. Provide a diskette copy of final comprehensive schedules for the project in the software and format as indicated in section 1.6.4.

**3.8 AS-BUILT DRAWINGS**

- A. The installation Contractor will be provided with 2 sets of D or E-size drawings at the start of the project. One set will be designated as the central location to document all as-built information as it occurs throughout the project. The central set will be maintained by the Contractor's foreman on a daily basis, and will be available to the technical representative upon request during the course of the project. Anticipated variations from the build-to drawings may include such things as cable routing and actual outlet placement. No variations will be allowed to the planned termination positions of horizontal and backbone cables or grounding conductors unless approved in writing by the Owner.
- B. The Contractor shall provide the central drawing set to the Owner at the conclusion of the project. The marked up drawing set will accurately depict the as-built status of the system including termination locations, cable routing, and all administration labeling for the cabling system. In addition, a narrative will be provided that describes any areas of difficulty encountered during the installation that could potentially cause problems to the telecommunications system.

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- C. A comprehensive installation, operation, programming and instruction manual shall be supplied as part of the system. The manual shall provide complete service information, including schematics, layout drawings, and interconnecting diagrams showing the location of all the outlets, cable taps, cable routes, and other installed components. Include final revised one-line system drawings. Include for this particular project parts lists to permit quick and efficient maintenance and repair of the equipment by qualified technicians. Manuals shall include 8 2" x 11" device location/cablings route drawings provided in CADD format Autodesk -AutoCAD Release 2014 or later (.dwg/.dxf) on CD disk. Manuals shall include a copy of the operations manuals listed below. Manuals shall be indexed and placed in a hard-cover three ring binder. Three (3) copies of this manual shall be provided to the Owner upon project completion. Contractor shall retain a minimum of one (1) copy for their permanent records. Provide one copy of Manual and disk(s) in the Main Equipment Rack. Refer to "General Provisions" in the contract for additional or documentation requirements.

3.9 SYSTEM ACCEPTANCE TESTING

- A. The Cable System Installer shall document the cable system testing methodologies in detail, including the scope, procedures and acceptance criteria for testing. The testing process shall be comprised of the test cycles outlined below. All test results (e.g. cable lengths, test result values, etc.) shall be documented in both hard copy and electronic format for the Owner's review and approval. Electronic format shall be provided using one of the products available in the Microsoft Office Suite (Word, Excel, etc.), and shall be provided in format acceptable to Owner.
- B. The Cable System Installer shall provide all necessary diagnostic tools (i.e. Time Domain Reflector (TDR), cable scanner, meters, logging equipment, etc.) The Cable System Installer shall describe any testing tools that are used, along with the capabilities and limitations of these tools.
- C. Cable System testing shall be conducted before, during and after installation. Upon completion of all prerequisite tasks to the corresponding test, the Cable System Installer shall notify the Owner in writing that the relevant portion of the cabling system is complete and ready for testing.
- D. Acceptance Test Failure: Failure of any portion of the Cabling System to successfully complete an Acceptance Test shall be deemed a failure of the entire cabling system. Such events shall be cause for Vendor obligation to execute the Retesting procedure outline below:

1. If the Cabling System, or any part thereof, fails in Acceptance test, the Cabling Installer shall either:
  - a. Modify or adjust the Cabling System to satisfy the necessary specifications and discrepancies;

-OR-

- b. Replace or add such components as may be necessary to make the Cabling System satisfy the specifications.
2. The cabling System installer shall notify the Owner in writing of the diagnosed problem, proposed method for correction and then once the corrections have been completed of the readiness of the Cabling System for re-execution of the Acceptance test.
3. Once all Acceptance Tests have been successfully completed, the Cabling System Installer shall provide for the Owner's signature, a document indicating that the system has passed all

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acceptance tests and certifying the installation. This document will then be signed by the Owner as acceptance of the Cabling Installation and Acceptance Testing methodology and results.

E. Cable System Acceptance Tests:

1. All copper cabling and terminations shall be tested, characterized and documented. At a minimum, the following tests must be performed:
  - a. Continuity Testing shall be performed to determine that the copper conductors are continuous with no opens or shorts.
  - b. Cable Characteristics Testing shall be performed to measure the intrinsic characteristics of a copper cable segment. Information derived from this test shall include the cables near end crosstalk (NEXT), capacitance, and characteristic impedance. This test shall be conducted on all installed end-to-end cable sections.
  - c. Time Domain Reflectometer (TDR) shall be used to evaluate copper loss per unit length (Db/ft) to measure both eth quality and length of copper cable. The TDR information shall be used to verify that the cable meets required IEEE 802.3 specifications for 1000 Base T connections over unshielded twisted pair cable.
  - d. Termination Testing shall be performed after the cable has been installed to verify that all cable pairs have been properly terminated. This testing shall assure that the pin-outs are correct and that there have been no flipped or unterminated pairs.
  - e. Link Confidence Testing shall measure the copper cables ability to support 100 Mb/s (Fast Ethernet) and 1000 Mb/s (Gig Ethernet) (250Mhz or greater) transmissions.
  - f. Link Confidence Testing shall measure the fiber cables ability to support 100 Mb/s (Fast Ethernet), 1000 Mb/s (Gig Ethernet) (250Mhz or greater), and 10 gig Ethernet transmissions.
  - g. Certification reports for all data wiring run shall be emailed to Art Morris [amorris@chesco.org](mailto:amorris@chesco.org) Test results shall be provided in Fluke Linkware format. In addition, hard copies of each test report and a CD-ROM with all reports shall be included in the project Operation and Maintenance Manual.
  - h. The matrix below defines when each of the above tests shall be performed:

<b>Copper Cable Test Requirements</b>				
Unit Test Name	On-Reel	After Install	Post Term	Final Test
Continuity Test		X	X	
Cable Characteristic Test				X
Time Domain Reflectometer (TDR)			X	X
Termination Testing			X	X
Link Confidence Test @ 100 Mb/s			X	X

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Link Confidence Test @ 1000 Mb/s			X	X
Link Confidence Test @ 10000 Mb/s (fiber only)			X	X

3.10 CLEANING

- A. On completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions from all areas worked in.

3.11 TRAINING:

- A. The Contractor shall include (4) four-hour on-site training sessions, or as required, of startup and training assistance during substantial completion and equipment to ensure a fully functional system. This training may also be used for system configuration during initial system startup or other services as required at the Owner's request.
- B. Training shall include a "walk-through" of the system for location and labeling orientation, a discussion of overall system concepts and configuration, specific instruction in system reconfiguration using patch cords in the wiring closets, a review of the as-built drawings, a review of the system testing and acceptance documentation, and guidelines for basic trouble-shooting of the structured cabling system. The contractor shall supply personnel who are thoroughly familiar with the installation to present the instruction in an organized and professional manner. Contractor to schedule the inspection and walk-through at a mutually agreeable time.
- C. The Contractor shall provide key personnel at each training session, as required by the Owner, at no additional cost to the Owner. Key personnel include Contractor's site-foreman, project manager and service manager.

END OF SECTION 271500