Centralized Optical Fiber Cabling System
Technical Specification

1.0 INTRODUCTION

This document is distributed for the use of Consultants, Designers and End-Users. The user of this document is instructed to review all of the information contained in this document and make changes, additions and deletions as necessary to meet the needs of their telecommunications section. At each major section header, the user of this document is instructed to add an overview description of the applicable portion of the cable system. This description is a useful aid for the installation contractor to understand the overall scope and intent of the project as well as the specific details the contractor must fulfill.

In this section, the user of the document should include an overview of the entire project, as well as any company or corporate mission information that may be applicable to the cable system installation. The user should also include any relation to other projects, such as telephone systems or network upgrades that have a dependency on this project. Project timing may also be discussed in this section.

1.1 PURPOSE

This document provides the minimum performance criteria for the components and sub-systems comprising a complete cabling system that shall accommodate the Owner’s requirements in excess of ten years.

Product specifications, general design considerations, and installation guidelines are provided in this written document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types for a specific Owner facility will be provided as an attachment to this document. If the bid documents are in conflict, the written specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

The Owner’s Cable Infrastructure Project requires an AMP NETCONNECT Systems structured cabling system. The Enhanced Category 5 portion of the cabling system shall comply with the proposed component, link and channel performance requirements of the latest revision of TIA SP-4195 "Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling" or, on publication, Addendum No. 5 of ANSI/TIA/EIA-568-A. The cabling system shall be backed by an AMP, or equivalent, 15-Year Performance Warranty. The performance warranty shall be facilitated by the Contractor and be established between the Owner and AMP.

1.2 SCOPE

The successful contractor is required to furnish all labor, materials supervision, tooling, and miscellaneous mounting hardware and consumables for each cabling system.
installed. The contractor shall maintain current status with the cabling system manufacturer, including all training requirements, for the duration of the Cable Infrastructure Project. The Contractor shall staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the 15-Year Performance Warranty requirements. After installation, the Contractor shall submit all documentation to support the warranty requirements in accordance with the manufacturer's warranty requirements, and to apply for said warranty on behalf of the Owner. The warranty will cover the components and labor associated with the repair/replacement of any failed link within the warranty period that is a valid warranty claim.

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany that the Contractor will furnish to install a complete telecommunications system supporting voice and data. The intent of this document is to provide all pertinent information to allow the vendor to bid the labor, materials supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the Contractor to propose any and all items required for a complete system if not identified in the Bill of Materials attached to this specification.

1.3 APPLICABLE DOCUMENTS:

The cabling system described in this is derived in part from the recommendations made in industry standard documents. The list of documents below are incorporated by reference:

1) This Technical Specification and Associated Drawings
2) ANSI/TIA/EIA TSB72 Centralized Optical Fiber Cabling Guidelines - October, 1995
3) ANSI/TIA/EIA SP-4195 Proposed Addendum No. 5 to TIA/EIA-568-A Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling (latest revision)
7) ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994
9) National Fire Protection Agency (NFPA) - 70, National Electrical Code (NEC) -1993
10) AMP NETCONNECT Design and Installation Contractor Agreement (current)

If a conflict exists between applicable documents, then the order in the list above shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity, and is therefore enforceable as law by a local, state, or federal inspection agency.
If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

2.0 TELECOMMUNICATIONS CABLING SYSTEM REQUIREMENTS

The user of this document should provide an overview of the telecommunications cabling requirements from the outlet to the main cross connect.

2.1 FACILITIES DESCRIPTION

The user of this document should provide an overview of the campus and/or facility(ies) to be cabled including the number of buildings, floors, closets, etc. that will comprise the overall project.

2.2 TELECOMMUNICATIONS CABLING SYSTEM DESCRIPTION

To accommodate the data requirements of the facility, the Owner has decided to implement a centralized optical fiber cabling (COFC) architecture. To do this, the Owner will have installed one data circuit and one voice circuit to each user outlet as a standard configuration. The data circuit is provided via one 50/125 µm 2-strand fiber optic cable (centralized architecture) to each outlet. The voice circuit is provided by one Enhanced Category 5 cable.

The centralized optical cabling architecture is based on the placement of LAN electronics at a central location, typically the main equipment room. Passive splices shall be located at the TC’s in order to maintain the distance of the closet to outlet terminations within the recommended TIA/EIA limitations for horizontal fiber cabling. A multi-strand 50/125 micron fiber optic cable backbone shall be installed between the MC and TCs. The backbone fiber strands shall be field terminated in rack-mounted fiber enclosures at the MC and fusion-spliced at the TC. The horizontal cable shall be two-strand 50/125 micron fiber optic multimode cable that shall be spliced to the backbone cable and stored in trays in the TC. The horizontal cables shall be field terminated with MT-RJ outlet jacks connectors at the outlet. The fiber connections will be cross-connected to the LAN electronics at the MC.

The voice backbone shall require high pair count Category 3 cables between the voice MC and each TC. Within the voice MC and the TCs, backbone copper pairs shall be terminated on wall-mount 110Connect XC termination blocks and frames. Horizontal voice cables shall be terminated to wall mount 110Connect XC blocks. Voice circuits shall be cross-connected to backbone riser circuits within each TC.

3.0 HORIZONTAL DISTRIBUTION SUBSYSTEM

The user of this document should describe the cabling system from the work area outlet to the closet termination hardware. The appropriate portion of this description should be carried over to the description of the individual horizontal distribution elements.
3.1 TELECOMMUNICATIONS OUTLETS

Each outlet location, unless otherwise noted, shall be served by one Enhanced Category 5 cable and one 2-strand 50/125 μm fiber optic cable. Each Enhanced Category 5 cable shall be terminated on an 8-position, 8-conductor Category 5 Universal jack to the T568A color code. The fiber optic cable shall be terminated onto a duplex SC style connector. The outlet shall be flush mounted on dry wall partitions and surface mounted when mounted to modular furniture. The outlet plate, unless otherwise noted, shall be mounted to a single gang box, box eliminator, and/or surface mount box as required.

3.1.1 PRODUCT SPECIFICATIONS

Modular Jacks - All modular jacks shall be terminated to the T568A wiring pattern. Modular jacks shall be constructed with a housing of polyphenylene oxide, 94V-0 rated. Modular jacks shall be terminated using a 110-style pc board connector (made of 94V-0 rated polycarbonate), color-coded for both T568A and T568B wiring. The 110 connector shall terminate 22-26 AWG solid or 20-26 AWG stranded conductors with a maximum insulation diameter of .050 inches. The modular jack contacts shall be plated with a minimum of 50 microinches of gold in the contact area and a minimum of 150 microinches of tin-lead in the solder area over a 50-microinch minimum nickel underplate. Modular jacks shall be compatible with panel thicknesses of .058” - .063”. Modular jacks shall snap into a .790” X .582” opening. Modular jacks shall be UL Listed under file number E81956.

Optical Fiber Connector - Each duplex fiber strand shall be terminated with a MT-RJ jack. The optical fiber workstation jack shall be a 50-micron MT-RJ jack capable of terminating either 250μm coated or 900μm buffered optical fibers in either a discrete or ribbon construction. The connector shall be field installable, without requiring epoxy, or polishing. It shall be reteratable without repolishing. The connector shall meet the performance requirements listed in the following table in addition to meet the intermateability requirements of ANSI/TIA/EIA-604-12, TIA/EIA-568-A and ISO11801. The optical fiber connector shall be AMP part number 1278414-1.

MT-RJ Jack Typical Performance Characteristics

<table>
<thead>
<tr>
<th>Test Description</th>
<th>FOTP</th>
<th>Requirement (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual and Mechanical Inspection</td>
<td>13</td>
<td>TIA/EIA-604-2 or -3_intermateability</td>
</tr>
<tr>
<td>Attenuation</td>
<td>34</td>
<td>≤ 0.75</td>
</tr>
<tr>
<td>Return Loss</td>
<td>107</td>
<td>≤ -20</td>
</tr>
<tr>
<td>Low Temperature (0°C for 4 days)</td>
<td>188</td>
<td>≤ 0.3 change</td>
</tr>
<tr>
<td>Temperature Life (55°C for 14 days)</td>
<td>7</td>
<td>≤ 0.3 change</td>
</tr>
<tr>
<td>Humidity (90 to 95% @ 40°C for 4 days)</td>
<td>5</td>
<td>≤ 0.3 change</td>
</tr>
<tr>
<td>Impact (8 drops from 1.8 meters)</td>
<td>2</td>
<td>≤ 0.75 IL, ≤ -20 RL</td>
</tr>
<tr>
<td>Durability (500 cycles)</td>
<td>21</td>
<td>≤ 0.75 IL, ≤ -20 RL</td>
</tr>
<tr>
<td>Cable Retention (0° and 90°)</td>
<td>6</td>
<td>≤ 0.75 IL, ≤ -20 RL</td>
</tr>
<tr>
<td>Flex (100 cycles)</td>
<td>1</td>
<td>≤ 0.75 IL, ≤ -20 RL</td>
</tr>
</tbody>
</table>
Outlet - Use 4-port flush 110Connect faceplates. Faceplates shall be constructed of ABS molding compound and be 4.53” X 2.77” X .60” in size. Each faceplate shall contain one Enhanced Category 5 jacks and one MT-RJ outlet jacks. There shall be two Enhanced Category 5 cables and one fiber optic cable terminated as noted in 3.1 above. Each port shall be provided with an icon to indicate its function. Faceplates shall accommodate two labels and provide a clear polycarbonate cover for each. Faceplates shall be light almond in color. Faceplates shall be AMP part number 558088-1 or an approved equivalent. The faceplates shall be mounted to in-wall single gang boxes.

3.1.2 TELECOMMUNICATIONS OUTLET INSTALLATION

All outlets shall be installed in the following manner:

- Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer’s bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12” of UTP and 36” of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be neatly coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-A document, manufacturer’s recommendations and/or best industry practices.
- Pair untwist at the termination shall not exceed one-half an inch.
- Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.
- The cable jacket shall be maintained as close as possible to the termination point.
- Voice jacks, unless otherwise noted in drawings, shall be located in the bottom position(s) of each faceplate. Voice jacks in horizontally oriented faceplates shall occupy the right-most position(s). Modem jacks shall be considered the last voice jack in the sequence.
- Data jacks shall occupy the top position(s) on the faceplate. Data jacks in horizontally oriented faceplates shall occupy the left-most position(s).

3.2 HORIZONTAL DISTRIBUTION CABLE

The horizontal distribution cable for the voice circuits shall be Enhanced Category 5, 4-pair unshielded twisted pair, plenum rated (CMP) cable. The horizontal distribution cable for the fiber data circuits shall be a plenum rated (OFNP), 2-strand, 50/125 µm fiber optic multimode zip cable. Quantities of cables to each outlet type shall be in accordance with the definitions provided in Section 3.1.1 above.

3.2.1 PRODUCT SPECIFICATIONS
Enhanced Category 5 Cable - Horizontal UTP cabling shall be Enhanced Category 5, 24 AWG, 4-pair, with a blue plenum (CMP) rated PVC jacket. Individual conductors shall be FEP insulated. Cable shall meet TIA Category 5 requirements for impedance and attenuation and shall exceed Cat 5 worst pair NEXT by 6 dB. Cable shall be supplied on 1000 ft. reel-in-a-box. Cable shall be UL listed under file number E138034.

Enhanced Category 5, 24 AWG, UTP 4-pair, CMP  AMP Part No. 57825-4

50/125 Micron Fiber Optic Cable - The optical fiber cable shall contain two tight-buffered multimode (50/125) fibers surrounded by aramid strength members and a PVC outer jacket. The cable shall have a UL rating of OFNP (Plenum). The cable shall have an outside diameter of 4.75 mm. The cable jacket shall be orange. The cable shall provide a maximum attenuation of 3.5 dB/km @ 850 nm and 1.5 dB/km @ 1300 nm. The bandwidth of the cable shall be 500 MHz/km @ both 850 nm and 1300 nm. Horizontal 50/125 fiber optic cable part number shall be 02MBHNTAHJPNN.

3.2.1 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

- Cable shall be installed in accordance with manufacturer’s recommendations and best industry practices.
- Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type.
- Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document.
- Where cable splices are allowed, they shall be in accessible locations and housed in an enclosure intended and suitable for the purpose.
- The cable’s minimum bend radius and maximum pulling tension shall not be exceeded.
- If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of four-foot intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- Horizontal distribution cables shall be bundled in groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.
- Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for drop cable legs are required, the contractor shall install clips to support the cabling.
- Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
Unshielded twisted pair cable shall be install so that there are no bends less than four times the cables outside diameter (4 X cable O.D.) at any point in the run and at the termination field.

Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle.

3.3 Horizontal Cross Connect Termination Hardware

3.3.1 Horizontal Data Interconnect

The horizontal fibers shall be fusion spliced to the backbone fibers in wall mounted WIMS enclosures. The splices shall be housed and protected in splice trays, up to 12 splices per tray.

WIMS Chassis AMP Part No. 559347-1
WIMS Splice Tray Holder AMP Part No. 559430-1
Splice Tray AMP Part No. 501321-1

3.3.2 Voice Cross Connect

The voice cross connect shall be a passive connection between the horizontal termination blocks and the backbone termination blocks. The wall mount frames shall be field terminated 110Connect XC kits including all blocks, connecting blocks, and designation strips. Management rings shall be mounted between vertical columns of blocks to provide management of cross connect wire. Backbone blocks shall use 5-pair connecting blocks, and horizontal blocks shall use five 4-pair and one 5-pair connecting block on each 25-pair row. Blocks shall be oriented so that backbone terminations are located on the left and horizontal frames are located on the right of the termination field when facing the frame assembly.

3.3.2.1 Product Specification

Wiring blocks, connecting blocks and horizontal troughs shall be constructed of polycarbonate molding compound. Wiring blocks shall be marked black every fifth pair. Connecting block terminals shall be constructed of phosphor bronze, plated with a minimum of 150 micro-inches of tin-lead over a 50 micro-inch minimum nickel underplate.

110Connect XC 100 Pair Kit, C4 & C5s AMP Part No. 569439-1
110Connect XC 100 Pair Kit, C5s AMP Part No. 569440-1
110Connect XC 300 Pair Kit, C4 & C5s AMP Part No. 569445-1
110Connect XC 300 Pair Kit, C5s AMP Part No. 569446-1
Management Rings, Small AMP Part No. 569431-1

3.3.3 Horizontal Cross Connect Installation

Copper termination and management hardware shall be installed in the following manner:

Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-A document, manufacturer's recommendations and/or best industry practices.

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Pair untwist at the termination shall not exceed one-half an inch.
Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
The cable jacket shall be maintained as close as possible to the termination point.
Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

Fiber optic termination hardware shall be installed in the following manner:
Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel(s).
Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member(s) shall be securely attached the cable strain relief bracket in the enclosure.
Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
A maximum of 12 strands of fiber shall be spliced in each tray.
All spare strands shall be installed into spare splice trays.

4.0 BACKBONE CABLING SUB-SYSTEM

The user of this document should provide an overview description of the desired backbone system from the horizontal cross connect in the telecommunications closet to the main-cross connect in the equipment room.

4.1 VOICE BACKBONE CABLE

The Contractor shall install 100-pair, 24 AWG twisted pair cable to provide backbone connectivity between the Voice MC each TC. Multiple 100-pair cables shall be provided as required, and shall be jacketed as appropriate for use in riser areas. The voice backbone cable shall be sized to provide two pairs for each outlet plus 25% spare pairs. A coupled bonding conductor shall be installed within the riser bundle and bonded to ground at each end.

4.1.1 PRODUCT SPECIFICATIONS

Voice backbone cabling shall be 24 AWG, 100-pair UTP, UL/NEC CMR rated, with a gray PVC jacket. Cable shall be third party verified to comply with TIA Category 3 requirements. Cable shall be supplied on 1000-ft. reels. Cable shall be UL listed under file number E138034. Backbone cable shall be AMP part number 57315-1 or an approved equivalent. A coupled bonding conductor will be installed within the riser bundle and bonded and grounded at each end.
4.2 **DATA BACKBONE CABLE**

The centralized optical cabling architecture shall require multi-strand fiber for backbone connectivity between the Data MC and each TC. At each closet, the contractor shall provide one pair of fiber for each station served by the closet plus 10% spare for future growth. This cable shall be jacketed as appropriate for use in a [riser or plenum] environment. Backbone fiber optic cable shall be colored orange to denote multimode fiber.

4.2.1 **PRODUCT SPECIFICATIONS**

The optical fiber cable shall be 50/125 micron multimode with a UL rating of **[OFNR or OFNP]**. The cable jacket shall be orange, and the cable construction shall consist of six-fiber sub-units. The optical fibers shall be 50/125 micron with optical performance ratings at 850 nm and 1300nm respectively: 3.5/1.5 maximum attenuation; 2.6/1.1 dB/km typical attenuation; and 500/500 MHz/km bandwidth. The individual fibers shall be covered with a 900-micron primary buffer; color-coded white and blue for identification. The buffered fibers shall be surrounded by aramid fiber strength members and an orange colored, low smoke, flame retardant PVC jacket. The cable shall have a storage temperature of -40°C to +70°C, operating temperature of -20°C to +70°C, and an installation temperature of 0°C to +50°C.

12-Strand, 50/125, Tight Buffer, MM, OFNR  AMP Part No. 12MBHNTATJRN
12-Strand, 50/125, Tight Buffer, MM, OFNP  AMP Part No. 12MBHNTATJPN
24-Strand, 50/125, Tight Buffer, MM, OFNR  AMP Part No. 24MB2TTATJRN
24-Strand, 50/125, Tight Buffer, MM, OFNP  AMP Part No. 24MB2TTATJPN
36-Strand, 50/125, Tight Buffer, MM, OFNR  AMP Part No. 36MB66TATJRN
36-Strand, 50/125, Tight Buffer, MM, OFNP  AMP Part No. 36MB66TATJPN
48-Strand, 50/125, Tight Buffer, MM, OFNR  AMP Part No. 48MB4TTATJRN
48-Strand, 50/125, Tight Buffer, MM, OFNP  AMP Part No. 48MB4TTATJPN
72-Strand, 50/125, Tight Buffer, MM, OFNR  AMP Part No. 72MB6TTATJRN
72-Strand, 50/125, Tight Buffer, MM, OFNP  AMP Part No. 72MB6TTATJPN
4.2.2 Backbone Cable Installation
All backbone cables shall be installed in the following manner:

- Backbone cables shall be installed separately from horizontal distribution cables.
- Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.
- Where cables are installed in an air return plenum, riser rated cable shall be installed in conduit.
- Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- All backbone cables shall be securely fastened to the side wall of the closet on each floor.
- Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

4.3  **Backbone Termination Hardware.**

4.3.1  **Optical Fiber Termination Hardware**
Each fiber optic cable for the distributed cabling backbone shall be terminated in the MC and TCs in 24-, 48- or 72-port rack mount fiber enclosures. The enclosures shall support MT-RJ patch panel jacks. The fiber optic enclosures will fully enclose both the hardwired terminations and the patch cord connections. Each fiber optic cable for the centralized cable architecture shall be terminated at the MC in 24, 48-or 72-port MT-RJ rack mount fiber enclosures providing protection to the terminated fibers. The fiber optic adapter plates and MT-RJ jacks shall be the same as defined in Section 3.1.1 of this document. The racks and rack mount cable management shall be the same as described in Section 3.3.1 of this document.

MT-RJ Patch Panel Jack, 50-micron  
AMP Part No. 1278414-1

24 Port Slim-Line MT-RJ Enclosure, Black  
AMP Part No. 1206704-4

72 Port MT-RJ Enclosure, Black  
AMP Part No. 559552-2

48 Port MT-RJ Enclosure, Black  
AMP Part No. 559614-2

24 Port MT-RJ Enclosure, Black  
AMP Part No. 559542-2

Fiber Optic Adapter Plates, MT-RJ  
AMP Part No. 1278328-3

4.3.2  **Voice Backbone Termination Hardware**
Voice backbone cables shall be terminated in wall-mount 110Connect XC frames. Management backboards shall be mounted between alternate vertical frames and between backbone and equipment frames to provide management of cross connect wire. Combinations of 300- and/or 900-pair frames shall be installed as required by the backbone pair counts. Backbone frames shall use 5-pair connecting blocks.
Frames shall be oriented so that backbone frames are located on the left and PBX vendor’s frames are located on the right of the termination field when facing the frame.

4.3.2.1 Product Specifications
Frames and bottom troughs shall be constructed of carbon steel, light almond in color. Wiring blocks, connecting blocks and horizontal troughs shall be constructed of polycarbonate molding compound. Wiring blocks shall be marked black every fifth pair. Connecting block terminals shall be constructed of phosphor bronze, plated with a minimum of 150 micro-inches of tin-lead over a 50 micro-inch minimum nickel underplate.

110Connect XC 900 Pair Frame Kit, C4 & C5s   AMP Part No. 569857-1
110Connect XC 900 Pair Frame Kit, C5s       AMP Part No. 569858-1
110Connect XC 900 Vertical Management Backboard   AMP Part No. 569852-1
110Connect XC 300 Pair Frame Kit, C4 & C5s   AMP Part No. 569854-1
110Connect XC 300 Pair Frame Kit, C5s       AMP Part No. 569855-1
110Connect XC 300 Vertical Management Backboard   AMP Part No. 569851-1

4.3.3 Termination Hardware Installation
Copper termination and management hardware shall be installed in the following manner:

- Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-A document, manufacturer's recommendations and/or best industry practices.
- Pair untwist at the termination shall not exceed one-half an inch.
- Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- Cables shall be neatly bundled and dressed to their respective blocks. Each block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- The cable jacket shall be maintained as close as possible to the termination point.
- Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

Fiber optic termination hardware shall be installed in the following manner:

- Fiber slack shall be neatly coiled within the fiber termination panel. No slack loops shall be allowed external to the fiber panel(s).
- Each cable shall be individually attached to the respective termination panel by mechanical means. The cables strength member(s) shall be securely attached the cable strain relief bracket in the panel.
- Each fiber cable shall be stripped upon entering the termination panel and the individual fibers routed in the termination panel.
- Each cable shall be clearly labeled at the entrance to the termination panel. Cables labeled within the bundle shall not be acceptable.
Dust caps shall be installed on the connectors and couplings at all times unless physically connected.

5.0 TELECOMMUNICATIONS SPACES

The telecommunications closet shall house the fiber optic splice center (WIMS) and voice termination fields mounted on 4’ x 8’ x .75” virgin plywood with two coats of white fire retardant paint unless otherwise noted in drawings. At a minimum, 4” conduit(s) and/or sleeves shall be installed shall between closets and as sleeves to exit the closet. Conduits for the data backbone shall be located adjacent to the 19” racks. Conduits serving the voice frames/blocks shall be located adjacent to the voice termination fields. The Contractor shall provide required ladder and wall mount management rings to properly support and dress cables from conduits to racks and frames.

The main cross connect shall house racks, voice termination fields and required cable routing hardware. If one mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 6” to the wall to allow room for cable routing and vertical management. Where more than one rack is installed, the racks shall be ganged with vertical managers between racks. Racks shall be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly.

5.1 INSTALLATION SPECIFICATIONS

Racks shall be installed in the following manner:

- Racks shall be securely attached to the concrete floor using a minimum 3/8” hardware or as required by local codes.
- All racks shall be grounded to the telecommunications ground bus bar in accordance with Section 9.0 of this document.
- Rack mount screws (#12-24) not used for installing fiber panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- Voice termination fields shall be mounted on 4’ x 8’ x .75” virgin plywood. The plywood shall be mounted vertically at 12” A.F.F. The plywood shall be painted with two coats of white fire retardant paint.
- Voice termination fields shall be installed at or above 18” AFF to the bottom of the frame.

6.0 WORK AREA AND PATCH CORD CABLE ASSEMBLIES

The contractor shall provide UTP and fiber patch cords for the distributed cable system and optical fiber patch cords for the centralized cable system. The telephone system shall be cross-connected by [the contractor or by others] The work area cable assemblies for telephone will be provided by others.
To support the voice cable system, the contractor shall provide one (1) Enhanced Category 5 patch cords at the outlet for each outlet installed; one 10-foot patch cord for the work area.

The contractor shall provide 2 MT-RJ patch cords to connect network electronics in each closet. [MT-RJ to MT-RJ, MT-RJ to SC, or MT-RJ to ST] fiber optic patch cords shall be provided depending upon LAN electronic interface. One (1) duplex 3-meter fiber optic patch cord for the work area and one (1) duplex 2-meter fiber optic patch cord for the centralized closet shall be provided for each optical fiber drop installed.

Enhanced Cat 5 Patch Cable, 10ft, Black  AMP Part No.  1-406483-0
Optical Fiber, Zip Cord, MT-RJ to MT-RJ, 1M  AMP Part No.  1278128-1
Optical Fiber, Zip Cord, MT-RJ to SC, 1M  AMP Part No.  1278126-1
Optical Fiber, Zip Cord, MT-RJ to ST, 1M  AMP Part No.  1278199-1
Optical Fiber, Zip Cord, MT-RJ to MT-RJ, 2M  AMP Part No.  1278128-2
Optical Fiber, Zip Cord, MT-RJ to SC, 2M  AMP Part No.  1278126-2
Optical Fiber, Zip Cord, MT-RJ to ST, 2M  AMP Part No.  1278199-2

7.0  CABLE SYSTEM TESTING

All cables and termination hardware shall be 100% tested for defects in installation and to verify cable performance under installed conditions. All conductors of each installed cable shall be verified usable by the contractor prior to system acceptance. Any defect in the cable system installation including but not limited to cable, connectors, feedthrough couplers, patch panels, splices, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

All cables shall be tested in accordance with this document, the ND&I Contract agreement, and best industry practices. If any of these are in conflict, the Contractor shall be responsible to bring any discrepancies to the attention of the project team for clarification and/or resolution.

7.1  COPPER

All twisted-pair cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Twisted pair cables shall be tested using a Class II cable analyzer.

7.1.1  CONTINUITY

Each pair of each installed cable shall be tested using a “green light” test set that shows opens, shorts, polarity and pair-reversals. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test set in accordance with the manufacturers recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

7.1.2  LENGTH
Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the TIA/EIA-568-A Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multipair cables, the shortest pair length shall be recorded as the length for the cable.

7.1.3 PERFORMANCE VERIFICATION

Enhanced Category 5 unshielded twisted pair (UTP) data cable link shall be performance verified using an automated test set. This test shall be conducted from the patch panel or wiring block to the outlet (installed link). The test shall include checks for continuity and length as defined above and the following:

- Bi-directional Near End Crosstalk (NEXT)
- Attenuation
- Attenuation to Crosstalk Ratio (ACR)

The cables under test shall meet or exceed the requirements for an Enhanced Category 5 link as defined by the following table:

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Expected Results (Cat5e Link @ 100 MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attenuation</td>
<td>21.6 dB</td>
</tr>
<tr>
<td>Pair-to-Pair NEXT</td>
<td>32.0 dB</td>
</tr>
<tr>
<td>ACR</td>
<td>10.4 dB</td>
</tr>
</tbody>
</table>

Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA/EIA Standard, and the result shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The printed test results shall include all tests performed, the expected test result and the actual test result achieved.

7.2 FIBER OPTIC TESTING

Each fiber strand shall be tested for attenuation with an optical power meter and light source.
7.2.1 Multimode Fiber Testing
Centralized distribution multimode optical fiber attenuation shall be measured in one direction at either 850 nanometers (nm) or 1300 nm using an LED light source and power meter. Backbone multimode fiber shall be tested at both 850 nm and 1300 nm in one direction. Test set-up and performance shall be conducted in accordance with ANSI/EIA/TIA-526-14 Standard, Method B. The MT-RJ system shall be tested in accordance with the AMP testing procedures established in “MT-RJ Optical Fiber Systems Testing” literature # 1307540.

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Max Segment Length (meters)</th>
<th>Attenuation (dB) @ 850</th>
<th>Attenuation (dB) @1300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>100</td>
<td>2.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Centralized (splice)</td>
<td>300</td>
<td>2.9</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Where concatenated links are installed to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. After the link performance test has been successfully completed, all patch cords shall be installed to complete and then the entire channel shall be tested. The test method shall be the same used for the test described above. The evaluation criteria shall be established between the Owner and the Contractor prior to the start of the test. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.

Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

7.2.3 LENGTH AND SPlice LOSS
Where required, each cable shall be tested with an Optical Time Domain Reflectometer (OTDR) to verify installed cable length and splice losses. The OTDR measurements for length shall be performed in accordance with EIA/TIA-455-60. The measurements to determine splice loss shall be performed in accordance with manufacturer's recommendations and best industry practices. These tests shall be employed where one or more of the following conditions exist.

- Where abnormal or unexpected results are obtained during attenuation testing
- Where the cable has been subjected to extreme conditions or stresses during installation.

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

8.1 PRODUCT SPECIFICATIONS

Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed. A drawing showing the proposed firestopped system, stamped/embossed by the cognizant PE shall be provided to the Owner’s Technical Representative prior to installing the firestop system(s).

8.2 FIRESTOP SYSTEM INSTALLATION

All firestop systems shall be installed in accordance with the manufacturer’s recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

9.0 GROUNDING AND BONDING

The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the buildings electrical and building ground and shall be designed in accordance with the recommendations contained in the TIA/EIA-607 Telecommunications Bonding and Grounding Standard.

The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB). Each telecommunications closet shall be provided with a telecommunications ground bus bar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.

9.1 PRODUCT SPECIFICATIONS

All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TC or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the System Documentation Section of this specification.
9.2 GROUND SYSTEM INSTALLATION

The TBB shall be designed and/or approved by a qualified PE, licensed in the state that the work is to be performed. The TBB shall adhere to the recommendations of the TIA/EIA-607 standard, and shall be installed in accordance with best industry practices. Installation and termination of the main bonding conductor to the building service entrance ground, at a minimum, shall be performed by a licensed electrical contractor.

10.0 SYSTEM DOCUMENTATION

The following section describes the installation, administration, testing, and as-built documentation required to be produced and/or maintained by the contractor during the course of the installation.

10.1 CABLE SYSTEM LABELING

The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

All label printing will be machine generated using indelible ink ribbons or cartridges. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

10.3 AS-BUILT DRAWINGS

The installation contractor will be provided with 2 sets of D size drawings at the start of the project. One set will be designated for as the central location to document all as-built information as it occurs throughout the project. The central set will be maintained by the Contractor’s Foreman on a daily basis, and will be available to the Owner’s Technical Representative upon request during the course of the project. Anticipated variations from the build-to drawings may be for such things as cable routing and actual outlet placement. No variations will be allowed to the planned closet termination positions of horizontal and backbone cables, and grounding conductors unless approved in writing by the Owner.

The Contractor shall provide the central drawing set to the owner at the conclusion of the project. The marked up drawing set will accurately depict the as-built status of the system including termination locations, cable routing, and all administration labeling for the cable system. In addition, a narrative will be provided that describes any areas of difficulty encountered during the installation that could potentially cause problems to the telecommunications system.
10.4 TEST DOCUMENTATION

Test documentation shall be provided in a three ring binder(s) within three weeks after the completion of the project. The binder(s) shall be clearly marked on the outside front cover and spine with the words “Test Results”, the project name, and the date of completion (month and year). The binder shall be divided by major heading tabs, Horizontal and Backbone. Each major heading shall be further sectioned by test type. Within the horizontal and backbone sections, scanner test results (Category 3, 4, or 5), fiber optic attenuation test results, and green light test results shall be segregated by tab. Test data within each section shall be presented in the sequence listed in the administration records. The test equipment by name, manufacturer, model number and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test.

Scanner tests shall be printed on 8-1/2” x 11” paper. Hand written test results (attenuation results and green light results) shall be documented on a contractor supplied test form. OTDR test results, if required, shall be printed or attached and copied on 8-1/2” x 11” paper and included in the test documentation binder.

When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be collocated in the binder.

11.0 WARRANTY AND SERVICES

The contractor shall provide a warranty covering the installed cable system against defects in workmanship, components, and performance, and follow-on support after project completion.

11.1 INSTALLATION WARRANTY

The contractor shall warrant the cabling system against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.

11.2 CABLE SYSTEM WARRANTY

The contractor shall facilitate a 15-Year Performance Warranty between AMP and the Owner. An extended component warranty shall be provided which warrants functionality of all components used in the system for 15 years from the date of acceptance. The Performance Warranty shall warrant the installed 100 MHz horizontal copper and the centralized optical fiber portions of the cabling system. Copper links shall be warranted against the link performance minimum expected results defined in the TIA/EIA 568A, TSB-67 and SP-4195. Fiber optic links shall be warranted against the link and segment performance minimum expected results defined in the TIA/EIA 568A, Annex H and the
attenuation values stated in 7.2. The performance warranty must include the labor and materials to replace or repair defective components for the life of the warranty.

Note: The user of this document must determine what, if any, of the following information will be contained in the final document. The user may elect to supply boilerplate information for the project management, post installation maintenance, inspection and acceptance of the cabling system.

11.3 POST INSTALLATION MAINTENANCE

The contractor shall furnish an hourly rate with the proposal submittal, which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs performed by the Contractor shall not void the Contractor’s or the manufacturer’s warranty.

11.4 PROJECT MANAGEMENT / GENERAL

The contractor shall establish a single point of contact with the Owner who will be responsible for reporting progress and updating the Owner’s Technical Representative with issues that the Owner must address to facilitate the cable system installation. The contractor’s POC shall provide (daily or weekly) (verbal or written) reports to the Owner’s Technical Representative detailing progress. Requests for access to limited access or restricted areas shall be made (the day prior to the required access). Information critical to the completion of the task or project shall be communicated to the Owner’s Technical Representative as the requirement becomes known. Casual information shall be passed during the scheduled progress report.

The contractor shall maintain the Owner’s facility in a neat and orderly manner during the installation of the communications cable system. All contractor’s tools, materials and personal effects shall be stored in a Owner provided staging area when not in use. The Owner’s facilities shall be maintained in broom clean condition at the completion of work each day. At the completion of work in each area, the contractor will perform a final cleaning of debris prior to moving the installation crew to the next work area. Contractor is responsible for removal of all associated scrap & debris from the Owner’s site, or if previously arranged, to a trash receptacle on the Owner’s site.

12.0 CABLE SYSTEM ACCEPTANCE

The Owner’s Technical Representative will make periodic inspection of the project in progress. One inspection will be performed at the conclusion of cable pulling, prior to closing of the false ceiling, to inspect the method of cable routing and support, and the firestopping of penetrations. A second inspection will be performed at completion of cable termination to validate that cables were dressed and terminated in accordance with TIA/EIA specifications for jacket removal and pair untwist, compliance with manufacturer’s minimum bend radius, and that cable ends are dressed neatly and orderly.
12.1 **Final Inspection**

Upon completion of the project, the Owner's Technical Representative will perform a final inspection of the installed cable system with the Contractor's Project Foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the drawing package, and that the installation meets the aesthetic expectations of the Owner.

12.2 **Test Verification**

Upon receipt of the test documentation, the Owner reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Owner testing will use the same method employed by the contractor, and minor variations will be allowed to account for differences in test equipment. If significant discrepancies are found the Contractor will be notified for resolution.

12.3 **System Performance**

During the three week period between final inspection and delivery of the test and as-built documentation, the Owner will activate the cabling system. The Owner will validate operation of the cabling system during this period.

12.4 **Final Acceptance**

Completion of: the installation; in-progress and final inspections; receipt of the test and as-built documentation; and successful performance of the system for a two week period will constitute acceptance of the system.