

SECTION 271500 – TELECOMMUNICATIONS

PART 1 - GENERAL SPECIFICATIONS

1.1 SCOPE

- A. This document describes the products and execution requirements relating to furnishing and installing Voice & Data. Horizontal cabling comprised of twisted pair category 6, series 6 coax, and support systems are covered under this document.
- B. The Horizontal (workstation) Cabling System shall consist of a minimum of 4-pair Unshielded Twisted Pair (UTP) Copper Cables to each work area outlet unless otherwise noted for specific locations. Cables shall be installed from the Work Area Outlet to the Telecommunications Room (TR). In the Telecommunications Room, they shall be routed to the appropriate rack and terminated as specified in this document.
- C. The work specified in this division of the specification and on the “T”, sheets must be completed thirty (30) days prior to substantial completion of the overall project. This thirty (30) day period is for the owner to provision the system prior to occupancy.
- D. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Telecommunications Contractor as detailed in this document and the project drawings.
- E. Product specifications, general design considerations, and installation guidelines are provided in this document. Typical installation details, cable routing and outlet location and types will be provided on the project drawings, an attachment to this document. If the bid documents are in conflict, this specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

1.2 REGULATORY REFERENCES

- A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, NEC, the local Electrical Code, authority having jurisdiction and present manufacturing standards.
- B. All materials shall be UL Listed and shall be marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.
- C. The performance of all modular jacks, patch cords, consolidation points, and patch panels shall be Category 6 components and channel compliant and/or meet and adhere to the below defined standards.
- D. The cabling system described in this is derived from the recommendations made in recognized telecommunications industry standards. The following documents are incorporated by reference:
 - 1. ANSI/TIA-568 (Most Current): Telecommunications Cabling Standards.
 - 2. ANSI/TIA-569-D: Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3. ANSI/TIA-607-C: Commercial Grounding – Earthing Standards.
 - 4. BICSI - TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM) – 13th Edition, 2014.
 - 5. National Fire Protection Agency (NFPA – 70).
 - 6. National Electrical Code (NEC) – 2002.

- E. 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 Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- F. This document does not replace any code, either partially or wholly. The contractor is responsible for adherence of all codes, including local codes, and the authority having jurisdiction which may affect this project.

1.3 APPROVED CONTRACTOR

- A. The Telecommunications contractor must have vendor approved and certified technicians that will install the cable system. **A copy of certification documents must be submitted with the quote in order for such quote to be valid.** The Telecommunications Contractor is responsible for workmanship and installation practices in accordance with the specific vendor solution that is proposed.
- B. The lead technician on the job site shall be certified by the manufacturer in the installation of the product and /or hold a BICSI, Technicians Level I or II certification.
- C. The T/C shall have a BICSI Certified Registered Communications Distribution Designer (RCDD) employed by their company (on their staff not a contract employee) that will be involved with the installation and project management of the job. The RCDD's name and company must be verifiable on the BICSI website and match the company name of bidder. **A copy of certification documents must be submitted with the quote in order for such quote to be valid.** Telecommunications Contractors that do not have an RCDD on staff may submit a list of (3) project references that include contact information, and project manager qualifications to Engineer prior to bid date to be considered. Submittal of references does not mean the Telecommunications Contractor will be approved to bid. Only the contractors receiving the invitation to bid, listed on a addendum, or approved in writing by Engineer will be considered.
- D. The RCDD shall be required to inspect the installation on a regular basis and submit in writing that they certify the installation to meet all EIA/TIA and NEC standards and codes.
- E. The RCDD shall review the individual cable test results and certify that they are within the acceptable parameters.
- F. The RCDD shall also be required to put into writing that the installation was built per the specifications and construction drawings.

1.4 APPROVED PRODUCTS

- A. The approved products are specified in this document and on the drawings for the horizontal and backbone systems. The telecommunications drawings indicate the associated part number/equivalent. Product and item numbers are defined in later sections of this document or indicated on the drawings.

1.5 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor; equipment, materials, supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The Telecommunications Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Furnish, install and terminate a complete communications infrastructure including wall plates, jacks patch panels, patch cords, cabinets and/or racks and any other material required to form a complete system.
 - 2. Perform link testing (100% of horizontal and/or backbone links/channels) and certification of all components.
 - 3. Furnish two (2) sets of test results of all cabling to the Owner/Owner's Representative on compact disk and paper format, listed by each closet, then by workstation ID.
 - 4. Adhere and comply with all requirements of the manufacturer of the products proposed in this specification.
 - 5. Provide owner orientation of the overall cable system and cable system documentation. (As-built drawings)

1.6 SUBMITTALS

- A. Under the provisions of this request for proposal, prior to the start of work the telecommunications contractor shall:
 - 1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this specification.
 - 2. Submit proof from manufacturer of contractor's good standing in manufacturer's program.
 - 3. Submit appropriate cut sheets for all products, hardware and cabling if different from the products that are called out in this specification.
 - a. Work shall not proceed without the Owner/Owner's Representative approval of the submitted items.
 - b. The telecommunications contractor must receive written approval from the Owner/Owner's Representative on all substitutions of material. Substituted materials shall not be installed except by written approval from the Owner/Owner's Representative.

1.7 QUALITY ASSURANCE

- A. The telecommunications contractor shall be a company specializing in communication cabling installation. Building Industry Consulting Services International (BICSI), or the proposed system solution vendor, must certify 30 percent of the termination crew for copper and 10 percent of the termination crew for fiber with a Technicians Level of Training.
- B. The T/C shall have a BICSI Certified Registered Communications Distribution Designer (RCDD) employed by their company that will be involved with the installation and project management of the job.

1.8 STORAGE AND HANDLING

- A. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If necessary, cable shall be stored off site at the contractor's expense.
- B. If the telecommunications contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner/Owner's Representative.

1.9 DRAWINGS

- A. It shall be understood that the telecommunications details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the telecommunications contractor in bidding the job. The telecommunications contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.
- B. The telecommunications contractor shall verify all dimensions and be responsible for their accuracy.
- C. Before submitting the bid, the telecommunications contractor shall call to the attention of the Engineer any materials or apparatus the telecommunications contractor believes to be inadequate and to any necessary items of work omitted.

1.10 WARRANTY

- A. An Extended Product Warranty shall be provided which warrants functionality of all components used in the vendor system solution for 20 years from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and/or backbone copper and fiber.
- B. The Application Assurance Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA/EIA-568-B.2.1. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, and 155 Mb/s ATM.
- C. The contractor shall provide a warranty on the physical installation of not less than one year at no cost to the owner. Information with regard to the proper procedures to follow if needed should be included with the warranty. They should include but not be limited to; contact name, contact telephone number, project reference, anticipated response time.

1.11 FINAL ACCEPTANCE & SYSTEM CERTIFICATION

- A. Final Acceptance of the implemented cable system solution will be provided in writing from the Owner / Owner's Representative. It will be issued upon successful completion of the installation, including but not limited to, final inspections, receipt of the successful test results and as-built documentation, and successful performance of the cabling system for a thirty-day period. Upon successful completion of the installation and subsequent inspection, the Owner/Owner's Representative shall be provided with a numbered certificate, from the Manufacturer of the installed system solution. This Extended Product Warranty shall be provided within thirty days of the completion of the project. Final payment will not be made until such warranty / numbered certificate is received.

PART 2 – PRODUCTS

2.1 EQUIVALENT PRODUCTS

- A. Equivalents are listed on drawings where approved.

2.2 WORK AREA OUTLETS

- A. Work area cables shall each be terminated at their designated work area location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a faceplate from the front.
- B. The Telecommunications Outlet Assembly shall accommodate:
 - 1. The number of jacks as noted on the project drawings.
 - 2. Additional accommodations for specific locations as noted in the plans for optical fiber and/or additional copper cables as necessary.
 - 3. A blank filler module will be installed when extra ports are not used.
 - 4. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Please refer to typical outlet configuration on project drawings prior to installation.
- C. Printed labels shall be permanent and compliant with ANSI/TIA/EIA-606-B standard specifications. Labels shall be machine printed. Hand written labels shall not be accepted.
 - 1. Faceplates: The faceplates shall:
 - a. be constructed of stainless steel.
 - b. be UL listed and/or match the color of the raceway if installed in surface raceway.
 - c. be available as single-gang or dual-gang and provide for easy access for moves, adds and changes.
 - d. provide designation field to facilitate labeling and identification.
 - e. comply with ANSI/TIA/EIA-606-A work area labeling standard.
 - f. be manufactured by an ISO 9001 registered company.
- D. Voice / Data Jacks
 - 1. Voice/Data jacks shall be 8-position modular jacks and shall meet or exceed Category 6 performance standards as defined by the references in this document. All pair combinations must be considered, with the worst-case measurement being the basis for compliance. Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.
 - 2. The modular jack shall be backwards compatible to Category 3, 5, and 5e.
 - 3. The modular jack shall be center tuned to category 6 test specifications.
- E. Video Jacks/Coax Connectors
 - 1. Video jacks shall be "F" connectors and shall be installed in locations per the project drawing.

2.3 MODULAR PATCH PANELS

- A. Modular Category 6 performance rated patch panels shall be used for the horizontal to terminate on. The panels shall be T568B standard, not high density, and use a standard 110-impact tool for termination.
- B. Modular patch panel shall be used to terminate the backbone voice cable on. The panel shall be 8 position,
- C. Modular Patch Panel kit shall be used to terminate coax cables. The kit shall provide for the placement of modules to be snapped in.

2.4 WIRE MANAGEMENT PANELS

- A. Cable management shall be provided above and below every 48 ports of patch / distribution panels or as shown on construction drawings. The wire management panels shall provide horizontal organization of patch cables on the rack.

- B. Wire management panels shall also be required for every 48 ports of network electronics, (i.e. switches, hubs), installed in a rack.

2.5 PATCH CABLES

- A. Category 6 patch cables shall be provided and installed as part of the project. They shall be installed and the remainder to be delivered to the Owner prior to completion of the project. Patch cables shall be provided in the types and quantities indicated on the contract drawings. Owner to provide port assignments.
- B. Fiber optic patch cables shall be provided as part of the project. They shall be installed and the remainder to delivered to the Owner prior to completion of the project. The fiber optic patch cables shall be provided in the types and quantities indicated on the contract drawings. Owner to provide port assignments.

2.6 FIBER TERMINATION CABINETS

- A. Fiber shall be terminated in a rack mountable cabinet that will secure, protect and organize fibers for interconnection.

2.7 FIBER AND CONNECTORS

- A. Fiber cables shall be field terminated using LC fusion spliced pigtail type connectors. The connector shall be compliant TIA/EIA 604-3.

2.8 RACKS

- A. All equipment, patch panels, wiring blocks, etc., shall be mounted in self-supporting equipment as indicated on the project drawing. The rack shall be able to support 19" panels and equipment. The equipment rack shall provide vertical cable management and support for the patch cords at the front of the rack and wire management, support, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack, on both sides, for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management. Refer to "Rack Detail" on drawings for specific information.

1. Free Standing Rack shall:

- a. provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B.
- b. have EIA hole pattern on front and rear.
- c. be available with a standard channel depth.
- d. be available with velcro straps for securing bulk cables inside the vertical U-channels.
- e. provide floor and ceiling access for cable management and distribution.
- f. provide pre-drilled base for floor attachment of rack.
- g. be manufactured by an ISO 9001 registered company.

2.9 HORIZONTAL DISTRIBUTION CABLE

- A. All horizontal cabling must be plenum rated Category 6. The horizontal cable shall be terminated on Category 6 modular patch panels as specified on the drawings. The horizontal cable must pass all Category 6 testing parameters upon completion of installation and termination.

2.10 COAX CABLE

- A. Plenum rated coax cable shall be installed to provide for video service within the facility. It shall run from the respective Telecommunications Room to specific locations as indicated on the project drawings.

2.11 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 to act as a current carrying conductor. 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.
- B. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bus bar (TGB). 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. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded green insulated copper bonding conductor and compression connectors, or as shown on drawings.
- D. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Black insulated wires shall be identified at each termination point with a wrap of green tape. All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.

2.12 FIRESTOP

- A. 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 of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- B. 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 item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped.
- C. Fire stop systems shall be UL Classified to ASTM E814 (UL 1479).

2.13 CABLE TRAY

- A. A welded wire mesh, cable management system shall be installed. The open mesh shall permit easy access to the tray and provides continuous ventilation of cables installed in the tray. The open mesh basket tray shall be produced from high mechanical strength steel wire. The welded wire mesh tray must meet applicable Underwriters Laboratories standards and requirements. The open mesh cable tray must have a continuous safety edge wire welded to the top of the tray and wire mesh welded at all intersections.

- B. A continuous insulated number six (6) AWG, stranded green insulated ground conductor shall be installed at one end with all open mesh cable trays. The ground conductor fixing system shall be accomplished by the use of the manufacturer's approved splices and bonding jumpers. Refer to drawings for additional information.

PART 3 – EXECUTION

3.1 WORK AREA OUTLETS

- A. 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 manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an "in-wall" box, modular furniture raceway, or insulated walls. Excess slack shall be loosely 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.
- B. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.1 document, manufacturer's recommendations, BICSI and best industry practices.
- C. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- D. Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the cable.
- E. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.

3.2 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

- A. Cable shall be installed in accordance with recommendations from the manufacturer, BICSI and best industry practices.
- B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- C. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-A maximum fill for the particular raceway type or 40%.
- D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points as noted on the project drawings. Additional splices, transition points or consolidation points must be approved in writing by the Owner / Owner's Representative.
- E. Cables shall be routed to allow a minimum of three (3) feet of slack in a neat bundle, not coiled behind rack. This cable may be used for future rearrangements and re-terminations.
- F. Where transition points, or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- G. J-hook or trapeze system shall be used to support cable bundles. All horizontal cables shall be supported at a maximum of 48 inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels or any other type of ceiling. They also shall not rest on tops of walls, duct work, or piping.
- H. Horizontal distribution cables shall be bundled in groups of not more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- I. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

- J. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- K. Any cable damaged or exceeding recommended installation or test parameters during installation shall be replaced by the contractor before final acceptance at no cost to the Owner.
- L. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. 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 (6" back from termination point). Brady LAT-18-361-1 or submit sample to engineer for approval prior to installation.
- M. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the outside diameter of the cable at any point in the run and at the termination field. The cable's minimum bend radius shall not be exceeded.
- N. Pulling tension on 4-pair UTP cables shall not exceed 25-lb. for a four-pair UTP cable. The cables maximum pulling tension shall not be exceeded.
- O. The installation of cable shall conform to the following clearances:
 - 1. At 5 inches (127 millimeters) from power lines carrying 2KVA or less.
 - 2. At least 12 inches (305 millimeters) from power lines carrying from 2 to 5 KVA.
 - 3. At least 36 inches (915 millimeters) from power lines carrying more than 5 KVA.
 - 4. At least 2 inches (305 millimeters) from all fluorescent lights and other sources of electromagnetic interference such as electric motors, HVAC equipment, arc welders, intercoms, etc.

3.3 HORIZONTAL CROSS CONNECT INSTALLATION

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard, manufacturer's and BICSI recommendations, and best industry practices.
- B. Cable pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective panels or blocks. 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.
- E. The cable jacket shall be maintained to within 25mm (1 inch) of the termination point.
- F. 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. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.4 OPTICAL FIBER TERMINATION HARDWARE

- A. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.
- B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.
- C. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

- D. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

3.5 BACKBONE CABLE INSTALLATION

- A. Backbone cables shall be installed separately from horizontal distribution cables.
- B. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- C. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
- D. Where backbone cables and distribution cables are installed in a cable tray or wire way, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- E. All backbone cables shall be securely fastened to the sidewall of the TR using ladder rack or some other comparable hardware.
- F. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- G. Vertical runs of cable shall be supported to cable ladder, or other approved method to provide proper support for the weight of the cable.
- H. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

3.6 COPPER TERMINATION HARDWARE

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard, manufacturer's recommendations, BICSI and best industry practice.
- B. Cable pair untwist at the termination shall not exceed 12 mm (one-half inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable. Bend radius of cables shall not be exceeded at any time.
- D. Cables shall be neatly bundled and dressed to their respective panels or blocks. 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.
- E. The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.
- F. 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. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.7 RACKS

- A. Racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.
- B. Racks shall be placed as shown on the construction drawings. When possible they shall be placed with a minimum of 36-inch clearance from the walls on all sides.
- C. All racks shall be grounded to the telecommunications ground bus bar.

- D. Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- E. Wall mounted termination block fields shall be mounted on 4' x 8' x .75" void free plywood. The plywood shall be mounted vertically 12" above the finished floor. The plywood shall be painted with two coats of white fire retardant paint.

3.8 CABLE TRAY

- A. All open mesh cable tray, shall be installed in accordance with the manufacturer's recommendations. The open mesh cable tray shall be Underwriters Laboratories (UL) compliant upon installation completion.
- B. The open mesh cable tray shall be installed using hardware, splice connectors, support components and accessories furnished by the manufacturer of the open mesh cable tray product.
- C. The open mesh cable tray shall be installed above the equipment racks as defined on the construction drawings. The cable tray must be secured to the equipment racks. Components to secure the rack may be furnished by either the cable tray manufacturer or the equipment rack manufacturer.
- D. It shall be contractor's responsibility to inspect areas to receive the open mesh cable tray and notify the Owner / Owner's Representative of conditions that would adversely affect the installation or subsequent utilization of the system. These conditions shall be corrected prior to installation of the open mesh cable tray.
- E. The contract shall install and support the open mesh cable tray system in accordance with span load criteria of L/240.

3.9 FIRESTOP SYSTEM

- A. All fire stop 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 before cable system acceptance.

3.10 GROUNDING SYSTEM

- A. The TBB shall adhere to the recommendations of the ANSI/TIA/EIA-607 standard, and shall be installed in accordance with best industry practice.
- B. A licensed electrical contractor shall perform installation and termination of the main bonding conductor to the building service entrance ground.

3.11 IDENTIFICATION AND LABELING

- A. Labeling shall be done as shown on construction drawings. 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 cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the red-lined as-built drawings and all test documents shall reflect the appropriate labeling scheme. Labeling shall follow the guidelines of ANSI/TIA/EIA-606-A.
- B. All label printing will be machine generated. Labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

3.12 TESTING AND ACCEPTANCE

- A. General

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B including all addendums. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed at no cost to the Owner.
2. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, and the Manufacturer's Certification Program Information Manual, BICSI and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the Owner / Owner's Representative for clarification and resolution.
3. The Engineer may request that the T/C verify at random that the patch cords meet test requirements defined in ANSI/TIA/EIA-568-B.2.1.

B. Copper link Testing

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level III test unit for category 6-performance compliance as specified in ANSI/TIA/EIA-568-B.2-1.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and/or replaced and re-tested before final acceptance.
3. Length - Each installed cable link shall be tested for installed length using a Time Domain Reflectometer (TDR) type device. The cables shall be tested from end to end, patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the longest pair length shall be recorded as the length for the cable.

C. Category 6 Performance

1. Follow the Standards requirements established in:
 - a. ANSI/TIA/EIA-568-B .1, B.2-1
 - b. A Level III test unit is required to verify category 6 performances. The basic tests required are:
 - ◆ Wire Map
 - ◆ Length
 - ◆ Attenuation
 - ◆ NEXT (Near end crosstalk)
 - ◆ Return Loss
 - ◆ ELFEXT Loss
 - ◆ Propagation Delay
 - ◆ Delay skew
 - ◆ PSNEXT (Power sum near-end crosstalk loss)
 - ◆ PSELFEXT (Power sum equal level far-end crosstalk loss)
2. The Contractor shall test each link from end to end to ensure the performance of the system. A complete link test is required. The contractor will install patch cords to complete the circuit and then test the entire channel.

D. Fiber Testing

1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices. Testing shall consist of an end-to-end power meter test performed per EIA/TIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers from both directions. These tests also include continuity checking of each fiber.
2. Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for singlemode) in both directions.
3. Test set-up and performance shall be conducted in accordance with ANSI/EIA/TIA-526-14 Standard, Method B.
4. Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. **ONLY LINK TEST IS REQUIRED.** The contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.
5. Attenuation testing shall be performed with an approved hand held tester from an industry recognized test equipment manufacturer.

E. Coax Cable Testing

1. 100% of coax cables placed shall be tested. They shall be tested for continuity and length. The results shall be recorded and provided to the Engineer for review.

3.13 SYSTEM DOCUMENTATION

- A. Upon completion of the installation, the telecommunications contractor shall provide two (2) full documentation sets to the Owner / Owner's Representative for approval. 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 testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test results and draft annotated drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. The telecommunications contractor shall provide copies of the original test results to the Owner / Owner's Representative.
- C. The Owner / Owner's Representative may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Owner / Owner's Representative, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.14 TEST RESULTS

- A. Test documentation shall be provided to the Owner / Owner's Representative within three weeks after the completion of the project. The telecommunications contractor shall provide one set of documentation, printed on paper and two copies on compact disk. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is mandatory on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

- B. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-B including applicable TSB's and amendments. The appropriate Level III tester shall be used to verify Category 6 cabling systems.
- C. Printouts generated for each cable by the (wire or fiber) test instrument shall be submitted as part of the documentation package. The telecommunications contractor must furnish this information in electronic form (CD-ROM) and print out on paper.
- D. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.15 AS-BUILT DRAWINGS

- A. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. 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 2007) 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/Owner's Representative.
- B. The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and compact disk (AutoCAD 2007) format.

END OF SECTION 271500