SECTION 270100

STRUCTURED CABLING

(Part of the Work of Section 260001)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

B. Filed Sub-Sub Bids Required

1. Sub-sub-bid requiring a paragraph “E” listing on the form for sub-bid required per M.G.L. Chapter 149 Section 44A, as amended to date. The Electrical Subcontractor shall be responsible for all related building preparation and coordination. See specification for additional Paragraph “E” listing requirements of the listed contractor, and coordination of responsibilities. Failure to meet or exceed the requirements of the Contractor, as detailed in this specification, shall be grounds to reject the applicable bidder.
2. It is the sole intent of this Paragraph "E" listing to ensure to the end-user, single source responsibility from a single qualified Contractor.
3. Bidders listing themselves must provide documentation that they themselves are factory-authorized representatives of all systems specified. Bidders listing themselves may not sub-contract any portion of this specification.

1.2 SCOPE OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, which includes:

1. Network Equipment as listed on IT Head End Equipment schedule on drawing E502
2. Category 6A Data and Voice Station Cabling to all equipment requiring data and voice connectivity, including but not limited to data outlets, voice outlets, video surveillance cameras, access control network connections, and other equipment specified in related sections.
3. Fiber Station Cabling to fiber outlets.
4. Category 3 Voice Riser Backbone Cabling.
5. Category 6A RJ-45 Style Data Jacks.
6. Category 6A RJ-45 Style Voice Jacks.
7. Category 6A RJ-45/110 Style Voice and Data Patch Panels.
8. Category 6A Patch Cords.
9. Fiber Optic Cabling – 50-Micron Multimode and Singlemode

10. Technology Outlet Faceplates.
11. Category 5e 110-style Voice Termination Blocks
12. Equipment Racks.
13. Horizontal Cable Managers.
14. Vertical Cable Managers.
15. Cabling Distribution Support.

1.3 EXAMINATION OF SITE AND DOCUMENTS

A. Bidders are expected to examine and to be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. The Awarding Authority (Owner) will not be responsible for errors, omissions and/or charges for extra work arising from Contractor's failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a bid, the Bidder agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

B. Pre-Bid Conference: Bidders are strongly encouraged to attend the Pre-Bid conference; refer to Advertisement for Bids for time and date.

1.4 SUBMITTALS

A. Material and equipment requiring shop drawing and product data submittal shall include but shall not be limited to:

1. Network Equipment as listed on IT Head End Equipment schedule on drawing E502
2. Category 6A Data and Voice Station Cabling.
3. Fiber Station Cabling to fiber outlets.
4. Category 3 Voice Riser Backbone Cabling.
5. Category 6A RJ-45 Style Data Jacks.
6. Category 6A RJ-45 Style Voice Jacks.
7. Category 6A RJ-45/110 Style Voice and Data Patch Panels.
8. Category 6A Patch Cords.
9. Fiber Optic Cabling – 50-Micron Multimode and Singlemode
10. Technology Outlet Faceplates.
11. Category 5e 110-style Voice Termination Blocks
12. Equipment Racks.
13. Horizontal Cable Managers.
14. Vertical Cable Managers.
15. Cabling Distribution Support

B. Prior to layout of MDF room, contractor shall submit to the Engineer and the Fitchburg’s Information Technology manager a proposed layout of the MDF room using equipment proposed on the project. The layout shall include Rack layouts of all patch panels and the electrical subcontractor’s cabling management plan for labeling and terminating all

cabling. The drawings indicate special purpose power for UPS equipment and the electrical subcontractor shall confirm exact plug configuration (NEMA Configuration). The MDF layout, cabling management plan, and UPS receptacle configurations shall be submitted for approval prior to any communication cabling or power circuit routing.

PART 2 - PRODUCTS

2.1 GENERAL

A. It is the intent of the Specification that one manufacturer, not a combination, be selected for each particular class of material. A combination of manufactures for cabling and connectivity is acceptable, as long as the solution provides for a certified, warranted cable plant as described herein.

B. Certain equipment is listed by manufacturer and model number. This is to define and establish a level of quality and functionality. The words, "or equal", are understood to follow all names of these specified products, trade names, catalog numbers, and detailed descriptions. It shall be interpreted to apply to any material, article, assembly or system, which in the opinion of the Owner is at least equal in quality, durability, appearance, strength and design to the material specified, and shall perform at least equally the functions imposed by the general design. The words, "or equal", shall not be construed to permit departure from the detailed requirements of the Specification.

C. All materials and equipment shall be new and unused.

D. All part numbers and manufacturers shall be according to this Specification unless otherwise noted on the construction Drawings.

E. Provide all mounting hardware, shelving, bracketing, bracing, support members and other hardware required to support all cabling and equipment specified.

2.2 MANUFACTURERS

A. Acceptable “or equal” manufacturers for the Structured Cabling System include:

1. Hubbell
2. Corning
3. Belden
4. Chatsworth
5. Commscope
6. Hitachi
7. Leviton
8. Mohawk
9. Superior Essex

2.3 VOICE AND DATA CABLING SYSTEMS

A. Voice and Data Channel Performance Specifications: Voice and Data Cabling System channels shall exhibit Category 6A performance capabilities. The data channel shall be comprised of the passive components including cabling, connectors, patch panel port,

and patch cords, providing up to a total of four (4) connections between network electronics. The Category 6A channel shall be component compliant, capable of supporting 10 Gigabit per Second networking. System shall be Belden 10GX series channel solution or equal.

B. Faceplates:

1. Outlet faceplates shall consist of single or double gang utility outlet faceplates, as specified. All faceplates shall match those of corresponding electrical in color, material and finish. All faceplates shall have labeling windows.
2. Faceplates without clear plastic labeling windows are not acceptable, and shall be replaced by the Systems Installer at no expense to the Owner.
3. Unused ports at each faceplate shall be provided with blank module inserts.
4. Wall mounted telephone locations shall have faceplates appropriate for the wall mounted telephones.
5. Provide blank faceplates on all empty boxes.

C. Category 6A Jacks:

1. All voice and data jacks shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in referenced TIA 568 Standards, and be part of the UL LAN Certification and Follow-up Program. Category 6A jacks shall contribute to the overall Channel Performance Specifications. Jacks shall be snap-in, 110 style, 8-pin insulation displacement contact (IDC), modular (RJ-45) jacks as specified herein and indicated on the Technology Outlet Plans.
2. Cat 6A Jacks shall be Belden 10 GX Modules Part #AX104156 (blue) for General Data, Part # AX102280 (gray) for Wireless APs, Part #AX104155 (green) for Voice, and Part #AX 102282 (white) for security, or equal. Confirm colors with Owner.
3. Cat6A Jacks for Wireless APs above ceiling shall be Belden Part # AX102652 loaded with dual 10GX ports, Belden Part # AX102280 (gray) or equal.

D. Category 6A Voice/Data Patch Panel:

1. Category 6A RJ45/110 Type modular jack panels shall be 48 ports. One wire management-retaining trough shall be installed above every patch panel. Modular Jack Panels shall accommodate both T568A/T568B configurations.
2. The patch panel shall support the appropriate Category 6A applications and contribute to the overall Channel Performance specification. The patch panel shall facilitate cross connection and inter connection using modular patch cords.
3. Provide rear cable management strain relief brackets, one for each row of patch panel terminations.
4. Category 6A Voice/Data Patch Panels shall be Belden 10 GX Part # AX103256, or equal. Provide rear cable management strain relief brackets, one for each row of patch panel terminations.

E. Category 6A UTP, 4 Pair Station Cable:

1. Voice and Data horizontal station cables shall be extended between the station location and the MDF/IDF, and consist of Category 6A UTP, and shall be terminated on the 8 pin modular jacks provided at each Outlet. Cable jacket shall

comply with Article 800 NEC for use as a plenum cable. The 4-pair UTP cable shall be UL® and c (UL®) Listed Type CMP (plenum).

2. All voice and data station cables shall conform to the referenced TIA-568 Standards, and be part of the UL® LAN Certification and Follow-up Program. These cables shall be capable of supporting evolving high-end applications, including but not limited to: 10GbE, 1000Base-T; 100 Base-T; 100Mbps TP-PMD; 155 Mb/s ATM; and 622Mbps ATM using parallel transmission schemes.
3. Cabling designated for data shall be blue. Cabling designated for voice shall be green. Cable designation for security shall be white. Confirm colors with Owner.
4. Category 6A cabling shall be Belden 10 GX Part # 10GX13 or equal. Cable colors shall be blue for general data (Part # 10GX13 D151000), gray for wireless data (Part # 10GX13 0081000), green for voice (Part # 10GX13 0051000), and white for security (Part # 10GX130091000).
5. All cabling shall be plenum rated. Cables routed through underground or under slab conduits shall be rated for underground/direct burial installation.

F. Category 6A Data Patch Cords:

1. Provide all patch cables required to connect systems specified herein, in related sections and Owner equipment. Patch cords shall be Belden 10 GX Category 6A, or equal. Provide two (2) modular patch cords for each wired port on the patch panels. Patch cord one shall be of sufficient length for connection from the data patch panels to the network switch electronics utilizing cable management in the MDF and IDFs. Provide the second data patch cord to other vendors in related sections for connectivity of equipment. Coordinate lengths of patch cords with vendors. Provide the remaining patch cords to the Owner for connection of owner equipment at the user end. Obtain length requirements from the Owner prior to purchase. Patch Cords shall be hand delivered to, and signed for, by the Owner or Owner's representative prior to substantial completion. Obtain signature receipt for patch cords.

G. Multi-Mode Fiber Optic Cabling:

1. Multimode Fiber optic cabling shall be provided between the MDF and IDFs. Cabling shall be furnished with the quantity of fibers as designated on the Technology Drawings.
2. All fiber optic cables shall be from the same manufacturer and shall be the same type. A mix of fibers from different manufacturers may not be used without written permission.
3. Multimode Fiber Specifications:
    a. All multimode fiber optic cables within the premises shall use multimode, graded-index fibers with 50-micron cores only. Fiber shall be laser-enhanced and guaranteed for transmission distances in 10 Gigabit Ethernet of up to 500 Meters.
    b. Fiber shall be Belden FI4D012P9A 12 Strand plenum indoor tight buffered OM4 10 gig 50 micron fiber or equal.
4. All cabling shall be plenum rated. Cables routed through underground or under slab conduits shall be rated for underground/direct burial installation.

H. Single Mode Fiber Optic Cabling

1. Single Mode Fiber optic cabling shall be provided between the MDF and IDFs, and between the MDF and all fiber optic outlets and as shown on the technology drawings, and shall be furnished with the quantity of fibers as designated on the Technology Drawings.
2. All fiber optic cables shall be from the same manufacturer and shall be the same type. A mix of fibers from different manufacturers may not be used without written permission.
3. Single Mode Fiber Specifications:
    a. All singlemode fiber optic cables within the premises shall use singlemode, graded-index fibers.
    b. All cables shall be of tight buffered, distribution style construction, or riser type construction, all dielectric.
    c. Fibers shall be Belden FISD006P9 6 strand plenum indoor tight buffered OS2 Single-mode Fiber or equal.
4. All cabling shall be plenum rated. Cables routed through underground or under slab conduits shall be rated for underground/direct burial installation.

I. Site Fiber Optic Cabling:

1. All fiber optic cables shall be from the same manufacturer and shall be the same type. A mix of fibers from different manufacturers may not be used without written permission.
2. Multi-Mode Fiber Specifications:
    a. All multimode fiber optic cables shall use multimode, graded-index fibers with 50-micron cores only. Fiber shall be laser-enhanced and guaranteed for transmission distances in 10 Gigabit Ethernet of up to 500 Meters.
    b. Fiber shall be Belden FD4D012P9 12 Strand plenum indoor/outdoor tight buffered OM4 10 gig 50 micron fiber or equal.
3. Single_Mode Fiber Specifications:
    a. All singlemode fiber optic cables shall use singlemode, graded-index fibers.
    b. Fibers shall be Belden FDSD006P9 6 strand plenum indoor/outdoor tight buffered OS2 Single-mode Fiber or equal.

J. Fiber Distribution Patch Panels: The Fiber Patch Panel is the termination and administration point for the fiber optic backbone between the Head End Room, Technology Rooms and the fiber outlets. These devices shall protect the connectorized fiber from mechanical stress, macro-bending loss at the connection point, tampering with the circuits, and provide circuit identification. The patch panels shall provide cross-connect and inter-connect capabilities and include support hardware to properly terminate cables, route the fibers and jumpers in a rack mount field. In addition panels shall:

1. Have connector panels to accommodate LC connectors;
2. Be UL approved;

3. Be from a manufacturer that is ISO 9001 certified.
4. Be Belden Fiber Express or equal

K. Multimode Fiber Optic Connectors: Provide multimode LC type connectors to terminate fiber optic cables for cable-to-cable, cable-to-equipment, and equipment-to-equipment, and to make jumpers. The connectors shall be Belden FiberExpress OM4 LC Fiber Connectors AX105202 or equal.

L. Singlemode Fiber Optic Connectors: Provide Singlemode LC type connectors to terminate fiber optic cables for cable-to-cable, cable-to-equipment or equipment-to-equipment, and to make jumpers. The connectors shall be Belden FiberExpress OS2 LC Fiber Connectors AX105203 or equal.

M. Fiber Optic Cabling Raceway: All fiber optic cables shall be enclosed in non-metallic corrugated flexible raceway for protection, ease of identification, and general organization of fiber optic cable installation.

1. Corrugated Flexible Raceway (Inner-duct) shall be plenum rated Carlon p/n CG4X1C or approved equal with pull string. The Inner-duct shall begin no more than 24" from the termination point and run continuously end-to-end with the appropriate number and size pull boxes according to the referenced TIA-568 Standards. The use of conduit sleeves shall not negate the requirement for use of innerduct for fiber optic cables

N. Patch Panel and Switch Equipment Racks

1. Equipment racks shall be 19" floor mount racks with wide floor mounting flanges, Belden BHRR194 or equal.
2. Four post racks shall be Belden XDR8419-31232 or equal.
3. Wallmount Racks shall be Middle Atlantic DWR-35-26PD with vented front door, rack rails, , or equal.
4. Vertical cable guides shall be Belden BHVH006 and BHSK020 with covers or equal. Provide on both sides of all racks.
5. Horizontal cable managers shall be Belden BHH193UR with covers or equal. Provide above and below all patch panels.
6. 10 position surge protected power strips shall be Belden 9BG1-101001or equal, modified to connect to receptacles mounted overhead on the underside of the cable tray.

O. Multi-pair voice backbone cable:

1. Shall be 24 AWG, Category 3, sized as shown on drawings.
2. Shall conform to the requirements of the referenced TIA-568 Standards.
3. ULÒ and c (ULÒ) Listed for Fire Safety
4. ISO 9001 Certified Manufacturer
5. Copper riser cable shall meet or exceed the following Specifications:

a. Attenuation (dB/100 m [328 ft.]):
b. Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]:

6. All cabling shall be plenum rated. Cables routed through underground or under slab conduits shall be rated for underground/direct burial installation.

P. Head End, Tech Room and Service Entrance Room Voice Termination Frame Wiring Blocks

1. Shall be Category 5e
2. Shall be from the same manufacturer as the data jacks and patch panels.
3. Shall be fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each.
4. Index strips shall be marked with five colors on the high teeth, separating tip and ring .
5. Fanning strips shall be located on each side of the block for dressing cable pairs terminated on the adjacent index strips.
6. The blocks shall accommodate 22 through 26 AWG conductors.
7. The blocks shall have mounting legs.
8. Separate termination fields shall be created for vertical backbone and horizontal station cable terminations.

Q. Wall phones jacks shall support wall phone mounting without any additional hardware.

2.4 CORRIDOR CABLE SUPPORT

A. Provide J-Hooks in suspended ceilings where cable trays or conduit are not available. Group cables in bundles of 50 or less, with Velcro cable tie wraps pulled snug, but not deforming the cable geometry. Support the cable bundles with approved "J" style hooks attached to the building structure at a maximum of three (3) foot intervals.

PART 3 -

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 INSTALLATION

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Prior to commencing Work of this Section or ordering equipment, examine site and conditions under which work shall be performed. Determine exact locations of items shown diagrammatically on Drawings. Determine dimensions needed to move in racks and any custom items. Notify the Architect of any conflicts or special requirements needed to provide for free access to doorways, corridors, stairs, and similar areas, required to move in the specified equipment. If the Systems Installer fails to provide such notification, any additional cost to remove and reinstall any building members will be back charged to the Systems Installer.

C. Prior to commencing Work of this Section, inspect drawings and verify that voice

and/or data horizontal station cabling, when fully installed shall not exceed a maximum length of 295' (90m) end to end. Notify the Architect in writing of any cable runs that may exceed this requirement. If the Systems Installer fails to provide such notification, any additional cost to remove and reinstall any cabling to satisfy this requirement shall be the responsibility of the Systems Installer

D. Provide all required adapters and/or accessories for a complete installation in all raceways, and other locations

3.3 LABELING

A. Meet with the Owner prior to the final labeling of all installed jacks, blocks, patch panels, patch cables and related equipment to verify and confirm the exact requirements and desired labeling scheme for the project.

B. Labeling of communication jack wall plates and patch panels shall initially consist of five digits, assigned as follows:

1. At the wall plate, the leading letter shall symbolize the Technology (i.e. D for Data, W for WAP, V for voice, S for Security). Patch panels shall not require the leading letter since all patch panels shall be separated according to technology in the IT Closets.
2. The first digit shall symbolize the IT Closets that connects to the Outlet. Zero (0) shall be used for cable runs that originate in the Head End Room; One (1) for cable runs that originate in the first IT Closets; Two (2) for cable runs the originate in the second IT Closets; and so on.
3. The next digit shall signify the floor level, with Zero (0) for Ground, One (1) for First, and Two (2) for Second Floors; and so on.
4. The third through the fifth digits is the unique jack/cable identifier.
5. Example: Jack number D11010 shall be data cable number 10 on the first floor, which originates in first IT Closet. The patch panel port for this cable shall be labeled using the number only. For this example the patch panel port for D11010 would be 1101.
6. Terminate Data Cables in closets on patch panels in sequential order by room number, then by cable number. If there are 6 cables for a given room they should be located in sequential order, next to each other in numerical order on the patch panel.
7. Terminate telephone cables in closets on frames and punch down panels in sequential order, by cable number. If there are 6 cables for a given room, they would be located in sequential order, next to each other in numerical order.
8. Fiber patch panels shall be labeled as follows: The Leading letter shall symbolize the type of cable (S for Single mode) (M for Multimode). The first digit shall symbolize the IT Closet at which the fiber terminates. Zero (0) shall be used for fiber that terminates in the MDF; One (1) for fiber that terminates in the first IT Closet; Two (2) for fiber that terminates in the second IT Closet, and so on. The second and third digits indicate the fiber strand. Example: S-0-06 shall be single mode fiber strand number 6 that terminates in the MDF. M-1- 12 is multimode fiber strand number 12 that terminates in the first IT Closet

C. Clearly label and identify all components. Logically and permanently mark all cable, jacks, connectors, patch panels, patch cables, racks, electronic equipment, and all wall plates.

D. Use a letter quality printer or other mechanically produced lettering for patch panel and outlet labels. Insert patch panel and outlet labels behind clear plastic designation strips. Labels which are surface mounted directly onto the patch panel or faceplate are not acceptable, and shall be replaced by the Structured Cabling Systems Installer at no expense to the Owner.

E. Place permanent cable markers 3 inches from all connectors to allow easy identification. Use Brady Markers with clear plastic ends. Acceptable markers are, Brady B-320, B- 292, SL-292, or Brady machine embossed labels with clear vinyl ends. Machine generated markers are required. Place cable markers on cables so that they can be easily seen.

F. Handwritten labels shall not be accepted, even if written with a permanent marker. Temporary handwritten labels may be used only during the “rough-in” stages; they must be replaced with permanent labels prior to Project completion.

G. Labeling of communication jack wall plates and patch panels shall be as directed by the Owner.

H. All labeling of Technology Outlets, patch panels, cross connect blocks, or similar types of items, shall be based on the finished project room numbers and not the architectural room numbers, or as directed by the Owner. The Structured Cabling System Installer shall be responsible to contact the Architect, GC and/or Owner Representative for obtaining the final room numbers.

I. Voice station blocks, riser termination blocks, and data patch panels shall be color coded as per TIA 606A.

3.4 TESTING

A. Voice and Data Cabling Testing.

1. All terminated cabling runs shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements found in the referenced TIA-568 Standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, patch panels, and cordage shall be repaired or replaced in order to ensure 100% usability of all installed runs.
2. Copper Channel Testing - All balanced twisted-pair cable links shall be tested for basic continuity and length, as indicated below. Additional testing shall be performed to verify compliance with Category 6A performance. The extent of testing shall be in accordance with the end-customer's testing requirements Provide 100% testing of permanent links for Insertion Loss, Return Loss, NEXT, PSNEXT and PSACRF. These tests shall be performed at the same time as the Continuity test using an automated tester, such as the Fluke DTX1800.

3. Continuity – Each pair in every installed cabling run shall be tested using a test set that detects and identifies opens, shorts, polarity and pair reversals, crossed pairs, and split pairs. The results shall be recorded as Pass/Fail (as indicated by the test set) and referenced to the appropriate cable identification number and circuit/pair number. Any fault shall be corrected and the run re-tested prior to final acceptance.
4. Length – Every installed cabling run shall be tested for installed length using a time domain reflectometer (TDR) device. The cable length shall not exceed 90 m (295 ft). The cable length shall be recorded, referencing the cable identification number and circuit/pair number.
5. Category 6A performance testing shall be done according to the published standards.
6. Bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
7. Document cable testing in accordance with Submittal paragraph. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.
8. Provide an electronic version of test results and any cable test software needed to read and evaluate results.

B. Multi-pair Voice Riser Tests

1. Test each pair of multi-pair voice riser cable for proper polarity; no reversals; no transpositions; continuity; no shorts; no AC voltages; no DC voltages; no opens; and proper numbering at each termination.
2. Bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
3. Document cable testing in accordance with Submittal paragraph. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.
4. Provide an electronic version of test results and any cable test software needed to read and evaluate results.

C. Fiber Option Cable Tests

1. Fiber testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end to end OTDR trace, or a bi-directional end to end power meter test performed per referenced TIA-455 Standard. The system loss measurement shall be provided at 850 and 1310 nanometers.
2. Pre-installation cable testing: Test all fiber optic cable prior to the installation of the cable. Assume all liability for the replacement of the cable should it be found defective after the installation.
3. Loss Budget: Fiber links shall have a Maximum Loss of:
    a. Maximum Loss = (allowable loss per km) (km of fiber in link) + (.4dB) (number of connectors) Note: A mated connector-to-connector interface is defined as a Single connector.
    b. Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two. Any link not meeting the requirements of the Maximum Loss shall be brought into compliance at no additional charge to the

Owner.

4. Prepare a certification report listing the test results and both the calculated and measure loss for each fiber. Submit this report with the test results.
5. The Structured Cabling Systems Installer shall bring cables and/or strands not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
6. Document cable testing in accordance with Submittal paragraph. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.
7. Provide an electronic version of test results and any cable test software needed to read and evaluate results

D. TRAINING

1. Train systems administrative and/or maintenance personnel in procedures involved in operating, troubleshooting, servicing and preventative maintenance of each system specified. Provide no less than 40 hours of training, including:
    a. Review of the physical configuration and interrelationship of the system components.
    b. Labeling and interconnection techniques used in the installation.
    c. Applications of systems including any unique connections or interfaces required in the use of systems on site.
    d. A review of warranty documents for the system.
2. For each session, provide two (2) DVD copies of recorded training. The Owner will not accept “train the trainer” models. Provide owner with complete user instructions used for training purpose as well as training log of all users who attended training classes.

END OF SECTION