SECTION 27 1500 – INTRABUILDING DATA/COMMUNICATION CABLE SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Data/Telecommunications Cable Systems

B. Fiber Optic Cable Systems

C. Multi-Media/CATV Communication Cable Systems

D. Associated Conduit Raceway Distribution and Equipment Rack/Cabinet Systems

1.02 RELATED SECTIONS:

A. Section 27 0502 – Required Submittals for Communications

B. Section 27 0504 – Communications Contractor Qualifications

C. Section 27 0526 – Grounding and Bonding for Communications Systems

D. Section 27 0528 – Pathways for Communication Systems

E. Section 27 0553 - Communication Identification and Labeling

1.03 REFERENCES:

A. NEC Compliance: Comply with NEC Article 800, 820, 830 and 840 National, State and Local codes as applicable to wiring methods, construction and installation of interbuilding data and communication cabling systems. Comply with NEC Article 770, National, State and Local codes as applicable to the installation of interbuilding fiber optic cable systems.

B. NFPA Compliance: Comply with NFPA, National, State and Local codes as applicable to wiring methods, construction and installation of interbuilding data and communication cabling systems.

C. NEMA Compliance: Comply with applicable portions of NEMA-250 standards (et.al.) pertaining to electrical and/or communication equipment and enclosures.

D. TIA Compliance: Comply with TIA 568-D.1,3-D, 568.2-D, 569-D, 606-B, 607-C, National, State and Local standards for commercial building wiring for interbuilding voice and data communications as applicable.

E. IEEE, ANSI and ISO Compliance: Comply with interbuilding data and communication cabling system standards of IEEE, ANSI and ISO as applicable.

F. REA, Telcordia, ECIA Compliance: Metallic telecommunications cable, fiber optic telecommunications cable and accessory components shall comply with REA, Telcordia and ECIA standards and specifications as applicable.

G. UL Compliance: All components shall comply with UL1863 standards (et.al.) and be UL listed and labeled as applicable.

H. Drawings, specifications and other contract documents are intended to comply with or exceed industry standards and code requirements. The Contractor shall notify the Associate in writing of any discrepancies or conflicts for resolution. In the absence of a written Associate accepted resolution, the more stringent criteria shall apply.

1.04 SYSTEM DESCRIPTION:

A. The Contractor shall furnish, install and test as required: conduits, conduit boxes, pull-boxes, conduit bushings, cable trays, cables, cable supports, cable ladders, cable ladder hardware, conduit sleeves, fire-stopping, fiber optic cable, fiber optic patch cords, fiber optic patch panels, inner duct, pull- rope, user voice cable, user data cable, voice and data patch cords and connectors, Category-6A and Category-6 patch panels, patch panel organizers, system and cable labels and designation strips, data equipment racks, equipment shelves, grounding, distribution blocks, interconnection cables, etc., as indicated on the Engineering Drawings and in this and other specifications and other contract documents.

B. The Contractor shall bid the project as specified and shown on the drawings and documents. The drawings illustrate the work specified and are intended to agree in every respect with one another and with the specifications. Any discrepancies shall be brought to the attention of the Associate for correction. No omission from any drawing shall release the Contractor from furnishing equipment, materials or services called for by the specifications or other drawings.

C. All equipment furnished shall be new and of the quality specified in the specification. No equipment may be furnished that has ever been in use either in the present installation or in another installation except as noted in the project specification or the drawings.

D. The Contractor shall clean and organize his work areas daily. He shall be responsible for maintaining cleanliness in all work areas so as to not adversely affect other trades, Contractors, vendors, suppliers, or the Owner in the timely installation of equipment and/or implementation and completion of concurrent responsibilities.

E. The Contractor shall also be responsible for protecting any and all equipment and materials from damage during his installation process. Any equipment, material and/or facilities damaged by the Contractor during, or due to, or in the performance of his contract, shall be replaced or repaired at the expense of the Contractor as directed by the Associate.

F. The Contractor shall provide for a manufacturer certified and warranted installation with an extended guarantee. The warranty shall be based fully upon the design criteria contained herein, meeting all specifications and standards for installation and materials. The warranty shall include shop drawings and cut sheets on all equipment and materials, documentation verifying the Contractors certification by the manufacturer, details of the manufacturer’s certification program, and full details of the extended warranty. **The warranty shall be provided by the cable manufacturer and supported by the connectivity manufacturer.**

1.05 SUBMITTALS:

A. Submit under provisions of Section 01 3300 and 27 0502.

B. Product Data: Provide catalog cut sheets for all materials, equipment, components, and software; description of system functions.

C. Shop Drawings

D. Test Reports: Submit factory test reports.

E. Test Procedures: Submit prior to performing field testing. Identify the test equipment to be used.

F. Project Record Documents: Submit under provisions of Section 01 7700.

1.06 INSPECTION OF WORK/CONSTRUCTION AREA:

A. Authorized representatives of the Owner, Associate and/or Architect shall have access to the construction site at any reasonable time to inspect equipment, material, and the installation and to obtain information on work progress and delivery.

1.07 ON-SITE PROJECT TEAM:

A. The Project Manager/Foreman will be responsible to the RCDD and Associate, Architect and/or Owner for all aspects of project quality of installation and compliance with standards, specifications and the Engineering drawings. **The Project Manager/Foreman shall have an office at the project site and shall be on-site whenever work is being performed and installation crews are present.**

B. The Project Manager/Foreman shall maintain and update all job-related documentation including but not limited to record drawings, specifications, addenda, and bulletins. He shall keep a master copy of project schedules and as-builts in his office at all times.

C. The Project Manager/Foreman shall coordinate all activities and interaction with other trades and Contractors on-site, and he shall direct and supervise all tradesmen and subcontractors working under him.

D. The Contractor’s Project Manager/Foreman/RCDD shall make weekly written project progress reports to the Associate. This report shall include, but not be limited to; work completed, problems encountered, corrective solutions proposed, resolution actions approved and/or taken, all changes, bulletin items, alternative proposals or solutions for consideration, approval or implemented, scheduling or delivery problems, conflicts and/or coordination problems with other trades, Contractors or in design elements, etc. This report shall be prepared by the Project Manager/Foreman/RCDD, and shall include the name, company and telephone numbers of all pertinent individuals involved in report items, as applicable (i.e. suppliers, vendor reps, other trades, Owner representatives, etc.).

E. The Contractor's Project Manager/Foreman shall immediately notify the Associate of any existing or developing conditions which may adversely affect the quality, completion date or performance of the installation. Notification of the Associate shall be made in a timely manner, as to minimize or eliminate changes and rework.

1.08 EQUIPMENT WARRANTIES:

A. The Contractor shall guarantee warranty installation to be free from inherent defects in design, workmanship and material. The installation shall function properly and continually under all operating conditions required, specified or reasonably implied in the contract documents. **The Contractor shall replace, at no expense to the Owner, total equipment and/or materials or any component thereof, found defective, upon delivery or within ~~one~~ two (2) years from date of final inspection and written acceptance by the Owner and/or Associate.**

B.The Contractor shall provide for a manufacturer certified and warranted installation with an extended warranty. The warranty shall be based fully upon the design criteria contained herein, meeting all specifications and standards for installation and materials. The warranty shall include shop drawings and cut sheets on all equipment and materials, documentation verifying the Contractors certification by the manufacturer, details of the manufacturers certification program, and full details of the extended warranty. The warranty shall be provided by the cable connectivity manufacturer and supported by the cable connectivity manufacturer.

C. The Contractor shall maintain and support the equipment manufacturers' warranties/guarantees for all electronic equipment furnished and installed by the Contractor under this contract for the life of the equipment manufacturers' warranties/guarantees as per specifications.

1.09 SPECIAL CONDITIONS:

A. Computer, voice or other systems may or may not be required to be taken off-line or removed from service during this contract. Other specific instructions may be found in the Project Specification accompanying this document.

B. If required, computer, voice or other systems associated with this work will not be taken off-line or removed from service during normal working hours. These systems are critical to the provision of services to the Owner's clients and shall not be interrupted by the Contractor's activities. Arrangements must be made by the Contractor to coordinate any such activities. The Contractor shall be required to work around the above conditions, as well as work with the Owner's staff to minimize disruptions to normal Owner activities.

C. The Contractor shall provide timely written notice of the need to disconnect any existing computer, voice or other systems to the Owner and copy the Associate. The Owner, Associate, Architect and Contractor shall schedule such outages as required, directed or as stipulated elsewhere in the project specifications, appendices, or schedules. System outages shall be performed only with the authorized consent of the Owner, Associate and Architect. The Contractor shall perform no testing, outages, modifications, or other functions on active operating systems without prior approval of the Owner, Associate and Architect. The Contractor will be responsible for any damages, expenses incurred, or losses suffered by the Owner or others caused by his unauthorized actions.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Design and workmanship shall be in accordance with the requirements of the contract documents and subject to acceptance by the Associate. Components shall be of the latest type and design, manufactured for the intended use, and shall be laid out and installed so as to afford easy maintenance and/or replacement without major disassembly of adjacent components.

B. All products shall be bid as specified. Any deviation from the products specified shall be noted in the bid and listed as a voluntary alternate to the base bid with price deducts listed. All substitutions require ten (10) days for evaluation for prior approval by the Associate. Products substituted must be demonstrated to the Associate to be electrically and mechanically interchangeable with the specified product. Samples of the substituted product may be requested from the Contractor to validate claims that the substituted product will meet the electrical and mechanical constraints of the specified product.

C. See Appendix “A” Owner/Associate approved material list.

2.02 CABLES:

***The University of Toledo campus is currently in a transition from analog voice phone system to a VOIP system. In the interim a project may require the following work. Apply as/if required.***

A. Horizontal Copper Data Cables:

1. Horizontal User Data Cables shall consist of four (4) 23 AWG solid copper unshielded twisted pairs that exceed TIA-568.2-D and the specification for Category-6 or -6A cable as Specified by the Drawings and/or Specifications.

2. The maximum length for user data cables shall be limited to 90 meters (295 ft.) from user telecommunications outlet faceplate to the data distribution cross-connect patch panel.

3. All horizontal user data cables shall be of a single manufacturer and manufacturer’s part number or part number series for multiple color cables, unless approved by the Associate in writing.

4. The horizontal user data cables shall be as specified on the Engineering Drawings; color blue.

5. The horizontal user data cable shall be Plenum Rated (CMP) unless otherwise noted on the Engineering Drawings.

6. All four (4) pairs of conductors shall be insulated with a common FEP material, thus assuring stable performance characteristics, a common nominal value of propagation for all four (4) pairs and a resulting minimum skew. It shall be the responsibility of the Vendor/Contractor to assure that the cable submitted shall meet the minimum installed channel performance specifications as noted elsewhere, herein.

7. The cables shall be independently verified Category-6 or -6A by E.T.L. or U.L. All shop drawing submittals shall indicate cable verification.

8. Horizontal copper cable colors shall adhere to the following:

a. Data, Wireless and Rocket Card point of sale = Blue.

B. Fiber Optic Cable - Indoor Backbone:

1. Fiber optic cable shall be used for longer runs as specified on the drawings and project specification. Backbone cables typically run from the Main Cross-Connect (MC) to each Intermediate Cross- Connect (IC) and to each horizontal cross-connect (HC). Cable shall be new, unused and of current design and manufacture. Fiber optic cable shall be manufactured in an ISO 9001 Certified Manufacturing Facility.

2. All fiber optic cable shall be designed, manufactured and tested to meet or exceed Telcordia GR-20 and GR-409 specifications, ANSI/ICEA S-87-640-2016 and ANSI/ICEA-S-104-696-2013 standards.

3. Fiber optic cable shall be armored multimode (50µm) or single-mode cable, of tight-buffered construction suitable for indoor use and be OFNR or OFNP rated depending upon application, as specified on the drawings and project specifications.

4. The outer jacket shall be smooth and free from holes, splits, blisters and other surface flaws.

5. The manufacturer's identification and required UL markings shall be printed on the outer jacket. Included on the manufacturer's identification shall be the date of manufacture, part number, and sequential meter markings. Length marks shall have tolerance ratings of -0% to +1% actual length measurements.

6. Interbuilding fiber optic backbone cable requirements shall include but not be limited to the following:

a. Optical Fiber Types, as Specified:

1) OM4, 50 micron, multimode, graded index fiber

2) Single-mode stepped indexed fiber

b. Proof Test:

1) All fiber shall be subjected to a minimal proof test of

0.7 Cpa (100 kpsi).

c. OM4, 50 micron, Multimode Fiber Core Dimensions:

Core diameter 50 µm + 3.0 µm

Cladding diameter 125 µm + 2.0 µm

Core-to-cladding offset ≤ 3.0 µm

Numerical Aperture 0.275

d. Single-Mode Fiber Core Dimensions:

Core diameter 8.3 µm + 0.5 µm

Cladding diameter 125 um + 1.0 µm

Core to cladding offset ≤ 0.8 µm

Numerical Aperture 0.13

e. Temperature Ranges:

Operating Temperature Range -40°C to +85°C

Storage Temperature Range -55°C to +85°C

Humidity 5% to 95%

f. Minimum Bending Radius:

1) Under Full Tensile Load - bending radius not less than 20 times outside diameter.

2) Under No Load - bending radius not less than 10 times outside diameter.

g. OM4 Multimode Operating Windows:

850 nm Attenuation ≤ 3.5 dB/Km

1300 nm Attenuation ≤ 1.5 dB/Km

850 nm OFL Bandwidth ≥ 3500 Mhz-km

1300 nm OFL Bandwidth ≥ 500 Mhz-km

Minimum Modal Bandwidth @ 850 nm ≥ 2000 Mhz-km

h. Single-Mode Operating Windows:

1310 nm Attenuation ≤ 0.5 dB/Km

1550 nm Attenuation ≤ 0.5 dB/Km

i. Survivability:

Crush Resistance ≥ 2,100 N/cm

Impact Resistance ≥ 1,500 Impacts

Flex Resistance ≥ 2,000 Cycles

j. The optical fiber shall be manufactured by OFS, Spectran, Corning Glass, Inc. or Associate approved equal. All shop drawing submittals shall indicate the supplier and manufacturer of the optical fiber.

k. Armored outer jacket color shall be:

1) Aqua for 50 micron multimode cable. Yellow for single-mode cable red for fire safety, and/or as Associate approved.

l. The fiber strand colors shall be per Standard TIA-598-D as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| Fiber 1 | Blue | Fiber 7 | Red |
| Fiber 2 | Orange | Fiber 8 | Black |
| Fiber 3 | Green | Fiber 9 | Yellow |
| Fiber 4 | Brown | Fiber 10 | Violet |
| Fiber 5 | Slate | Fiber 11 | Rose |
| Fiber 6 | White | Fiber 12 | Aqua |

m. Cable shall be as specified on the Engineering Drawings.

C. 75 ohm Trunk and Horizontal Coaxial Cable:

**1. The broadband coaxial cable shall be terminated and balanced (including the system design and installation of all splitters taps, amplifiers, etc.) by Buckeye Telesystems Inc. at the Contractor’s expense.**

a. 75 ohm Coaxial Cable:  RG-11/U (series 11), plenum rated CATVP, 14 AWG solid copper center conductor, foamed "FEP" dielectric, dual laminated quad shield, 100% aluminum foil + 60% aluminum braid + 100% aluminum foil + 40% aluminum braid, plenum grade PVC jacket, 0.385" O.D. nominal.

b. 75 ohm Coaxial CATV Cable:  RG-6/U (series 6), plenum rated CATVP, 18 AWG solid copper center conductor, foamed "FEP" dielectric, quad shield, 100% aluminum foil + 65% Aluminum braid + 100% aluminum foil, + 55% Aluminum braid, plenum grade PVC jacket, 0.273" O.D. nominal

c. Where it has been indicated on the Drawings that a cable shall be installed outside/below grade, the cable assembly shall include water-blocking characteristics.

d. Where it has been indicated on the Drawings that a single cable “Cable System” installation shall be provided, one (1) run of plenum rated, RG-6, 75 Ohm CATVP Cable:

 1. Comm Scope #2227V shall be provided to each outlet from the “headend” equipment as per the specifications of the “Cable System” provider. Contractor shall verify vendor requirements.

e. See Appendix A for manufacturers and part numbers.

2.03 CONNECTIVITY HARDWARE:

A. Telecommunications Faceplate:

1. Unless specified otherwise, outlet locations shall consist of a faceplate mounted on a metal outlet backbox, floor mounted outlet box, surface mounted raceway system, or as otherwise specified on the detailed Engineering Drawings and/or Specifications. Wall mounted conduit outlet boxes, etc. shall be as per Section 270528

2. Faceplates shall be flush mounting, with label fields, colored to match the electrical faceplates as specified by the Architect. Faceplates shall be designed for flush mounting of jacks unless noted otherwise. Label fields shall allow for the individual identification of each outlet location. Mounting screws shall be captive, which retains the mounting screws during installation. The faceplate shall be molded from 94-VO rated thermoplastic or equal and U.L. rated. Stenciling or engraving of pre-labeled markings shall be by the thermal ink transfer method or Associate approved equal.

3. Contractor shall coordinate faceplate material (i.e. thermoplastic or stainless steel) with the appropriate Division 26 electrical specification for electrical devices and faceplates. Contractor to notify the Associate of any conflict prior to purchase of materials, for clarification.

4. The telecommunications faceplates shall be as specified or Associate approved equal.

5. Furnish and install jacks in the faceplates as per the Connectivity Schedule on the Drawings or elsewhere in the contract documents.

6. See Appendix A for manufacturers and part numbers.

B. Surface Mounted Enclosures:

1. In areas requiring the telecommunications faceplate assembly to be surface mounted on a wall, a single gang or double gang deep [metallic] [non-metallic] surface mounted box, shall be utilized as required. Coordinate color with Architect.

2. The surface mounted box shall be secured to the wall with a minimum of two (2) panhead screws or mushroom headed nail anchors, located in diagonally opposite corners.

3. Non-metallic surface mounted boxes shall be provided with double-sided, self-adhesive tape backing to aid in the positioning of the box prior to screw fastening and anchoring.

4. Coordinate the surface mounted box with the surface mounted raceway as required.

5. 5) Utilize [office white] [ivory] [gray] faceplates and snap-in fittings ("CATV", "F/O" and blanks) to match the raceway in color.

6. Surface mounted outlet enclosures and raceway shall be as specified on the drawings.

C. Standard Wall Phone Faceplate:

1. The standard wall phone faceplate for use at wall phone, emergency phone locations shall be a stainless steel plate with one (1) data jack for wall phones, U.L. listed, as specified or Associate approved equal.

D. 2-Port Duplex Receptacle Mounting:

1. The 2-port duplex receptacle mounting (designed for use in pedestals, monuments, recessed floor boxes, poke- throughs, flush floor boxes, communication poles, surface mounted raceway, etc., which has an electrical duplex opening) shall be a 106 series jack mounting frame, color to match the faceplates, U.L. listed; as specified or Associate approved equal.

 E. Data/CATV/Communication Jacks:

1. Unless specified otherwise on the drawings or in the contract documents, data/CATV/communication jacks for faceplates shall be as follows:

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a. Modular 8-position, 8-conductor data jacks shall be non-keyed and terminated according to T568B sequence, U.L. or E.T.L. verified Category-6 or -6A rated, meet FCC Part 68.5 specifications, with insulation displacement contact (IDC) terminations. The IDC contacts shall be tin-lead plated for #22 to #26 AWG solid conductors. Modular jack contacts shall be beryllium copper with a minimum of 50 micro inches of gold plating, molded of high impact 94-VO rated thermoplastic material, U.L./CSA listed. Modular data jacks shall exceed the TIA-568-C.1 and specifications for Category-6 or -6A modular connectors.

1) Data jack colors shall adhere to the following:

a) Data, wireless, and Rocket Card point of sale = blue.

2) All Category-6 or Category-6A modular jacks shall be independently verified by E.T.L. or U.L. All shop drawing submittals shall indicate connector verification.

3) The connectivity manufacturer and the cable manufacturer shall have collaborated to match their respective component products to provide maximum channel performance, exceeding proposed draft specifications. See test specifications herein.

4) The CATV modular female/female F-Connector color shall match the faceplate and be U.L. listed.

5) The blank modular jack insert "snap-in" fitting, color shall match the faceplate.

6) Install all data modules in accordance with the manufacturer's instructions, using a single-punch 110 style impact tool or as specified for cable termination by the connectivity manufacturer.

7) 75 ohm, RG-6/U and RG-11/U coaxial cables shall be terminated with Universal "F" type connectors of a "compression" type single piece brass construction with a 7/16" attached ferrule as manufactured by Ideal, LCR, T&B, Hubbell or Engineer approved equal. Install as per the manufacturer's instructions with approved tooling. "Crimp” or “twist-on" Type F-Connector are not acceptable.

2.04 CROSS-CONNECT HARDWARE:

A. General:

1. Unless specified otherwise on the drawings and detailed engineering documents, the Contractor shall provide data, fiber optic, and CATV cross-connect hardware as per the detailed Engineering Drawings and documents. The cross-connect hardware shall be mounted on equipment racks, in cabinets, or on backboards as indicated on the drawings.

B. Distribution Rack Frames:

1. The distribution rack frames shall be as per EIA Specification RS310C standards for open relay type equipment racks for 19" wide equipment. Racks shall be of heavy duty aluminum construction, 84” high x 20-1/4" wide x 15" deep overall, with 3.0" x 1.265" x 1/4" thick, side channels, two (2) 3-1/2" x 6" x 3/8" thick base angles, two(2) 1-1/2" x 1-1/2" x 1/4" top angles, 12-24 rolled thread panel mounting holes in front and rear mounting flanges, universal 5/8"- 5/8"-1-1/2" hole pattern, finish [clear chemical anodize] [flat black enamel], including all hardware and 12-24 x 5/8" pan head pilot point mounting screws. **The equipment racks shall have a minimum of 44 1-3/4" mounting spaces.** The distribution rack frame shall be as specified or Associate approved equal. Provide the equipment rack with two (2) guard rails for protection of equipment, minimum 5-1/4" deep, one (1) rack base dust cover and one (1) rack installation anchoring kit as per the Equipment Schedule or Associate approved equal. Install equipment racks as per the manufacturer's recommendations and instructions.

2. The Contractor shall provide and install equipment and materials in the equipment racks as per the detailed Engineering Drawings and documents. Additional equipment racks shall be provided as indicated on the drawings and documents for the installation and mounting of Owner furnished equipment and/or as otherwise indicated.

3. Where specified and/or indicated on the drawings and engineering documents, the Contractor shall provide and install wall mounted open equipment frames as per the Equipment Schedule or Associate approved equal.

4. Where specified and/or indicated on the drawings and engineering documents, detailed Engineering Drawings and documents the Contractor shall provide and install wall mounted open equipment frames as per the Equipment Schedule or Associate approved equal.

5. See Appendix A for manufacturers and part numbers.

C. Equipment Cabinets and Enclosures:

1. The free-standing distribution equipment cabinets shall be provided and installed as indicated on the detailed Engineering Drawings and documents for the housing of materials and equipment where such materials and equipment must be enclosed and secured for appearance and/or security purposes. Free standing distribution equipment cabinets shall be double (front and back) accessible with provisions for adjustable 19" rack mounting rails and accessories and provisions for power (120 VAC) and ventilation as indicated.

 2. The wall mounted distribution equipment cabinets shall be provided and installed as indicated on the detailed Engineering drawings and documents for the housing of materials and equipment, in such locations as where space for such equipment and material is limited, a controlled environment is limited, security and protection of the equipment is required. Wall mounted distribution equipment cabinets shall provide 19" rack mounting on a swing frame for double (front and back) access to equipment on the 19" frame and access to equipment mounted on the back panel. Enclosure shall be provided with knockouts on the top and bottom for cable access, a lockable full access front door over the swing frame, and provisions for power (120 VAC) and ventilation as indicated. Wall mounted distribution equipment cabinets shall be as specified on the detailed Engineering Drawings and documents or Associate approved equal, with accessories and features as indicated.

3. See Appendix A for manufacturers and part numbers.

D. Patch Cord and Cable Organizers:

1. The Contractor shall provide and install single and double space horizontal patch cord and cable organizers on the equipment racks and/or cabinets between patch panels as indicated on the detailed Engineering Drawings and documents. Generally, single space patch cord and cable organizers shall be located at the top and bottom of the rack only, with double space organizers located between 48-port patch panels and/or other equipment as indicated. Generally, patch cord and cable organizers shall be of the "front side only" design where cable support bars are utilized; and also selected for use with or without vertical patch cord and cable organizers. Patch cord and cable organizers shall have welded metal primary cable management rings and loops.

2. In cases where the specified patch panel is not provided with rear side cable support bar/bars, the Contractor shall provide cable support bars: to match the manufacturer of the patch panel(one bar per 24 patch panel ports).

3. The Contractor shall provide and install vertical patch cord and cable organizers between distribution equipment rack frames as indicated on the detailed Engineering Drawings and documents, for the routing of patch cords and cables vertically between equipment racks of high cable/port density. Mount organizer with the rings to the front, to organize the patch cables. Where applicable and/or indicated on the drawings, Contractor shall mount the multi-outlet power distribution strip on the backside of the vertical organizer. The vertical patch cord and cable organizer shall be 3" or 6" wide, as indicated on the drawings, have welded metal primary cable management rings and loops,

4. The Contractor shall provide and install horizontal interbay organizers for the horizontal bulk routing of patch cords between distribution equipment racks as indicated on the detailed Engineering Drawings and documents. Horizontal interbay organizers shall have welded metal primary cable.

5. See Appendix A for manufacturers and part numbers.

E. Patch Panels:

1. The Contractor shall provide unloaded 24 or 48-port, 8-position, 8-conductor, Category-6 or -6A modular keystone patch panels as indicated on the detailed Engineering Drawings and documents, for the termination of user side Category-6 or -6A data cables at the MC/IC/HC's. The jacks shall be wired according to T568B wiring sequence. The patch panels must be verified by U.L. or E.T.L. Patch panels shall be furnished with cable support bars and designation label kits.

2. The Contractor shall furnish and install equipment shelves, brackets, keyboard trays, equipment tie-downs, power strips, printer/paper shelves and trays, modem racks, etc., and such other equipment and accessories as indicated on the detailed Engineering Drawings. Contractor shall install the above equipment and other Owner furnished equipment as required and indicated, and completely wire and interconnect the same as per the manufacturer's and Owner's instructions to provide a complete and functioning system.

F. Cross-Connect Blocks:

***The University of Toledo campus is currently in a transition from analog voice phone system to a VOIP system. In the interim a project may require the following work. Apply as/if required.***

1. The Contractor shall furnish and install 50 pair cross-connect wiring blocks for #22 26 AWG conductors; Siemon #M1-50 or Associate approved equal, as indicated on the detailed Engineering Drawings and documents. Install cross-connect blocks on a pre-fabricated modulate frame or on 89B stand-off brackets on the telephone backboard, for termination of user side Category-3 voice cables and voice tie/trunk cables at the MC/IC/HC's, as indicated on the detailed Engineering Drawings and documents. The pre-fabricated modular frame for M1-50 blocks shall be the 50M Series module as manufactured by Homaco, Inc., or Associate approved equal.

2. Provide a clear “snap-on” plastic cover (Siemon’s #MC4) to be installed on each “66-Block” to prevent the label information from being rubbed off.

3. The Contractor shall furnish and install distribution rings (D-rings), Avaya 20A wire distribution spools, etc. or Associate approved equals as indicated and/or required to provide a clean organized cross-connect field with orderly management of cross-connect jumpers. D-rings shall be cast metal; Allen-Tel No. 13A, 13B or 13C or Associate approved equal.

G. Fiber Optic Interconnect Centers:

1. The Contractor shall furnish and install fiber optic interconnect centers in the telecommunications rooms as indicated on the detailed Engineering Drawings and documents, to provide storage and protection for fiber optic cable, terminations and connectors. Units shall contain mounting provisions for multi-fiber splice trays to facilitate splicing pigtails to the incoming cable or for field termination of cable by allowing a point to secure fan-out tubing and support a break-out point for the fibers. Fibers shall terminate on LC style compatible connectors on adapter panels compatible with the interconnect centers. The interconnect center types and sizes shall be as specified on the drawings and contract documents. Interconnect centers shall have front covers/doors that are magnetically held closed. See Appendix A for manufacturers and part numbers.

2. The fiber optic interconnect centers shall be equipped with multiple 6-port adapter panels, as specified below and as indicated on the detailed Engineering Drawings and documents.

3. The fiber optic interconnect centers shall be installed in accordance with the manufacturer's recommended instructions.

4. The wall mounted interconnect centers shall be as specified or Associate approved equal.

H. Modular Fiber Optic Couplers and Adapter Panels:

1. The modular duplex LC couplers for fiber optic cable shall be mechanically compatible with TIA-568.C.3 and TIA-604-10A standard LC connectors as specified or Associate approved equal. All couplers/adapters are to be provided with dust covers installed.

2. Modular couplers shall be of the same manufacturer as the connectors.

3. Color of fiber optic couplers shall conform with TIA-568-C.3

4. See Appendix A for manufacturers and part numbers.

2.05 MISCELLANEOUS:

A. Patch Cords fiber and copper patch cords to be provided by the University of Toledo Network department.

PART 3 – EXECUTION

3.01 GENERAL:

A. Whenever possible, cable and raceway routing paths shall follow the logical structure of the building (e.g. follow hallways, aisles and corridors). When walls must be breached, cables shall pass through pre-established metal conduit sleeved openings. Cables shall enter and/or exit areas at right angles to the structure. Route all telecommunications cables and raceways parallel to or perpendicular to the building structure. No diagonal runs will be permitted unless noted otherwise or pre-approved by the Associate. Corridor crossovers shall be kept to a minimum.

B. For the purpose of this specification, all above ceiling space shall be considered "return air plenum space", unless noted otherwise. All above ceiling cables shall be plenum rated, unless specified otherwise. All non-plenum rated cables must be routed in conduits or enclosed raceways unless noted otherwise. It is the responsibility of the Contractor to verify "non-plenum" rating requirements.

C. All telecommunications cables shall be installed as single, continuous runs from workstation outlet faceplate to patch panel, etc. No in-line connectors or splices, etc. will be permitted. Cabling shall be free of bridges, splices, taps, splitters, baluns, and other connections between workstation outlet faceplate and the patch panel.

D. **The Contractor shall purchase the cable on 1000-foot minimum reels only.** Boxed and/or coiled cable is unacceptable. All cable shall be new cable, manufactured as specified on the Drawings, purchased for the project. Salvaged, leftover, or reused cable is not acceptable. Factory seconds and/or factory shorts are not acceptable. All cable of a given type shall be of a single manufacturer and manufacturers part number unless approved in writing by the Associate. All unacceptable cable shall be removed immediately from the jobsite. All unapproved and/or unacceptable cable will be removed and replaced at the Contractor's expense.

E. The Contractor shall verify that all equipment and materials meet the Specifications and descriptions. The Contractor shall be responsible for notifying the Associate in writing if the vendor/manufacturer alters his product specification, description, part number, etc. Such notification shall be made in a timely manner such that changes may be properly evaluated and corrective measures implemented as required. Products, materials and equipment installed which do not meet the Specifications and/or product description will be replaced at the Contractor's expense.

F. Telecommunications cables that are routed above a suspended ceiling or in open exposed space and not routed in conduit, shall be supported by Associate approved cable tray and channel or supported by an Associate approved open ceiling distribution system. An open ceiling distribution system shall not be installed above inaccessible ceiling areas, such as "lock-in" type ceiling tiles, drywall or plaster. Adequate and suitable space shall be available in the ceiling area for the distribution system. A minimum of 3" of clearance space all around shall be available for the "open wiring" distribution system installation, this shall be clear accessible space not required for the removal of tile, light fixtures or for service and access to other systems.

G. Cables shall be supported on Caddy brand “Cable-Cat” hangers or Associate approved equal supports from the building structure, and shall be neatly bunched, bundled and routed above the suspended ceiling supported from the bar joist or trusses. The “open” wiring should be accessible from an 8’-0” stepladder. **The suspended ceiling and/or lighting fixture support wire or rod shall not be utilized to support telecommunications cables.** Do not support cables from ductwork, plumbing lines, fire suppression or mechanical systems, etc. Do not lay telecommunications cables on ductwork, piping, plumbing systems or on top of lay-in ceiling tile and lighting fixtures.

H. All power devices and power sources emit a given amount of radio frequency interference (RFI) and/or electro-magnetic interference (EMI). To reduce or eliminate the field effects of RFI/EMI on data traffic on a given cable channel, cable runs shall be kept at the maximum possible distance from such sources. Running cables through the center of the building can reduce the external interference effects of RFI/EMI. Open wiring or non-metallic raceway shall be routed a minimum of six (6") inches away from fluorescent fixtures. Special attention shall be given to the routing of such pathways away from lighting ballasts and high intensity discharge devices. The minimum separation distances between data/communication distribution pathways and power wiring of 480 Volts or less shall be per Table-1 herein.

|  |
| --- |
| **TABLE 1** |
| **SEPARATION OF DATA/CO****MMUNICATIONS PATHWAYS FROM****<480V POWER LINES** |
| CONDITION | MINIMUM SEPARATION DISTANCE |
| < 2 kVA | 2-5 kVA | > 5 kVA |
| Unshielded power lines or electrical equipment in proximity to open or nonmetal tel/comm pathways. | 6 in | 12 in | 24 in |
| Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to open or non-metallic tel/comm pathways | 3 in | 6 in | 12 in |
| Unshielded power lines or electrical equipment in proximity to a grounded metal conduit tel/comm pathway. | 3 in | 6 in | 12 in |
| Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit tel/comm pathway. | 1/2 the trade Size of the larger conduit, 2” minimum separation | 3 in | 6 in |
| Electric Motors and Transformers | 48 in |

I. In an open ceiling distribution system, cables shall be supported on Caddy brand CAT HP Series J-Hooks or other Associate approved supports located on 48" maximum spacing. With longer spans, the constant heating and cooling of the cable causes expansion and contraction, which over time may actually change the electrical characteristics of the conductors. The weight of the cable bundle on the hanger will cause crushing and deformation of the cables, requiring more frequent support. A maximum of 24 (2 x 12) cables shall be supported in a single hanger on 48" centers, no exceptions.

J. In no case will unsupported spans of greater than 48" be approved by the Associate. For spans longer than 48", the Contractor shall provide cable tray, channel, ladder, conduit, wire way, messenger wire, J-Hooks or other Associate approved cable support. J-Hooks shall be used as designed only, for short distances or areas where there are less than 25 cables or cable pathways will not allow basket tray etc., spacing must be 4 feet or less between J-Hooks.

K. Open unsupported spans between cable trays, conduit sleeves and trays, etc. shall not exceed 12” horizontally, 24” vertically. Provide “drop-out” supports for changes in elevation as required.

L. Where telecommunications cables are routed in an open ceiling distribution system or routed on cable tray, channels and ladders or routed through surface mounted raceways and/or wireway, cables shall be separately bundled in groups of twelve (12) cables as described below.

M. Hook and loop type cable ties shall be utilized for organizational purposes and on horizontal cable runs only, Hook and loop type cable ties are not acceptable for providing vertical cable support. Utilize large (3/16” wide) plastic cable ties, installed in a “Figure 8” pattern around the support and over the cable bundle, pulled up to minimum tension to provide cable bundle support without pinching or deforming the cables.

N. Data, CATV, and fiber optic cables are to be separately bundled as required to maintain a neat and orderly installation. Data, CATV, and/or fiber optic cable bundles may be supported in the same or separate hangers. Cables within the bundles shall be straight and parallel, free of twists, tangles, kinks, knots, etc. Cable supports shall not pinch, bind, crimp or in any way cause physical damage to the data/communication cables. Cables shall be free from tension at both ends and for the entire length of the cable. In cases where a cable or cables must bear some stress (e.g. vertical risers, etc.), "Kellem" grips shall be used to distribute the strain over a longer length of the cable(s). All vertically routed cables shall be neatly bundled and supported on a vertical cable ladder or rings, by means of cable ties on 24" centers or as directed.

O. Where required to meet maximum cable loads (e.g. for multi-pair trunk and tie cables), a vertical messenger cable shall be installed in the riser. The messenger cable shall be grounded to the telecommunications grounding system at both ends and shall not be used in itself as a grounding conductor. The messenger cable shall be utilized to support the multi-pair trunk and tie cables only. Supporting of various and miscellaneous cables or bundles of cables from the messenger will not be approved.

P. Cable Damage:

1. Physical Damage: Cabling Contractor shall take care to assure that **during the installation and upon completion,** all cables have been installed free from kinks, twists, knots, sharp bends, gouges or cuts to the cable jacket or conductor insulation, or any other physical damage. During installation, the Contractor shall not allow the cables to lay on the floor and be exposed to foot, vehicle or equipment traffic, or be exposed to any other forms of abuse which may pinch, crush, bind, over tension, or in any way cause any physical damage to the data/ communication cables. Such physical damage to the data/ communication cables may cause electrical characteristic alterations to the cables, which may or may not be detected by standard testing procedures. **Any cables exhibiting such physical damage or an attempt by the Contractor to correct, cover-up, hide or otherwise conceal such damage will be replaced at the Contractor's expense**.

2. Paint Damage: Cabling Contractor shall take care to assure that **during the installation and upon completion,** all cables have been installed free from paint or paint overspray. Paint products may affect the cable fire rating as well as deteriorate the cable sheath, thus compromising the integrity and/or performance of the cable. For these reasons, paint or paint overspray on the cable sheath voids the manufacturer’s warranty. Cleaning or removal of paint from the cable sheath by means of water, detergents, solvents or other methods also voids the manufacturer’s warranty. **Any cables exhibiting such paint damage or an attempt by the Contractor to correct, cover-up, hide or otherwise conceal such damage will be replaced at the Contractor's expense**.

Q. Cables that require service loops or additional length should be coiled at 200% of their recommended minimum bend radius or in a 16" diameter coil (whichever is larger). The coil shall then be cable tied and attached to a nearby support. The coil shall be located, if possible, above the workstation, individually bundled and tagged with the cable number.

R. Fiber optic trunk and tie cables shall be provided with a minimum 40-foot service loop at each end. Loops shall be mounted cable management rings. See example photo below. See Appendix A for manufacturers and part numbers.



## S. The Cabling Contractor shall observe all minimum bend radius and tension limitations, etc. as specified by the cable manufacturer and/or the TIA standards when installing the cables. The maximum pulling tension for 4 pair 23 AWG horizontal UTP cables shall not exceed 25 ft/lbs. to avoid disturbing the conductors configuration during installation, however it should be noted that this tension is capable of causing jacket or other unacceptable damage. The minimum radius for Category-6 or 6A UTP cable shall be 1-1/2"R. When conflict exists between manufacturer’s specifications and this specification, the more stringent criteria shall apply.

## T. Cables routed from cable trays, cable ladder, channel or other raceways onto the telephone backboard, onto a distribution frame or onto the equipment distribution racks shall be neatly organized and supported by cable support brackets, distribution rings, cable clips, cable loops, or by other Associate approved method as required to minimize tension or stress on the connector block terminations.

## U. It is absolutely imperative that extreme care be exercised when installing the Category-6 or -6A data cables, as any sharp bends, cable kinks, crushing, or other abuse will cause deformity of the cable, discontinuity of twisted pairs and their relationship to one another, which will adversely affect the high speed electrical performance of the cable. Category-6 and -6A data cables shall be terminated in accordance with the TIA-568.2-D standards and the most current industry practices. Since cable performance is adversely affected by wiring practices, it is important that the Contractor preserve wiring pair twist as close as possible to the point of termination. The amount of "un-twisting" of a pair as the result of termination to the connector hardware shall be no greater than 0.38 inches. To maintain the inter-relationship of pairs, the amount of "un- jacketing" of the cable shall be limited to 0.5 inches or less at the point of termination, unless noted otherwise.

## V. Where cables pass through walls, the Contractor shall provide a conduit sleeve, sized as per Section 270528. All conduits and sleeves shall be reamed and provided with insulated bushings, grounding bushings shall be provided as required. The Contractor shall patch and repair any holes, removals, adds, etc. or other damage, and paint the area to match.

W. All ceiling removal and restoration required for the execution of this work shall be the responsibility of the Contractor. Contractor shall furnish and install any damaged tiles with like kind at conclusion of project.

X. Cables should be laid in cable trays as opposed to being pulled through, if possible. Where cable must be pulled through cable tray, the Contractor shall station an installer at each turn and intersection in the cable tray to guide the cables around the corners and through the intersections.

Y. Cable pulls longer than 100 feet in length are not authorized by the Associate. Pulls greater than 100 feet are made solely at the Contractor's risk. Cable shall be neatly coiled in a figure "8" pattern at the completion of a pull in preparation for the next pull.

Z. Inside plant telecommunications and fiber optic cables shall not be stored or installed in an unheated building where the temperature is less than 40°F. The structure and the cable must be brought to a minimum 50°F. ambient for a minimum of 48 hours prior to installation of the cables. Failure to observe this precaution may result in damage to the cable and will result in the cable being replaced at the Contractor's expense.

AA. The Contractor shall coordinate the location of all partition furniture workstation outlets with the Architectural Drawings and the Architect prior to installation. It shall be the responsibility of the Architect and the furniture partition manufacturer to assure that the furniture partitions meet all requirements of the cabling system. See Section 270540 for partition furniture raceway requirements.

AB. Surface mounted outlet enclosures for use in modular furniture partition locations shall be securely mounted, utilizing a modular furniture adapter bracket designed for the modular furniture system, such as manufactured by Leviton or an Associate approved equal, or the enclosure may be secured to the underside of the modular furniture work surface as directed, with a minimum of two (2) pan head screws in diagonal corners or as required, to assure a flat flush installation. Cables shall be anchored with a cable tie to the enclosure, so as to relieve any stress to the terminations. All cable markers shall be unexposed inside the enclosure. All exposed cables shall be neatly bundled and tied and routed on the partition surface from the surface mounted enclosure, back to the partition raceway. Surface routed exposed cables shall be secured to the partition, using "hair pin" clips or other approved retainers as available from the furniture partition manufacturer, subject to the approval of the Associate.

AC. The Cabling Contractor shall provide in his bid, prices for providing and installing grommetted holes, chaffing gear, split convoluted tubing, etc. as required and/or as directed by the Associate, Architect and/or Owner, to enclose and/or protect cables from damage.

AD. With the Associate's prior approval, at those locations where pre-stubbed conduits and outlet boxes have not or can not be installed in the wall, the Contractor shall install an approved single gang and/or double gang mounting plate/bracket (Caddy MPLS series or Associate approved equal), and fish the cables within the existing wall structure, to a location above the ceiling. The Contractor shall provide and install an approved bushing or grommet in all metal studs, to prevent damage to cables. In those locations where telecommunications cables must be fished through a concrete block wall to a "mudded-in" rework box, the Contractor shall fish the wall with approved convoluted sleeving, non-metallic tubing or greenfield as required, to prevent damage to the cables. The Contractor shall insure that all faceplates, labels and associated items are properly aligned, centered and installed perpendicular and/or parallel to the floor as required.

AE. All wall openings will be neatly cut and trimmed with a drywall saw. No rough or exposed edges will be permitted. The faceplate or surface mounted box shall be neatly installed and plumb to the floor. No exposed cables will be permitted.

AF. Standard flush mounted faceplates shall be mounted on the standard telecommunications outlet with the appropriate (single gang or double gang) plaster ring, as per Specification 270528 or shall be mounted on appropriate surface mounted (single gang or double gang) deep raceway boxes (i.e. "FD" series cast, 2-3/4" deep metallic or non-metallic) as indicated on the Drawings.

AG. Maintain separation of dedicated telephone and data cables when and where the telephone system in service is an analog phone system utilizing signaling levels of 25 Volts or greater (i.e. ringer voltage). Contractor to verify.

AH. The Cabling Contractor shall maintain separation of dedicated telephone and data cables wherever required, with the exception of the vertical feeder conduit from the workstation data/communication outlet box, to above the ceiling or joist space, or in furniture partition raceway. Where cables must occupy the same raceway, maintain maximum separation and/or loose coupling between the cables as possible.

AI All items including racks, patch panels, faceplates, cables, fiber optic conductors and their respective terminations, shall be identified and labeled as required. See Section 270553.

AJ. The Contractor shall label all patch panels with pre-printed labels enclosed in self-adhesive clear strips (e.g. Hubbell #LPH174 or Associate approved equal). Patch panel labels shall be printed with the associated user outlet location identification and jack identification number as Per Section 270553. All cables must be terminated and labeled in sequential alphanumeric order on the patch panels. The Contractor shall provide a machine generated, laminated label (e.g. "Brady Wrap" or Associate approved equal) black letters on a white background on each patch panel, indicating the facility floor or area served from the panel as indicated on the drawings.

AK. All 120 VAC rack or cabinet mounted power strips, dedicated power outlets, etc. in the telecommunications rooms and equipment rooms the Contractor shall install a permanent, machine generated, nylon cloth label with black lettering on white background (e.g. Brady BMP21 Series Label #M21-750-499 or Associate approved equal). The label shall contain the receptacle distribution panel identification and circuit number information that the receptacle is served from. If the receptacle is dedicated to a specific piece of equipment or purpose, include that information on the label.

AL. The distribution equipment rack frames shall be securely anchored to the floor at all four (4) corners, using anchors into the concrete floor, or toggle bolts through raised floors as per the manufacturer's recommendations and instructions. When specified on the Engineering Drawings and documents or otherwise required, the Contractor shall provide and install "raised floor rack support" kits for the installation of distribution equipment racks on raised floors. The tops of the distribution equipment racks shall be securely tied together and braced from the wall from behind or from structural steel from above.

AM. Free standing cabinets shall be securely anchored to the floor at all four (4) corners, using anchors into the concrete floor, or toggle bolts through the raised floors as per the manufacturer's recommendations and instructions. Wall mounted cabinets and wall mounted racks shall be securely mounted to the walls as required. The Contractor shall provide for the installation of special blocking and bracing as required between studding in the walls, etc. and shall provide additional bracing and support as required from the floor and/or ceiling structure above as approved by the Associate.

AN. Distribution equipment racks and/or cabinets shall be laid out and located as indicated on the detailed Engineering Drawings and documents, with vertical cable organizers located between racks as indicated. All racks and cabinets shall be bonded to the telecommunications grounding system. Patch panels, cable organizers, fiber interconnect cabinets, etc. shall be mounted in the racks and cabinets as indicated on the drawings. Discrepancies or conflicts shall be brought to the attention of the Associate for resolution, before proceeding with the installation. Power strip installation, cable and cord routing on the equipment rack and/or in the equipment cabinet, shall not obstruct or restrict the mounting of rack mounted equipment or access to said equipment. The completed distribution equipment rack with installed equipment and/or the completed equipment cabinet with installed equipment shall be such, that there shall be complete unobstructed access to all equipment, components, cables, terminations, etc., without requiring the removal of one item to gain access to another. Each item of equipment shall be removable from the rack or cabinet, without having to remove another piece. No mounting space in the rack or cabinet shall be made unusable by the inappropriate mounting of another component, item or cable routing. Distribution equipment racks and equipment cabinets shall be installed such as, to afford the maximum accessibility and working space in and around the equipment as indicated on the detailed Engineering Drawings. Any discrepancies or conflicts shall be brought to the attention of the Associate.

AO. The cable ladder installation shall be as shown on the detailed Engineering Drawings and documents. The cable ladder installation shall be self-supporting, independent of the distribution equipment racks, except for the ladder support bar or unistrut support at the top of the rack. The cable ladder shall not be mounted directly to the distribution rack mounting channel or in any way, block access to or the availability of the rack mounting channel. The ladder support bar or unistrut brace shall be utilized approximately every other rack or as required. The unistrut support may when applicable, be extended to the backwall, to act as a brace. Vertical elements of the cable ladder assembly shall be anchored to the floor, using proper end support brackets and anchor bolts per the manufacturer's recommendations and instructions. The cable ladder structure shall be located with the inside rail approximately 3" behind the distribution equipment rack channel. The cable ladder system shall be bonded to the telecommunication grounding system.

AP. The power strip shall be mounted centered on the backside of the vertical organizer, between the distribution equipment racks, with the cord to the top. The power for the power strips shall be provided by means of a split duplex receptacle in a surface mounted handy-box, centrally located between the power strips at the top of the racks, or by means of 2-1/2" x 2-1/2" electrical wireway. The handy-box to be mounted horizontally on the top of the rack rear top angle, with the conduit routed along the rack top and outlets located as required. The duplex receptacle is to be split with a dedicated circuit to each receptacle, as indicated. An alternative and sometimes preferred solution is to cut off the power cord plug, provide a flexible cord connector on the raceway and hard wire the power strip installation.

AQ. The Contractor to provide two (2) 20A-120V-2P-3W NEMA 5-20 connector body receptacle (Hubbell #5369C) on a 2#12, 1#12G “SO” drop cord, elev. 42” A.F.F., per rack each on a dedicated circuit (at least one on Emergency Power), for Owner use. Receptacles shall be located between the racks as directed by the Owner. Each Data Rack shall have at least one 20AMP Power Strip. No power will be run from wall to racks, all power to be hard wired within the racks.

AR. The telecommunications room(s), wiring closet(s), etc. shall contain the mechanical terminations for the horizontal workstation wiring, voice and data trunk cable terminations, fiber optic backbone cable terminations, distribution and cross- connect fields, patch panels, key switch unit (KSU) equipment, service entrance equipment, surge protection, network system side electronic equipment, etc., which may be furnished and installed as part of the contract and/or by others. Facilities for this equipment and services may or may not be included under this contract and as such, are covered under separate specifications.

AS. Wiring closet layout guidelines and recommended perimeters are described and illustrated in the detailed Engineering Drawings.

AT. Unless otherwise indicated, equipment racks and wall mounted equipment shall be installed such that a minimum of 36" clearance is available from all sides for installation and maintenance.

***The University of Toledo campus is currently in a transition from analog voice phone system to a VOIP system. In the interim, a project may require the following work. Apply as/if required.***

AU. Provide a minimum of 12” clearance from the corner to the wall mounted 66M block distribution frame, mount the top of the frame a maximum of 74” off the floor and the bottom of the frame a minimum of 34” off the floor. 110 block cross connect fields shall be similarly mounted.

***The University of Toledo campus is currently in a transition from analog voice phone system to a VOIP system. In the interim, a project may require the following work. Apply as/if required.***

AV. All “voice” station cables, telephone riser and tie cables shall enter the wall mounted cross connect distribution frame at the bottom right.

AW. Cast “D” rings cable ladder shall be utilized only for the support and management of high pair count “voice” copper backbone cables and fiber optic backbone cables. “D” rings shall not be utilized for the support and management of horizontal distribution voice, data, fiber optic and coaxial cables.

AX. Telecommunications cables shall be arranged on the patch panels in alphanumerical order according to the faceplate number scheme.

***The University of Toledo campus is currently in a transition from analog voice phone system to a VOIP system. In the interim, a project may require the following work. Apply as/if required.***

AY. Voice Riser cables shall be arranged on the cross connect fields in alphanumerical order by cable pair per PIC color code.

AZ. The Contractor shall obtain shop drawings of emergency telephones, prior to rough-in, to assure proper installation.

BA. Total cooperation, coordination and communication between the different contractors, the Owner and the Associate are required for the timely scheduling and completion of all elements and components of the total construction project. It shall be recognized and acknowledged by all participants, that all phases and elements cannot finish the same day, and certain elements and items must be completed prior to the start of other elements. The Contractor shall provide to the Associate, at the very start of the project, a construction schedule that is coordinated with the other elements of the project, indicating significant construction and project milestones and completion dates. This schedule shall be adjusted and modified by the Associate and/or Project Construction Manager, as required to meet the overall project schedule requirements.

BB. The Project Construction Manager and others shall be made aware of and understand the importance and necessity for the completion of general contract work on the telecommunications spaces, wiring closets, equipment rooms, etc. prior to the installation of equipment and pulling cables to these areas. The spaces shall be essentially completed, cleaned and secure prior to the installation of equipment and cables. Equipment racks, cabinets, cable ladders, cable trays, backboards, distribution frames, power, raceways, lighting, HVAC systems, etc. shall be in place prior to pulling any cable in the area. Pre-pulling cable to the area and building the space around the cable is not acceptable.

BC. Cable routing from the outlet location conduit stub, through the open ceiling distribution system J-hooks, to zone conduits, cable trays and cable ladders, and onto the telephone backboard distribution frames, into the data/communication cabinet, or onto the cable ladder system and onto the distribution equipment rack patch panels shall be neatly organized and supported by cable support brackets, cable clips, cable ties, cable loops, etc. as required to minimize tension and stress on the cables, conductors, terminations, connectors and connector blocks.

BD. All racks, cabinets, and raceways shall be bonded to the telecommunications grounding system. Each rack or cabinet shall be provided with a ground bar or grounding stud, Section 270526.

BE. All cable trays, ladders, equipment racks, cabinets, etc. shall be securely bolted and installed according to the manufacturer's recommendations and instructions. Only factory manufactured parts, accessories and components shall be utilized for the construction, contractor fabricated components and assemblies are subject to the Associate's approval.

BF. All unistrut, cable channel, cable tray, cable ladder, bracket, etc. shall be cleanly and squarely cut with the appropriate metal cutting saw, then filed and chamfered clean and free from all burrs and sharp edges. All drilled holes shall be de-burred and chamfered free from sharp edges. Associate approved chaffing gear shall be provided on all holes, edges, and corners subject to possible cable exposure.

BG. The Contractor shall remove at his expense, all unusable, unacceptable, or otherwise unapproved cables or materials from the installation, no cable or materials shall be abandoned in place without written approval of the Associate.

BH. Provide a minimum of 2 meters (78") of service slack in each fiber optic conductor at each termination or splice. Slack to be coiled on the fiber storage spacer rings provided.

BI. The Contractor shall identify and remove all abandoned and unused cables from the conduits, cable trays, chases, risers, and from above the ceilings or below the floors, in the areas of renovation. Remove cables complete back to the source.

3.02 SYSTEM TESTING AND VERIFICATION

A. GENERAL:

1. Upon completion of the cable installation, the Contractor shall perform and submit for approval, complete cable documentation and verification testing reports. Required testing and reports shall include, but shall not be limited to providing the following information:

 a. Continuity checks of all cable, all pairs, checking for opens and shorts.

b. Determining and recording all cable lengths.

c. Checking all cables, all pairs for proper termination and correct pair polarity.

d. Verifying correct cable labeling at both ends of the cable, the outlet faceplate and jack labeling, and the cross-connect field and patch panel labeling.

e. Test equipment model and serial number.

f. Date testing was performed and the name of the Technician/Operator performing the tests and/or inspections.

g. Completely test all telecommunications and fiber optic cables installed and terminated by the Contractor, including but not limited to horizontal UTP data cables, multi-twisted pair trunk, riser and tie cables, and coaxial CATV and cables as described herein.

2. The purpose of the systems testing and verification requirements are twofold:

a. To verify and document that the completed installation meets or exceeds minimum systems performance and quality standards as outlined herein.

b. Established base standard criteria against which the completed installation can be tested and compared to in the future, to facilitate troubleshooting and maintenance.

## 3. The Contractor shall at the onset of the project, submit to the Associate for approval cut sheets, shop drawings, technical specifications, operator manuals, etc. as provided by the manufacturer of the testing equipment proposed for use by the Contractor, to test and verify his installation.

## 4. Such equipment shall be subject to the approval of the Associate. The Contractor and his representative Technician/Operator shall demonstrate to the satisfaction of the Associate, a thorough knowledge and understanding of the test equipment proposed to be utilized, and a proficiency in its operation. The Contractor shall provide a written detailed test equipment set-up procedure, indicating how all test parameters are entered into the tester equipment. Approved set-up procedures will be provided to the Owner as a component of the final submittals, providing the Owner with all information required to duplicate the original test conditions and parameters.

## 5. The Contractor shall provide written descriptions of the proposed calibration and testing procedures to the Associate, for approval before beginning any testing.

## 6. The Contractor shall provide 48-hour prior notice to the Associate before commencing cable testing. The Associate shall, at the Associate’s discretion, observe any and/or all cable testing procedures. Cable testing procedures shall be acceptable to the Associate.

## 7. The Contractor shall only test cables which have been completely installed, terminated and visually inspected. Prior to testing, all connectors are to be installed, conductors terminated, faceplates installed and mounted, cable routed, bundled, tied, etc. It is recommended that the Contractor coordinate with the Associate for a visual inspection and preliminary acceptance of the physical installation prior to performing certification testing, as any rework, changes, or alterations will necessitate retesting.

## 8. Contractor shall perform a continuity test on cable while on reel at jobsite prior to installation. Submit test to Engineer and University of Toledo IT department. Failure of any strand or pair shall be brought to attention of Engineer. Failure of cable after this test will deemed an installation issue and replacement of lable shall be at contractors expense.

## 9. Approved U.L. or E.T.L. verified TIA-568.2-D Level III or higher test equipment with accessories, software, etc. shall be:

a. Fluke DSX Cable Analyzer Series, Fluke Versiv cable certifier with proper test heads or approved equal.

b. Contractor shall provide documentation that the test equipment proposed for utilization has been updated to the most currently available upgrades from the manufacturer.

10. The Contractor shall obtain from the cable manufacturer and submit to the associate, copies of the manufacturing Master Reel Test Reports indicating the worst case minimal electrical performance for each pair of each cable reel for all Category-6 and -6A cable.

11. The Contractor shall obtain from the cable manufacturer and submit to the associate, copies of the manufacturing Master Reel Test Reports indicating factory OTDR readings for the fiber optic cable.

12. The Contractor shall submit for approval only tests performed on cables which have been completely installed, terminated and visually inspected. All connectors are to be installed, conductors terminated, faceplates installed and mounted, cable routed, bundled, etc.

13. The Contractor shall submit for approval, only test reports which indicate full compliance with minimum acceptable standards and specifications indicated here-in. Marginally acceptable test results, as indicated by some test equipment manufacturers as within a 15% Fault Anomaly Threshold, \* or other notation will not be acceptable.

14. Contractor shall perform minimum verification testing of all cables on the reels before pulling and installation. The Contractor shall be responsible for all cable installed, and all cable must be fully acceptable and verified upon completion.

15. The Contractor shall prepare complete cable test reports for all installed cables, for review and acceptance by the Associate prior to final acceptance of the cabling system. It is recommended that the Contractor coordinate with the Associate for a visual inspection and preliminary acceptance of the physical installation prior to performing certification testing, as any rework, changes, or alterations will necessitate retesting. Test reports on completed and acceptable installations only shall be submitted. All test reports shall be signed and dated by the Technician performing the tests and/or inspection.

16. A copy of the final completed and reviewed cable test reports shall be enclosed in clear vinyl protective covers, and posted in the telecommunications room and/or as directed by the Associate for use and reference by the Owner.

17. The Contractor shall recognize that the available programmable micro-computer based test equipment for copper media, and the fiber optic power meter test equipment described herein is limited in its ability to completely test all pertinent parameters of an acceptable cabling installation and as such**,** a "pass" test result will not be the determining criteria for acceptability of an installation which does not otherwise meet the standards and intent of this specification and the Engineering documents.

18. The Contractor shall provide a minimum of 48 hours (two working days) notice to the Associate and Owner prior to commencing with cable testing. The Associate shall at the Associate's discretion, observe any and/or all cable testing procedures. Cable testing procedures shall be acceptable to the Associate and Owner.

19. The Contractor shall coordinate with the Owner, to perform at the Owner's discretion, concurrent Owner testing of randomly selected outlets and cables as to be determined by the Owner.

3.03 HORIZONTAL UNSHIELDED TWISTED PAIR CABLES:

A. Category-6 and -6A cable testing shall be performed utilizing pre-manufactured, factory terminated, U.L. verified Cat-6 or -6A patch cords or factory manufacture field tester patch cords. Test patch cords shall be provided in designated pair sets. Each test patch cord set shall be utilized for no more than 750 insertion/withdrawal cycles before being replaced. Upon changing test patch cord sets, the tester shall be self-calibrated and the last three (3) cables tested are to be retested and the test results compared. Test results shall not vary by greater than 5% from the original results, results greater than 5% shall be reported to the Associate immediately for review. Test cord sets shall be turned over to the Associate at project completion.

B. Each telecommunications outlet and each backbone cable shall pass a complete "active" operational test as performed by and acceptable to the Owner.

C. Any outlet, cable or component not satisfactorily passing all of the "static" visual inspections, electronic micro-computer based automatic scanner testing, Owner performed "passive" testing, "active" operational tests or failing to meet quality installation standards as described in the specifications and standards herein, shall be repaired and/or replaced as directed by the Associate at the Contractor's expense.

D. Cable testing shall be conducted by an Associate approved testing facility, utilizing a programmable microcomputer based automatic scanner/tester capable of generating complete alphanumerical and graphical printed test reports.

E. Cable installations shall be fully tested and verified in accordance with TIA-568.2-D Standards for Full Channel Performance. Written descriptions of the proposed calibration and testing procedures shall be submitted to the Associate for prior approval before beginning any testing.

F. The test instrument manufacturer shall make available a simple procedure for verifying, reporting and Owner recording the calibration of the tester. The Contractor shall utilize this procedure to daily verify the calibration of the test instrument, and after the instrument has been dropped or has received other abuse. The Contractor shall submit for approval the calibration procedure and shall document the verification/calibration.

G. The category cable test equipment shall be pre-programmed with a custom "auto-test" program to include the following channel parameters:

1. Wire Map

2. Channel Length (< 328 ft.)

3. Propagation Delay (< 540 nsec)

4. Delay Skew (< 30 nsec)

5. Impedance (100 +15%)

6. Insertion Loss (Attenuation)

7. NEXT - Adjacent & Remote

8. ELFEXT - Adjacent & Remote

9. ACR - Adjacent & Remote

10. PS-NEXT - Adjacent & Remote

11. PS-ELFEXT - Adjacent & Remote

12. PS-ACR - Adjacent & Remote

13. Return Loss - Adjacent & Remote

H. The category cable test equipment shall have the capability to provide ambient threshold noise level (≤0.2 Impulses/Sec. @ 260 mV threshold) readings as a manually selected single test function. The testing instrument shall support time domain analysis on NEXT (TDX) for fault analysis and shall monitor 10 Base-T,100 Base-T and 1000-Base-T ethernet traffic.

I. The category cable test equipment shall provide the following additional information on the Test Report:

1. Contractor's company name

2. Job Site Location

3. Operator's Name

4. Cable Tester Manufacturer, Model Number, Serial Number

5. Test Summary (i.e. Pass/Fail)

6. Cable Identification Number

7. Date and Time

8. Test Standard

9. Limits Version

10. Software Version

J. Category-6 cables shall be tested to parameters exceeding TIA-568.2-D for Category-6 for Full Channel Performance as follows:

|  |
| --- |
| **MINIMUM CATEGORY-6 CHANNEL PERFORMANCE** |
| Test Parameter | Freq. (MHz) | TIA-568.2-D | Min. Perform. | Head Room |
| Insertion Loss (dB) | 250 | 35.9 Max. | 34.0 Max. | 1.9 dB |
| NEXT (dB) | 250 | 33.1 Min. | 35.4 Min. | 2.3 dB |
| PSNEXT (dB) | 250 | 30.2 Min. | 34.1 Min. | 3.9 dB |
| ELFEXT (db) | 250 | 15.3 Min. | 15.8 Min. | 0.5 dB |
| PSELFEXT (db) | 250 | 12.3 Min. | 12.8 Min. | 0.5 dB |
| Return Loss (dB) | 250 | 8.0 Min. | 10.0 Min. | 2.0 dB |
| PS-ACR (dB) | 250 | NA | 0.1 Min. | 5.7 dB |
| Propagation Delay (ns) | 10 | 555 Max. | 480 Max. | 75 ns |
| Delay Skew (ns) | 100 | 50 Max. | 50 Max. | 0.0 ns |

K. Category-6A cables shall be tested to parameters exceeding TIA-568.2-D for Category-6A for Full Channel Performance as follows:

1. In addition to testing the “In-Link” performance parameters previously listed, Alien Cross Talk shall be carried out in accordance with Section 4.7 of ANSI/TIA-1152.

|  |
| --- |
| **MINIMUM CATEGORY-6A CHANNEL PERFORMANCE** |
| Insertion Loss | 44.0 dB Max. |
| NEXT | 35.8 dB Min. |
| PS-NEXT | 34.8 dB Min. |
| ACRF | 17.8 dB Min. |
| PS-ACRF | 15.8 dB Min. |
| Return Loss | 15.2 dB Min. |
| PS-ACR @ 300 MHz | 3.0 dB Min. |
| PS-ANEXT | 52.0 dB Min. |
| PS-AACRF | 24.2 dB Min. |
| Prop. Delay @ 10 MHz | 480 ns Max. |
| Delay Skew @ 1 MHz | 50 ns Max. |
| TEST FREQUENCY: 500 MHz U.N.O. |

L. Copies of the horizontal UTP cable test reports shall be provided in hard copy and in electronic format. Test Reports provided electronically shall include a copy of the appropriate software for managing and viewing the reports. After the horizontal cable tests have been performed, the Contractor shall install the permanent faceplate labels, modular jack dust covers and permanent pre-printed patch panel labels. Where the Contractor submits cable verification test reports generated by the micro-computer based tester, the submittal shall include a cover letter and/or cover sheet (Form 1A) providing all additional required information not available on the printouts, or the Contractor shall complete Test Report Form 1, included herein or Associate approved equal.

3.04 MULTI-TWISTED PAIR TRUNK, RISER AND TIE CABLES (SHIELDED & UNSHIELDED):

A. All cables and all pairs shall be tested for opens, shorts, continuity, pair- reversals (flips), and inspected for proper 25 pair color code sequence, 25 pair primary unit color code sequence, and 100 pair multi-unit color code designation termination sequence. In addition, the first pair in each 25 pair binder group, shall be tested for loop-resistance to the nearest 0.1 ohms. Test and inspection results shall be recorded on Test Report Form 2, included herein or Associate approved equal.

3.05 75 ohm COAXIAL CABLES:

A. All coaxial cables shall be tested for "opens", "shorts", continuity, capacitance, impedance, loop resistance and length. Coaxial cables shall be tested utilizing a programmable microcomputer based automatic scanner/tester capable of generating complete printed test reports as noted above. Written descriptions of the proposed calibration and testing procedures shall be submitted to the Associate for prior approval, before beginning any testing. When the Contractor submits cable verification test reports generated by the micro-computer based tester, the submittal shall include a cover letter and/or cover sheet providing all additional required information not available on the printouts, or the Contractor shall complete Test Report Form 3, included herein or Associate approved equal.

1. “Loop Resistance” readings shall be made utilizing a high impedance digital ohm meter and an acceptable “wrap plug”.

2. “Loop Resistance” readings shall be recorded to the nearest 1/100 of an ohm.

B. Where applicable or otherwise noted on the Engineering Drawings or documents, the Contractor shall perform such additional testing of the coaxial cable system as is required and/or indicated. For a CATV system installation, the Contractor shall verify and record the incoming signal level. The Contractor shall test the frequency response of system and shall provide filters as required to provide a flat response from 50 MHz to 750 MHz. The maximum deviation shall be less than +5 dB. Contractor shall record and document (1) the location and value of all taps, splitters, directional couplers, attenuators, end of line resistors, amplifiers, filters, equalizers, etc. and (2) the loss/gain (+dB) at each location. Other coaxial cable systems shall be tested as directed.

C. Cable runs utilizing RG-6 shall be no longer then 150 foot maximum. Cable runs between 150 foot and 250 foot will be run using RG-11 cable. Runs longer then 250 foot shall be run using QR-860 CommScope QR860 JClass with a maximum distance of 2,000 feet.

D. All outlet or sub-distribution runs from the main points of demarks to individual outlets or IDF’s must be run in a “home run” fashion and not be allowed to be “daisy chained”.

3.06 MULTIMODE AND SINGLE-MODE FIBER OPTIC CABLE:

A. All fiber optic cables shall be fully tested for Tier 1 and Tier 2 continuity, VFL, attenuation and optical return loss utilizing a fiber optic power meter and Optical Time Domain Reflectometer (OTDR). The fiber optic test equipment shall be capable of testing multimode and/or single-mode fiber cable.

B. Contractor shall provide shop drawings, catalog cut sheets and operational procedures describing the test equipment proposed to be utilized for the Associate's review and approval. Tester shall be Fluke Versiv cable certified with proper test heads or approved equal.

C. Fiber conductor shall be tested with the cable completely installed and in final placement, with connector installed inspected for workmanship, labeling, etc. and connector verified by the Contractor to be free from any visual defects, such as scratches and chips. All connector installations exhibiting any defects and/or improper assembly procedures shall be replaced at the Contractor's expense.

D. Each fiber shall be tested at both frequencies, in both directions, with all readings recorded. The worst case readings will be utilized to determine acceptability of the fiber.

E. Maximum optical attenuation per connector pair for multimode fiber connectors shall be 0.3 dB or less when measured at 850/1300 nm in accordance with TIA-526-14-C. (NOTE: It is recognized by the Associate that this specification is much more stringent than TIA-568-C.3).

F. Maximum optical attenuation per connector pair for single-mode fiber connectors shall be 0.5 dB or less when measured at 1310/1550 nm in accordance with TIA-526-7 (NOTE: It is recognized by the Associate that this specification is much more stringent than TIA-568-C.3).

G. Maximum optical return loss (reflectance) shall be 45dB or less.

H. The fiber optic cable test report shall provide the following information:

1. Contractor's name

2. Test equipment identification: Manufacturer, model number and serial number

3. Client/Owner identification

4. Date test performed

5. Cable manufacturer and part number

6. Cable identification number

7. Cable location (i.e. building - from/to)

8. Cable description (i.e. number of fibers, S/M, M/M)

9. Name, signature and date of signature of Technician performing the tests.

10. Cable length

11. Proper conductor termination verification, both ends

12. Link attenuation (loss) measurement in dB per fiber

13. Reference dB

14. Visual connector (both ends) inspection verification

15. Calculated fiber loss based on fiber length and factory OTDR readings

16. Calculated optical attenuation per connector pair (fiber link attenuation loss measurement), less the calculated fiber loss, less the reference dB equals optical attenuation per connector pair

17. Test results (i.e. Pass/Fail)

I. Copies of the fiber optic cable testing and inspection results shall be provided in hard copy and in electronic format. Test Reports provided electronically shall include a copy of the appropriate software for managing and viewing the reports. Where the Contractor submits cable verification test reports generated by the micro-computer based tester, the submittal shall include a cover letter and/or cover sheet providing all additional required information not available on the printouts, or the Contractor shall complete Test Report Form 4, included herein or Associate approved equal.

J. The fiber optic test OTDR test results shall be submitted in both hard and soft copy (printed and electronic-linkware) formats. The fiber optic OTDR test equipment shall test multimode fiber at both 850 and 1300 nm, and single-mode fiber at both 1310 and 1500 nm. Measurements to be recorded to the nearest 1/100 dB. The fiber optic OTDR test report shall include "Pass-Fail" test parameters as indicated above. Provide OTDR generated trace diagrams in addition to the generated test report

3.07 INDEPENDENT SYSTEM VERIFICATION:

A. The above described testing procedures are the minimum acceptable. Additional independent system verification testing may be required as described in the drawings and/or documentation. In addition, independent system verification testing may be required at the Contractor's expense, in the event of non-performance of specified testing procedures and submittals or contested materials and/or installation procedures. Independent testing shall be determined by and arranged by the Associate at the Contractor's expense.

3.08 CABLING TEST REPORTING FORMS INCLUDED:

A. REPORTING FORMS:

1. Form 1 – 100 ohm U.T.P. Test Report]

2. Form 1A – 100 ohm U.T.P. Cover Sheet

3. Form 2 – 100 ohm Multi-Twisted Pair Test Report

4. Form 3 – Coaxial Cable Test Report

5. Form 4 – Fiber Optic Test Report

3.09 SUBMITTALS

A. RECORD DRAWINGS:

1. The Contractor shall keep in the field and open to inspection, an accurate, current, progressive record of the actual installation of the data/communication cabling system. Upon completion of the work, the Contractor shall deliver marked up prints showing the actual routing of cable runs, outlet locations, outlet/cable identifications, cable tray sizes and routes, conduit sizes and routes, distribution frame layouts, punchdown block locations, coax cable system splitter and tap locations with dB values and signal levels indicating system loading and balancing, etc.

2. Where applicable or otherwise noted on the Engineering Drawings or documents, the Associate will provide to the Contractor an Auto-Cad diskette of the appropriate available floor plans and/or drawings as required for the Contractor to update and/or provide the required record documentation.

3. All drawings, specifications and other contract documents, and the Owner's proprietary information shall be returned to the Owner/Associate/Architect upon satisfactory completion of the contractual work as per the contract documents.

B. CABLING SYSTEM INSTRUCTION MANUALS:

1. Provide complete written system instruction manuals, which shall include, but not be limited to the following:

a. First Page: Title of job, Owner, address, date of submittal and name of Contractor.

b. Third Page: Introduction to first section containing a cross- reference to the equipment schedule and cable schedule.

c. First Section: One copy each of accepted shop drawings, equipment catalog cuts and manufacturer's instructions for all components and materials utilized in the data/communication cabling system.

d. Second Section: One copy each of accepted test equipment catalog cuts, operating instructions and manufacturer's test instructions and procedures as incorporated into the testing of the data/communication cabling system.

e. Third Section: One copy each of completed and accepted cable test reports unless noted otherwise.

2, Bind the written system instruction manual's information and materials into a hardback binder of 8-1/2" x 11" size.

3. Submit two (2) copies to the Associate for approval.

4. After approval, submit four (4) copies to the Associate for delivery to the Owner.

5. Submit two (2) complete sets of record drawings to the Associate for review.

6. Reference “Appendix A” for submittal requirements, listings schedules, etc.

END OF SECTION 27 1500