SECTION 16731 - INTERBUILDING DATA/COMMUNICATION CABLE SYSTEMS

PART 1 - GENERAL

A. RELATED DOCUMENTS:

1. Division 16 Basic Materials and Methods sections apply to work specified in this section. The Contractor is held responsible to be familiarized with the provisions contained therein and in this Section.

B. SCOPE OF WORK:

1. Extent of the interbuilding data/communication cable system is indicated on the drawings, schedules and contract documents.

2. Types of interbuilding data/communication cable systems specified in this section include the following:
   a. Telephone/voice communication cable systems
   b. Data communication cable systems
   c. Fiber optic cable systems

3. Furnish and install conduit, ductbanks, cable trays, cable, splice enclosures, lightning protection equipment, grounding systems, distribution blocks, distribution frames, network interface equipment, etc. as indicated on the drawings, schedules and the contract documents.

4. 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.

5. Any deviation, alteration, or substitution from the drawings and specifications shall be fully documented by the Contractor and submitted as a voluntary alternate to the base bid with the amount of deduct to the base bid specified. Approval of requests for substitution of products, processes, or procedures other than those specified will be contingent upon submission of fully acceptable documentation to the Associate and shall be the sole decision of the Associate.
6. 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.

7. Products that are submitted for substitution, must be electrically and mechanically interchangeable with the specified product. **Substitutions will only be allowed with written approval by the Associate.** Samples of proposed substitutions must be submitted prior to approval at the discretion of the Associate. Any substitutions without the written approval of the Associate are done so at the risk of the Contractor. Substitutions unacceptable to the Associate will be rejected without explanation or appeal.

8. 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.

9. 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.

10. 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.

C. **QUALITY ASSURANCE:**

1. **Manufacturers:** Firms regularly engaged in the manufacture of data and communication cabling system components of the types specified herein and on the drawings and whose products have been satisfactorily used in similar applications for not less than five years.

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2. **Data/Telecommunications Contractor:** Shall be fully capable and experienced in the information transport systems specified. This contractor and/or all subcontractors engaged in this Data/Telecommunications Installation shall have experience in the business of Data/ Telecommunications Systems installations of not less than five (5) years and shall have successfully completed a minimum of three (3) projects of similar size and complexity. They shall be fully capable and experienced in the information transport systems specified [and shall provide at minimum three (3)
reference accounts at which similar work (both in scope and design) has been successfully completed by the Contractor and his sub-contractor(s) within the last three (3) years. Client reference information shall include but not be limited to the following items:

a. Client Company Name and Address
b. Contact Name, Title and Telephone Number
c. Installation Start-up, Completion & Acceptance Dates
d. Brief Description of Project

** [3. Failure to provide client reference accounts and project information will eliminate the bid from consideration.]

** [4. The Contractor shall specify all sub-contractors who will be utilized in the project. The bid will include:

a. Sub-Contractor responsibilities and scope of work
b. Supportive documentation verifying sub-contractor qualifications]

** [5. The Associate may, with full cooperation of the Contractor, visit client installations to observe equipment operations and consult with references. Specified visits shall be arranged by the Contractor. However, the Contractor may not be present during discussions with references.]

** [6. The Contractor shall have a Registered Communications Distribution Designer (RCDD) on staff who will ultimately be responsible to the Associate, Architect and/or Owner for all work performed by the Contractor and/or his subcontractors under this Specification and associated data/communication specifications. The RCDD shall have the authority of the Contractor to make immediate decisions regarding implementation of changes to the project as directed by the Associate/Architect. The RCDD shall have sufficient experience in this type of project to be able to answer questions of field forces during installation and anticipate problems and ensure the smooth and timely transition to the new Data/Telecommunications System being installed. The RCDD’s resume

** *Delete if Annex “F” is utilized (use for minor renovation projects only, utilize Annex “F” for all major renovation and all new construction)*

shall be attached to the Contractor’s bid. Should the RCDD change or be reassigned during the project, the new RCDD shall follow the same procedure of review and acceptance by the Associate, Architect and/or Owner.*
If in the opinion of the Associate, Architect and/or Owner the RCDD does not possess or demonstrate adequate qualifications to support the project, the Owner reserves the right to require the Contractor to assign a RCDD who, in the Associate’s and/or Owner’s opinion, possesses the skill necessary to complete the project.

Acceptability of qualifications of the RCDD shall be made solely by the Associate, Architect and Owner and shall be based upon but not limited to the following:


b. Information provided by and the recommendations of Reference Accounts.

c. A demonstrated history for the timely submittal of shop drawings, test equipment descriptions, test procedures, test set-up parameters and calibrations, reports, schedules, etc.

d. Demonstrated ability for the maintenance of project documents, records, drawings, schedules, progress reports, as-buils, etc. on the construction project in a current and up-to-date condition and available for inspection.

e. Demonstrated ability and willingness to coordinate, communicate and cooperate with other contractors, vendors, trades, the Associate, Architect, Owner and others as may be required and/or requested.

f. Demonstrated ability to properly supervise, oversee and manage the project and installation crew so as to ensure compliance with Engineering Documents and Industry Standards.

g. A demonstrated and verifiable commitment to a continuing and on-going educational program designed and intended to maintain the

*** Delete if Annex “F” is utilized (use for minor renovation projects only, utilize Annex “F” for all major renovation and all new construction) RCDD’s knowledge and expertise consistent with the latest industry standards and developments (such as BICSI educational programs and other relevant seminars, etc.)

Reference “Annex-F” for detailed Contractor qualifications, registrations, certifications, reference submittal requirements.

D. STANDARDS COMPLIANCE:
1. **NEC Compliance:** Comply with NEC Article 800, 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.

2. **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.

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

4. **EIA/TIA Compliance:** Comply with EIA/TIA 568-B1, -B2, -B2 Addendum 1, -B3, 569A, 606A, 607, National, State and Local standards for commercial building wiring for interbuilding voice and data communications as applicable.

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

6. **REA, Bell Core, EIA Compliance:** Metallic telecommunication cable and fiber optic communication cable and accessory components shall comply with REA, Bell Core and EIA standards and specifications as applicable.

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

8. 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.

*** Delete if Annex “F” is not utilized

E. **INSPECTION OF WORK/CONSTRUCTION AREA:**

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

F. **ON-SITE PROJECT MANAGER (OR PROJECT FOREMAN):**

1. 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 shall have an
office in a designated office area, as approved by the Owner at the project site and shall be on-site whenever work is being performed and installation crews are present.

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2. The Project Manager/Foreman shall be approved by the Associate and shall be a BICSI Registered Installation Cabling Technician, NJATC certified installer/technician journeyman or an Associate approved equal. The Contractor shall provide the Project Manager's (Foreman's) name, resume and supportive documentation for registered installer/technician, or equal qualifications as directed. [See Annex “F”].

3. The Project Manager/Foreman shall maintain and update all job-related documentation including but not limited to record drawings, specifications, addendums, and bulletins, drawings and other pertinent contract documents. These documents shall be readily and conveniently available to the tradesman and technicians for reference. He shall keep a master copy of project schedules and as-buils in his office at all times.

4. All workmanship by the Contractor shall be of the highest quality. All tradesmen and technicians performing work under this specification and associated data/communication specifications shall be enrolled in and/or have completed the NJATC Installer/Technician Apprenticeship Program, be a BICSI Registered installation cabling apprentice/installer/technician, or an Associate approved equal. All apprentices or tradesmen with two (2) years or less experience after completion of an approved training program shall work under the direct supervision of a Registered Installation Cabling Installer or a tradesman with a minimum of two (2) years of Associate approved experience after completion of an approved training program.

5. The Contractor's Project RCDD shall immediately notify the Associate of any existing or developing conditions which may adversely affect the

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quality and/or performance of the installation. Notification of the Associate shall be made in a timely manner, as to minimize or eliminate changes and rework.

G. EQUIPMENT WARRANTIES:

1. The Contractor shall guarantee 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 (1) year from date of final inspection and written acceptance by the Owner and/or Associate. 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.

H. SPECIAL CONDITIONS:

1. Computer and voice 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.

2. The computer, telephone and 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.

3. The Contractor shall provide timely written notice of the need to disconnect any existing voice, computer or other system 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

A. GENERAL:

1. 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.

2. 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.

3. Eight (8) sets of shop drawings shall be submitted in a timely manner for all specified equipment and substituted equipment to the Associate for approval prior to purchase, installation, or fabrication. Shop drawing submittals shall indicate full complete compliance with all Specifications herein. Shop drawings not indicating full compliance will be returned unapproved for resubmittal. Non-approved materials and equipment shall be immediately removed and replaced at the Contractor's expense. [Reference Annex “G” for submittal requirements]

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

B. CABLES:

Unless specified otherwise on the drawings or in contract documents, interbuilding data/communication cables shall be as specified herein. Cables are to be categorized as follows:

1. **100 OHM Multi-Twisted Pair Telephone Exchange Cables:**

   a. Available in multi-pair counts from 6 to 3,600 pairs. Pairs are to be color coded using solid wire color with tracer color and utilize the insulation color code standard. Unless otherwise noted, conductors shall be 24 AWG solid copper unshielded twisted pairs (U.T.P.).

   * SPECIFIER TO MAKE SELECTION

   The cable shall be rated as for the application-aerial, direct buried or underground (ductbank or tunnel), as per REA or Bell Core standard designations. Cable to be further classified as to “filled core” or “air core”
construction and “gopher resistant”.

b. Interbuilding cable construction shall generally consist of the cable core wrapped with a non-hygroscopic tape and enclosed in a metallic cable sheath and jacket.

c. Cable shall be suitable for voice frequency use and carrier frequency, both analog and digital at performance Category-3 (<=16 Mbps), on a selected pair assignment basis. Cables greater than 100 pair shall be performance rated as reduced Category-3 (<=10 Mbps). Cable is intended for high speed LAN applications and shall meet the electrical and corresponding distance requirements of the EIA/TIA-568-B1,-B2.

d. Category-3 specifications:
   1) Maximum D.C. Resistance = <9.38 Ohms per 100M @ 20°C
   2) Impedance at 16 Mhz = 100 Ohms ±15%
   3) Insertion Loss 16 Mhz = <13.1 dB per 100M @ 20°C
   4) PS Next * at 16 Mhz = >23 dB per 100M @ 20°C
   5) Mutual Capacitance = <6.6 nfd per 100M @ 20°C

e. “Filled” cable construction to be specified for aerial and ductbank installations. “Air core” cable construction to be specified for tunnel installations only. “Gopher resistant-filled” cable construction to be specified for direct buried applications.

f. Interbuilding cable to be:
   1) AT&T type “BKMA” for tunnel installation only.
   2) RUS PE-39 (Sealpic-F) for concrete enclosed ductbank installation.
   3) ATT type “ANMW” for direct burial, directional bored PVC/PE conduit, non-encased buried conduit installation.
   4) As required, or Associate approved equal.

2. **100 Ohm Multi-Pair Category-5 OSP Broadband Cable:**

   a. Available in multi-pair counts of 4, 25 and 100 pairs, 24 and 22 AWG, standard insulation color code, filled and non-filled construction, gopher and non-gopher resistant. UL verified to Category-5 electrical requirements per
EIA/TIA-568-B2 as applicable. Suitable for ADSL, HDSL and VDSL Technologies.

b. Outside plant broadband cable is also available as a 4-pair Category-5e, as manufactured by Superior Essex.

3. 75 Ohm Broadband Coaxial Feeder Cable:

[a. Cable to meet the requirements specified in IEEE 802.7. Nominal 1/2" diameter, 0.109" diameter copper clad aluminum center conductor, 0.450" diameter expanded polyethylene dielectric, 0.500" diameter solid aluminum sheath outer conductor (0.025" thick), 0.560" diameter black medium density polyethylene jacket (0.030" thick). Cable to be flooded with a self-healing flooding compound between the jacket and aluminum sheath. Minimum bending radius = 8", maximum pulling tension = 200#:

1) Nominal Impedance = 75 ± 2 OHMS

2) Capacitance = 15.3 ± 1.0 pfd/ft.

3) Velocity of Propagation = 87%

4) Attenuation at:
   a) 5 MHz = 0.16 dB/100 ft.
   b) 50 MHz = 0.52 dB/100 ft.
   c) 108 MHz = 0.75 dB/100 ft.
   d) 211 MHz = 1.09 dB/100 ft.
   e) 300 MHz = 1.31 dB/100 ft.
   f) 450 MHz = 1.63 dB/100 ft.

5) 75 OHM broadband coaxial cable to be Comm/Scope #P-3 75-500JCASS or Associate approved equal.]

* SPECIFIER TO MAKE SELECTION

[OR]

[a. Broadband coaxial feeder cable shall be utilized to distribute cable television signal as specified on the drawings and project specifications. Interbuilding backbone coaxial cables typically run from entrance facility to entrance facility. Cable shall be new, unused and of current design and
manufacture. The broadband coaxial cable shall be manufactured in an ISO 9001 certified manufacturing facility. The interbuilding 75 OHM broadband coaxial cable shall meet the requirements specified in IEEE 802.7. Requirements shall include, but not be limited to the following:

1) Nominal 1" outside diameter
2) 0.203" diameter copper clad aluminum center conductor
3) 0.828" diameter expanded polyethylene dielectric
4) 0.860" diameter solid aluminum sheath outer conductor (0.016" thick)
5) 0.960: diameter black medium density polyethylene (MDPE) jacket (0.050" thick)
6) Cable to be flooded with a self-healing flooding compound between the jacket and aluminum sheath
7) Minimum bending radius $\geq 7"$
8) Maximum pulling tension $\leq 450#$
9) Nominal impedance $= 75 \pm 2$ OHMS
10) Capacitance $= 15.3 \pm 1.0$ pf/dl/ft.
11) Velocity of Propagation $= 88$
12) Attenuation @ 5 MHz $= 0.16$ dB (@68°F/20°C)

$$
\begin{align*}
50 \text{ MHz} & = 0.27 \text{ dB} \\
108 \text{ MHz} & = 0.40 \text{ dB} \\
211 \text{ MHz} & = 0.59 \text{ dB} \\
300 \text{ MHz} & = 0.71 \text{ dB} \\
450 \text{ MHz} & = 0.88 \text{ dB}
\end{align*}
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* SPECIFIER TO MAKE SELECTION

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\begin{align*}
600 \text{ MHz} & = 1.04 \text{ dB} \\
750 \text{ MHz} & = 1.17 \text{ dB} \\
1000 \text{ MHz} & = 1.38 \text{ dB}
\end{align*}
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13) The 75 OHM broadband coaxial cable shall be Comm/Scope #QR-860-JCASS or Associate approved equal.
b. All termination and balancing of the broadband coaxial system shall be included in the cabling contract. The Contractor shall provide a minimum of fifty (50') feet of spare cable length to be coiled at the backboard for future use. The broadband coaxial system cables shall be terminated and balanced by Buckeye CableSystems, Inc. at the Electrical Contractor’s expense.

* 4. Fiber Optic Cable – Outdoor Interbuilding (Tight-Buffered) Backbone:

a. Fiber optic cable shall be utilized for interbuilding runs as specified on the drawings and project specifications. Interbuilding backbone cables typically run from entrance facility to entrance facility. Cable shall be new, unused and of current design and manufacture. Fiber optic cable shall be manufactured in an ISO 9001 certified manufacturing facility.

b. Interbuilding fiber optic cable shall be multimode, single-mode, or composite cable and of tight-buffered construction suitable for outdoor use and be OFNR or OFNP rated depending upon application, as specified on the drawings and project specifications.

c. Interbuilding fiber Optic Backbone Cable requirements shall include but not be limited to the following:

1) Optical Fiber Type: Tight-buffered, multimode, graded index fiber and/or single-mode stepped indexed fiber, as specified.

2) Proof Test: All fiber shall be subjected to a minimal proof test of 0.7 Cpa (100 kpsi).

3) Multimode Fiber Core Dimensions:

   Core diameter: 62.5 um ± 3.0 um
   Cladding diameter: 125 um ± 2.0 um
   Core-to-cladding offset: ≤ 3.0 um
   Numerical Aperture: 0.275

   * SPECIFIER TO MAKE SELECTION

4) Single-Mode Fiber Core Dimensions:

   Core diameter: 8.3 um ± 0.5 um
   Cladding diameter: 125 um ± 1.0 um
   Core to cladding offset: ≤ 0.8 um
   Numerical Aperture: 0.13

5) Temperature Ranges:

   Operating Temperature Range: -40°C to +85°C
Storage Temperature Range: -55°C to +85°C
Humidity: 5% to 95%

6) Minimum Bending Radius:
   a) Under Full Tensile Load - bending radius not less than 20 times outside diameter.
   b) Under No Load - bending radius not less than 10 times outside diameter.
   c) NEC Rated OFNP (Optical Fiber Non-conducting Plenum Rated) or OFNR (Optical Fiber Non-conducting Riser Rated) as specified on drawings and project specifications. Refer to NEC Sections 770-51 (a) and 770-53 (a) for compliance.

7) Multimode Operating Windows:
   - 850 nm Attenuation \(\leq 3.5 \text{ dB/Km} @ 200 \text{ Mhz}\)
   - 1300 nm Attenuation \(\leq 1.0 \text{ dB/Km} @ 500 \text{ Mhz}\)
   - 850 nm OFL Bandwidth > 200 Mhz-Km
   - 1300 nm OFL Bandwidth > 500 Mhz-Km
   
   Effective Modal Bandwidth @ 850 nm > 385 Mhz-Km

   * 1GbE Distance @ 850 nm > [300 meters] [500 meters]
   * 1GbE Distance @ 1300 nm > [500 meters] [1000 meters]
   10 GbE Distance @ 850 nm > 33 meters

8) Single-Mode Operating Windows:

<table>
<thead>
<tr>
<th></th>
<th>Loose Tube</th>
<th>Tight Buffered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1310 nm Attenuation</td>
<td>(\leq 0.4 \text{ dB/Km})</td>
<td>(\leq 1.0 \text{ dB/Km})</td>
</tr>
<tr>
<td>1383 nm Attenuation</td>
<td>(\leq 0.4 \text{ dB/Km})</td>
<td>(\leq 0.4 \text{ dB/Km})</td>
</tr>
<tr>
<td>1550 nm Attenuation</td>
<td>(\leq 0.3 \text{ dB/Km})</td>
<td>(\leq 0.75 \text{ dB/Km})</td>
</tr>
<tr>
<td>Zero Dispersion</td>
<td>(\leq 0.093 \text{ ps/(Km-Nm}^2)</td>
<td>(\text{ps/(Km-Nm}^2)</td>
</tr>
</tbody>
</table>
Crush Resistance  > 2,100 N/cm
Impact Resistance  > 1,500 Impacts
Flex Resistance  > 2,000 Cycles

10) 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.

d. Tight-Buffer Construction:

1) Tight-buffered optical fiber shall consist of a central glass optical fiber surrounded by a dual layered UV-cured acrylate polymer buffer to 900 um. The fiber optic cable shall be assembled by laying dielectric aramid yarns parallel to the fiber optic strands as additional strength members and extruding a flame resistant jacket over the combination to complete a sub-unit of six (6) or twelve (12) fibers. The sub-units are then stranded around a dielectric central strength member. A flexible, flame resistant outer jacket is then extruded over the cabled core assembly. Appropriate materials are utilized to achieve an OFNR (riser) or OFNP (plenum) rating. Fibers are 900 um buffered for standard connectorization, aramid yarn provides strength and high flexibility. OFNR-UL1666 riser rated of OFNP-UL910 plenum rated. Designed, manufactured and tested to meet or exceed Bellcore GR-20 and GR-409 specifications, ICEA-640 and ICEA-696 standards. Indoor/outdoor rated, where installed in the exterior, below grade, under the slab or otherwise exposed to the elements, dry-waterblocked construction shall be utilized. The outer jacket shall be smooth and free from holes, splits, blisters and other surface flaws. The jacket shall be designed for easy removal without damage to the optical fibers by incorporating a ripcord under the jacket. The cable shall be all dielectric. Printed on the outer jacket shall be the manufacturer's identification and required UL markings. 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.

2) Outer Jacket Color To Be:

a) Black or Orange for OFNR multimode and composite cable. Gray or Orange for OFNP multimode and composite cable, Yellow for single-mode cable, and/or as Associate approved.

3) The tight buffered fiber coating primary colors shall be per Standard EIA-STD-RS-389 as follows:
<table>
<thead>
<tr>
<th>Fiber 1</th>
<th>Blue</th>
<th>Fiber 7</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber 2</td>
<td>Orange</td>
<td>Fiber 8</td>
<td>Black</td>
</tr>
<tr>
<td>Fiber 3</td>
<td>Green</td>
<td>Fiber 9</td>
<td>Yellow</td>
</tr>
<tr>
<td>Fiber 4</td>
<td>Brown</td>
<td>Fiber 10</td>
<td>Violet</td>
</tr>
<tr>
<td>Fiber 5</td>
<td>Slate</td>
<td>Fiber 11</td>
<td>Rose</td>
</tr>
<tr>
<td>Fiber 6</td>
<td>White</td>
<td>Fiber 12</td>
<td>Aqua</td>
</tr>
</tbody>
</table>

e. Cable shall be as specified on the Engineering Drawings.]

Fiber Optic Cable – Outdoor Interbuilding (Loose Tube) Backbone:

a. Fiber optic cable shall be utilized for interbuilding runs as specified on the drawings and project specifications. Interbuilding backbone cable typically run from entrance facility to entrance facility. Cable shall be new, unused and of current design and manufacture. Fiber optic cable shall be manufactured in an ISO 9001 certified manufacturing facility.

b. Outdoor duct/aerial cable to be engineered to separate as many environmental conditions from the fiber as possible. UV inhibitors to be embedded in the outer jacket for protection against the sunlight. Cable to utilize a loose buffer design to remove any tension or pulling forces from the fibers. Proper slack of fiber within the buffer tube allows the cable to sag during temperature cycles in aerial installations. All duct/aerial cables are to be loose buffer, gel-filled and all-dielectric.

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c. Armored cables are to be suitable for direct buried installations either by being placed in an open trench or by plowing. These cables to feature rodent protection, a corrugated tape between the UV resistant outer and inner jackets and a loose buffer design to prevent damage to the fibers even during rigorous installation and external impacts. All armored cables are to be loose buffered and gel-filled.

d. 62.5/125 um Multi-Mode Optical Fiber Cable:

1) Multi-mode fiber shall be graded index optical fiber waveguide with nominal 62.5/125 um core/cladding diameter. The fiber shall comply with EIA/TIA-472 and 492 specifications.

2) Multi-Mode Fiber Optic Cable Performance Specifications:

a) Maximum Attenuation:

   = 3.5 dB per KM at 850 nm
b) Minimum Band Width:

= 200 Mhz-KM at 850 nm
= 600 Mhz-KM at 1300 nm

c) As measured per EIA/TIA-455-46, 455-51, 455-53 and 455-61 procedures.

e. **8.3/125 Single-Mode Optical Fiber Cable:**

1) Single-mode fiber shall be stepped index optical fiber waveguide with nominal 8.3/125 um core/cladding diameter. The fiber shall comply with EIA/TIA-472 and 492 specifications.

2) Single-Mode Fiber Optic Cable Performance Specifications (Unless Noted Otherwise):

a) Maximum Attenuation:

= 0.5 dB per Km at 1310 nm
= 0.5 dB per Km at 1383 nm
= 0.5 dB per Km at 1550 nm

b) Zero Dispersion:

= ≦0.093 ps/(Km-Nm\(^2\))

c) Enhanced water peak.

d) As measured per EIA/TIA-455-61, 455-78, 455-53, 455-168 and 455-175 procedures.

f. **Mechanical and environmental specifications for outdoor optical fiber cable shall be per Bell Core Specification TR- TSY-000020.**

C. **HARDWARE:**

Unless specified otherwise on the drawings or in the contract documents, interbuilding data/communication cabling system hardware shall be as specified herein. Hardware is generally categorized by the transmission media as follows:

1. **100 OHM Multi-Pair U.T.P. Cable System Hardware:**

a. Splice enclosures are to be used to encase and protect cable splices from
a wide variety of environmental conditions, and are classified for aerial, underground, buried or building application. Splice enclosures shall be determined by the application, type and size of cable, pair count and splice connectors. All splice enclosures shall be of the re-enterable type, direct buried splice enclosures shall be encapsulated. Splice enclosure shall be as manufactured by Tyco/Raychem, 3M, Marconi or Associate approved equal.

b. Splice connectors shall be of the modular (Systimax No. 710) or single (Systimax No. 709) type design, compatible with the splice enclosure as required and shall be as manufactured by Systimax, 3M, AMP or Associate accepted equal. Splices shall be made using only the manufacturer's recommended crimping tools.

c. A sheath, bonding and grounding jumper shall be installed across each splice enclosure, as required to assure grounding continuity of the sheath and enclosure. The bonding and grounding jumper shall be compatible with and as manufactured by the enclosure manufacturer or as manufacturer recommended. All abandoned or dead ended pairs shall be grounded in the splice enclosure, using an approved bonding bus bar.

d. All abandoned or dead ended pairs shall be grounded in the splice enclosure using an approved bonding bus bar.

e. Building entrance protection equipment shall be of the indoor type, sized as required for the incoming pair count. All incoming conductor pairs shall be landed on entrance protection equipment. Building entrance protection equipment shall be Systimax No. 190 for digital voice and data carrier frequency applications. Systimax No. 190 equipment inputs shall terminate by means of a splice enclosure as per noted above, outputs shall terminate on “66” wiring blocks. Plug-in protector module units are provided separately.

f. All entering telephone pairs to be terminated on entrance protectors. All unused pairs to be shorted to ground using an Systimax No. 3B1D dummy protector.

g. Plug-in protector modules are available with gas tube or solid state overvoltage protection. Type 3 modules offer overvoltage protection only, Type 4 modules have heat coils for sneak circuit protection. Plug-in protector modules as manufactured by Systimax are:

1) Type 3B1-EW: Gas tube protector, general purpose, voltage protection only; digital phone and “data user drop” use only.

2) Type 4B1-EW: Gas tube protector with 4 OHMS heater coils, voltage and sneak current protection; analog/digital phone system
side and “data user side” use.

3) Type 3C1S: Balanced solid state protector with test access, voltage protection only, as required by equipment vendor.

4) Type 4C1S: Balanced solid state protector with 4 OHMS heater coils and test access, voltage and sneak current protection, as required by equipment vendor.

5) Type 4C3S-75V: Balanced solid state protector with 4 OHMS heater coils, voltage and sneak current protection; color red, for special purpose non-ringing circuits.

6) Type 3B1D: Line grounding protector to be used for all unused non-working circuits at both ends.

2. Cross-Connect Blocks:

a. The Contractor shall furnish and install 50 pair cross-connect wiring blocks for #22 - 26 AWG conductors; Siemon #S66M1-50 or Associate approved equal, as indicated on the detailed Engineering Drawings and documents. Install cross-connect blocks on a pre-fabricated modular 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/TC’s as indicated on the detailed Engineering Drawings and documents. The pre-fabricated modular frame for 66M1-50 blocks shall be the 50M Series module as manufactured by Homaco, Inc., or Associate approved equal.

b. The Contractor shall furnish and install distribution rings (D-rings), Systimax 88A retainers, Systimax 188 B/C/D backboards, Systimax 20A/B 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; Systimax No. 13A, 13B or 13C or Associate approved equal.

3. Optical Fiber Cable System Hardware:

a. Splice Enclosures:

1) Splice enclosures are used to enclose and protect fiber optic cable splices from a wide variety of environmental conditions and are classified for indoor or outdoor applications. Splice enclosures shall utilize splice trays which are designed to offer maximum protection for both fusion and mechanical splices of loose tube and tight buffered optical fiber cable designs. The trays are to provide ample bend radius for the fiber preventing induced attenuation. A splice organizer to be mounted in the tray holds and protects the splices.
Splice enclosures shall be of the re-enterable type. Outdoor types used in duct, aerial and direct buried applications shall be encapsulatable. Splice enclosures shall be as manufactured by Tyco/Raychem, Corning or 3M.

2) Splices for 62.5/125 um multi-mode fiber optic cable shall be of the mechanical type unless noted otherwise, as manufactured by Systimax, Corning or 3M and acceptable to the Associate. Splices shall be made as per the manufacturer’s instructions, utilizing manufacturer’s recommended tools. Multi-mode fiber optic splices shall not exceed a maximum optical attenuation of 0.2 dB when measured in accordance with EIA/TIA-455-59. Mean splice loss for the assembly shall be 0.15 dB or less, when measured at 850 and 1300 nm.

3) Splices for 8.3/125 um single-mode fiber optic cable shall be of fusion type unless noted otherwise. Single-mode fiber optic splices shall not exceed a maximum optical attenuation of 0.15 dB when measured in accordance with EIA/TIA-455-54. Mean splice loss for the assembly shall be 0.1 dB or less when measured at 1310 and 1550 nm.

b. Interconnect Centers:

1) Interconnect centers are compact modular units, designed for use as building entrance terminals or in wiring closets to provide storage and protection for fiber optic connections. Unit 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 “ST” or “FCPC” style compatible connectors. The interconnect center shall be as specified on the drawings and contract documents or Associate accepted equal as manufactured by Hubbell, Corning or 3M Company.

c. Modular Fiber Optic Couplers:

1) The modular duplex “SC” coupler fittings for multimode fiber optic cable at the outlet faceplate shall be mechanically compatible with NTT-SC type and the EIA/TIA-568-B3 standard “568SC” connectors as specified or Associate approved equal. All “SC” coupler/adapters are to be provided with dust covers installed.

a) Modular "SC" couplers shall be:
b) Modular "SC" couplers shall be of the same manufacturer as the "SC" connectors.

2) The modular "FC/PC" coupler fittings for single-mode fiber optic cable shall be mechanically compatible with EIA/TIA-604-4 standard connectors with highly concentric precision Zirconia ceramic alignment sleeve as specified or Associate approved equal. All "FC/PC" coupler adapters are to be provided with dust covers installed.

a) Modular "FC/PC" couplers shall be:

(1) "FC/PC"; Amphenol P/N 94-120-6000
(2) "FC/PC"; Corning P/N TER-052

b) Modular "FC/PC" couplers shall be of the same manufacturer as the "FC/PC" connectors.

4. **Modular Fiber Optic Connectors:**

a. The multimode fiber optic interbuilding and/or intrabuilding cables shall be terminated with permanently installed connectors per EIA/TIA-455-21. The median multimode connector loss shall be 0.15 dB or less. The median single-mode connector loss shall be 0.2 dB or less. The "SC" connectors shall be mechanically compatible with the NTT-SC type and the EIA/TIA-568B3 standard "568SC" connectors. The connectors shall exhibit less than 0.2 dB change after 500 mating cycles, operating temperature range to be –40°C to +85°C. The "SC" compatible connectors shall be heat cured or UV cured epoxy adhesive type with pre-radiused precision ground ceramic ferrule and composite housing, with the following ferrule specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Diameter</td>
<td>2.5 mm (.0984&quot;) +0.5 um</td>
</tr>
<tr>
<td>Capillary Diameter</td>
<td>128 um +2/-0 um - Multimode</td>
</tr>
<tr>
<td></td>
<td>126 um +1/-0 um - Single-Mode</td>
</tr>
<tr>
<td>Concentricity</td>
<td>≤ 2 um</td>
</tr>
<tr>
<td>Out of Roundness</td>
<td>≤ 1 um</td>
</tr>
</tbody>
</table>

1) The multimode "SC" connectors shall be Amphenol P/N 954-101-5010, Corning P/N 95-100-08 or "3M" P/N 6300 with beige body or Associate approved equal. The "SC" connectors shall be installed and polished according to the manufacturers recommended instructions. All "SC" connectors shall be provided with dust covers installed.
2) Maximum optical attenuation per connector pair shall not exceed 0.5 dB per EIA/TIA-455-34 or EIA/TIA-455-59.

3) Mean connector loss for the system shall be 0.3 dB or less when measured at 1300-1310 nm.

b. The single-mode fiber optic interbuilding and/or intrabuilding cables shall be terminated with permanently installed connectors per EIA/TIA-455-21. The median single-mode connector loss shall be 0.2 dB or less. The "FC/PC" connectors shall be mechanically compatible with NTT FC Type and EIA/TIA-604-4 standard connectors, and conform to JIS-C-5970. The connectors shall exhibit less than 0.15 dB change after 1000 mating cycles, operating temperature range to be –20°C to +70°C. The "FC/PC" compatible connectors shall be heat cured or UV cured epoxy adhesive type with pre-radiused precision ground ceramic ferrule and metal housing, with the following ferrule specifications:

- Outside Diameter: 2.5 mm (.0984") +0.5 um
- Capillary Diameter: 126 um +1/-0 um – Single-Mode
- Concentricity: ≤ 2 um
- Out of Roundness: ≤ 1 um

1) The single-mode "FC/PC" connectors shall be Amphenol P/N 944-601-5006 or Corning P/N 95-250-10-BP9Y with yellow body or Associate approved equal. The "FC/PC" connector shall be installed and polished according to the manufacturer's recommended instructions. All "FC/PC" connectors shall be provided with dust covers installed.

2) Maximum optical attenuation per connector pair shall not exceed 0.3 dB per EIA/TIA-455-34 or EIA/TIA-455-59.

3) Mean connector loss for the system shall be 0.2 dB or less when measured at 1310-1550 nm.

* [4) The Contractor [shall] [may] furnish and install factory pre-manufactured and polished "ST-m/m" and/or "FC/PC"-s/m" fiber optic "pigtail" assemblies per the above specifications. "Pigtail" assemblies shall be [fusion spliced (s/m)] [mechanical spliced (m/m)] to the interbuilding fiber optic cable. The Contractor shall furnish and install Associate approved splice panels and enclosures, compatible with the specified fiber optic patch panels. Light loss budget for the spliced "pigtail" assembly shall be as noted above.]

* [5) Optical fibers utilized for fiber optic "pigtail" assemblies shall be constructed of dispersion and modal matched fiber of the identical
manufacture as the optical cable fibers. The Contractor shall provide documentation certifying the fiber match.]

*  

[6] The single-mode pigtail assemblies shall be fusion spliced in fiber optic splice trays utilizing an Associate approved fusion splicing machine. Contractor shall submit shop drawings/specification sheets for the equipment proposed to be utilized for the Associate’s review and acceptance.]

*  

[7] The fusion splices shall be protected with optical fiber heat shrink protective sleeves, 3M #2170 or Associate approved equal.]

8) The multi-mode pigtail assemblies shall be mechanically spliced in fiber optic splice trays utilizing an Associate approved mechanical splice by 3M or Corning. Contractor shall submit shop drawings/specification sheets for the equipment proposed to be utilized for the Associate’s review and acceptance.

D. DISTRIBUTION HARDWARE:

1. General:

   a. Unless specified otherwise on the drawings and detailed engineering documents, the Contractor shall provide voice, 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.

2. Distribution Rack Frames:

   a. 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 or 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, 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.

* SPECIFIER TO MAKE SELECTION

b. 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.

c. 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, as manufactured by Homaco Inc., or Associate approved equal.

d. 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.

3. Equipment Cabinets and Enclosures:

a. 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. Free standing distribution equipment cabinets shall be as specified or Associate approved equal, with accessories and features as indicated.

b. 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 or Associate approved equal, with accessories and features as indicated.

4. **Backboards:**
   
a. Furnish and install in the areas or rooms as indicated on the detailed engineering drawings and documents, for mounting electrical, electronic, data and telecommunication equipment, A/C PLUGGED-INT-APA void-free plywood sheets 48"W x 96"H x 3/4"THK in size, painted with two (2) coatings of fire retardant paint Flame Control No. 20-20 as available from Glidden, Benjamin Moore, Pittsburgh Paint and Sherwin Williams. Unless noted otherwise, plywood sheets shall be installed flush on the finished drywall, block or concrete wall, securely anchored to the building structure, and extending 4" or less from the floor or curb up the wall 8'-0". All data/communication cable conduits shall stub onto either the backboards or onto cable trays and ladder systems.

5. **Cable Trays:**
   
a. Cable trays shall be as indicated on the Engineering Drawings and sized as per Table 1 attached. Cable trays shall be center hung, facilitating loading from both sides:

   1) Industrial type, single-piece, formed aluminum trough cable tray for heavy cable loads and large cables shall be Chalfant Series 6A, as indicated on the drawings.

   2) Welded steel wire basket type cable tray shall be EZ-Tray by Cablofil, Flextray by GS Metals, or Associate approved equal as indicated on the Engineering Drawings.

   3) Single spline, welded steel hoop, hand bendable, cable trough shall be “Snake Tray” by Cable Management Solutions, as indicated on the Engineering Drawings.

   4) Cable tray installation shall meet all applicable UL standard requirements for use as an equipment ground conductor.

6. **Cable Ladder:**
   
a. Cable ladder shall be B-Line/Saunders Type “SB” aluminum cable runway with removable/relocated rungs, in standard bare aluminum finish unless otherwise noted, as indicated on the drawings. The ladder shall be installed per manufacturer's instructions, utilizing manufacturer's
accessories and components.

7. **Conduits:**
   
a. Conduits shall be installed per Raceway Specification Section 16110 of this specification except as noted. The sizes of conduits shall be as shown on the drawings, minimum size is 3/4". All conduits shall be reamed and furnished with insulating and/or grounded bushings as required.

b. Flexible steel conduits shall not be utilized for telephone/data raceway systems without specific written approval of the Associate for the application.

8. **Grounding and Bonding:**
   
a. Contractor to provide an isolated, low A.C. impedance path to ground, and a stable "0" volt to ground reference point for the data/telecommunication system. The ground system shall comply with EIA/TIA-607A standards and others as may apply, see Data/Telecommunication Grounding Specification, Section 16453 as applicable.

b. The ground conductor shall originate from the electrical service entrance ground bus, shall be sized as indicated on the drawings or in the engineering documents (#2 AWG minimum), shall be run in PVC conduit to the main teleboard, main distribution frame, main wiring closet or as indicated, terminating on an approved distribution bus bar located at/or near the telephone service entrance protection equipment. The data/telecommunication ground conductor shall be utilized to ground service entrance protection equipment, surge suppression equipment, data/communication equipment, rack frames, cabinets, raceways, etc. The ground shall be sized as noted, and extended as required to ground the Computer Room raised floor systems. The ground shall not be utilized for the electrical power distribution system ground or building lightning protection ground. The data/telecommunication ground shall meet NEC Article 250 requirements. All equipment racks, cabinets, frames, etc. shall be provided with an approved grounding lug.

c. Setscrew type and/or box lug type terminations are not acceptable for the data/telecommunication grounding system unless specifically noted otherwise. Joined segments of the data/telecommunication grounding system shall be connected using only irreversible compression-type connectors, exothermic welding, stainless steel bolt, star washers and nut connections. Crimp type lugs are not acceptable. Common zinc-cad and nickel-plated steel hardware fasteners are not acceptable. The Contractor shall provide oxide inhibiting joint compound on all compression, nut and bolt, and mechanical type terminations.
d. Interbuilding cable sheaths and armor, surge suppressors and building entrance protection equipment shall be provided with a ground lug or other means as per manufacturer’s instructions that will accommodate a grounding conductor that will provide a low D.C. resistance path to ground. The grounding conductor should not be less than #6 AWG copper, and shall meet N.E.C. Article 250 requirements. The interbuilding cables and equipment shall be bonded together via the grounding conductor which shall be bonded to data/telecommunications grounding system originating from the service entrance grounding point.

e. Upon completion of the installation of the data/tele-communication cabling system, the Contractor shall perform standard ground resistance tests with approved ground resistance test equipment and procedures as per Specification 16453

PART 3 - EXECUTION

A. RACEWAYS:

1. Cable Trays:

   a. Where indicated on the drawings and in the contract documents, cable ladders, trays and/or cable channel shall be furnished and installed by the Contractor.

   b. Cable ladders, cable trays and cable channels shall be as indicated on the drawings or Associate approved equal and sized as per Table I herein.

   c. The Contractor shall furnish and install additional cable racks, cable tray, channels and ladders per specification as required to facilitate the data/communication cabling installation. The minimum required installation is indicated on the drawings.

   d. Cable racks, trays, channels and ladders shall be installed per manufacturer's recommendations and instructions, utilizing manufacturer's accessories and components.

   e. All cable ladders, trays, channels, and supporting unistrut and brackets shall be cleanly cut with an appropriate metal cut-off saw and be clean and free of all burrs and sharp edges. Associate shall approve all fabrications.

   f. Minimum bend radius for cable tray or channel shall be 12" when utilized for data/telecommunication cables, unless noted otherwise.

   g. Cable trays and channels shall be supported from building structure above
h. The Contractor shall verify cable tray, channel and ladder loading requirements, and install the raceway system as per the manufacturer's recommendations and directions. The Contractor shall size and support the raceway system for 100% future growth and expansion.

i. The Contractor shall provide all end caps, tube caps, mounting spacers, couplings, hangers, brackets, dropouts, connectors, supports, braces, and other manufacturer's accessories and components as required to provide a complete and functional installation.

j. The Contractor shall verify with the Architect or the local building authority, the fire rating requirements of any wall or floor to be breached by a conduit, cable, raceway or other penetration as per ASTM E-119 (NFPA-251 and UL-263) standards. The Contractor shall notify the Associate, Architect and Owner in writing of all existing non-compliant conditions for resolution.

k. The presence of existing non-compliant conditions will not exempt the Contractor from meeting the installation fire rating requirements for new construction.

l. The Contractor shall provide through penetration firestops as per ASTM E-814 and UL-1479. Firestop systems shall have been tested by UL and meet the rating criteria, as published in the UL Fire Resistance Directory. The Contractor is referenced to the latest BICSI Telecommunications Distribution Methods Manual (TDMM) and EIA/TIA-569A Annex “A” for general guidelines and overview of firestop technology and methods. Contractor shall consult individual manufacturers instructions for specific application details.

m. Openings around cable trays, cable channels, conduits or in sleeves penetrating fire-rated floor slabs, walls, partitions, ceilings or smoke partitions, shall be sealed at both sides of the partition. Pack openings with calcium silicate blocks, 3M Brand Fire Barrier Caulk "CP25" and Putty "303", 3M Brand Series 7902/7904 systems for floor and walls, Nelson Flame Seal System, or an Associate accepted material having the same fire-rating as the floor or wall penetrated. Fiberglass is not acceptable.

n. All firestopping systems shall be of a single manufacturer, as manufactured by 3M, Nelson, Specified Technologies, Hilti or Associate approved equal. Contractor shall submit cut sheets with “Authority Having Jurisdiction” (AHJ) approval to the Associate for review and acceptance.
2. **Conduit:**

   a. Conduits shall be sized as per Table-1 attached or as noted on the drawings. Where sections of conduit runs are longer than 100'-0", or have more than 180° of bends, or have a reverse (greater than 90°) bend, pull boxes shall be provided and installed. Bends in conduits larger than 2", shall be long sweep bends. Unless otherwise noted, in no instance shall the inside radius of bends be less than:

      1) Six times the internal diameter for conduits 2" and smaller.
      2) Ten times the internal diameter for conduits 2-1/2" and larger.

   b. Conduits entering telephone and data closets shall terminate as close as possible to the wall through which the conduits enter, unless otherwise noted. In-floor conduits shall terminate 4" A.F.F. or curb unless noted otherwise. All conduits shall be left clean, dry and free of debris or other obstructions, with insulated grounding bushings installed.

   c. Pull boxes shall be constructed of code gauge steel, etched, primed and shall have rust resistant ANSI 61 gray finish and be NEMA 1 construction with screw covers unless noted otherwise. For conduits 1-1/4" and larger terminating in a pull box, the minimum length of pull box shall be 8 times the diameter of the largest conduit terminating in the pull box. Splice boxes shall be sized as per EIA/TIA-569A Table 5.2-3. Pull boxes and/or splice boxes shall be placed in straight sections of conduit runs and should not be used in lieu of a bend without approval of the Associate. Pull boxes and/or splice boxes shall be installed in readily accessible locations. Where boxes are installed above suspended ceilings, they shall be located immediately above the suspended ceiling or the ceiling shall have a suitably marked and hinged panel or equivalent to facilitate direct access to the box. Location and sizes of pull boxes and splice boxes shall meet the approval of the Associate. Condulate fitting shall not be used in lieu of pull boxes or full sweep bends.

   d. Conduit, sleeves and stubs through fire rated floors and walls shall be rigid galvanized steel conduit with insulated and/or grounding bushings as per specifications, sized as per the schedule herein. Conduit sleeves shall be a minimum 12" long. Install fire stop as per specifications and codes upon completion of the work.

   e. Furnish and install conduit sleeves as shown on the drawings. The sleeves shall extend 4" above the floor and a minimum of 2" below the bottom of ceiling slab. The inner edges of the sleeve at both ends shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors.
and/or insulated bushings (when occupied). Sleeves shall be installed plumb and shall be vertically aligned to provide a clear vertical pull of cable without offsets. The number, size and location of sleeves shall be as shown on the drawings.

3. Miscellaneous:

a. Raceway systems shall be bonded to the telecommunications grounding system, as per N.E.C. Article 250, EIA/TIA 607 standard and Specification 16452.

b. Provide and install a minimum of two duplex isolated ground receptacles rated 20 amp 110 volt on a dedicated circuit, on the telephone backboard, to be located as directed, 72" M.H. unless noted otherwise. Full area of the backboard shall be kept free of all pipes or conduits with a minimum of 36" depth of maintenance area in front.

c. All wiring, cabling and telephone/data equipment shall be furnished and installed by the Contractor and/or the local telephone/data/CATV company as per Specification 16751 and detailed engineering drawings and documents.

d. Provide a 1/8" nylon or polypropylene line in all conduits.

e. The Contractor shall contact the telephone/data companies before proceeding and shall coordinate his work with theirs.

f. The Contractor shall submit for Associate review and acceptance, drawings indicating cable tray, conduit or other raceway routing, size, cable fill, etc. as required to verify that the installation will meet all aspects of the Specification.

B. INTERIOR CABLE - INSTALLATION:

1. Whenever possible, primary cable and conduit routing paths shall follow the logical structure of the building (e.g. follow hallways, aisles and corridors whenever possible). 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, minimizing potential harmful field effects on the data signal from other powered devices in the area, such as fluorescent lighting, transformers and motors. Route all data/communication 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.

2. 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.

3. 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 to the maximum possible distance from such sources. In addition, running cables through the center of the building may 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 are per Table-2 herein.
### TABLE-2

**SEPARATION OF DATA/COMMUNICATIONS PATHWAYS FROM ≤480V POWER LINES**

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>MINIMUM SEPARATION DISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 2 kVA</td>
</tr>
<tr>
<td>Unshielded power lines or electrical equipment in proximity to open or nonmetal tel/comm pathways.</td>
<td>6 in</td>
</tr>
<tr>
<td>Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to open or non-metallic tel/comm pathways.</td>
<td>3 in</td>
</tr>
<tr>
<td>Unshielded power lines or electrical equipment in proximity to a grounded metal conduit tel/comm pathway.</td>
<td>3 in</td>
</tr>
<tr>
<td>Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit tel/comm pathway.</td>
<td>1/2 the trade size of the larger conduit</td>
</tr>
</tbody>
</table>

4. Cable ties and 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.

5. 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 data/telecommunication 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.


7. 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 will cause electrical characteristic alterations to the cables, which may or may not be detected by standard testing procedures. **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.**

8. Fiber optic backbone cables shall be provided with a minimum 40-foot (12 M) service loop at each end.

9. **The Cabling Contractor shall observe all minimum bend radius and tension limitations, etc. as specified by the cable manufacturer and/or the EIA/TIA standards when installing the cables.** When conflict exists between specifications, manufacturer recommendations and standards, the more stringent criteria shall apply.

10. 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 cables and the connector block terminations.

11. Where cables pass through walls, the Contractor shall provide a conduit sleeve, sized as required. 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.

12. All ceiling removal and restoration required for the execution of this work shall be the responsibility of the Cabling Contractor.

13. The Contractor shall verify with the Architect or the local building authority, the fire rating requirements of any wall or floor to be breached by a conduit, cable, raceway or other penetration as per ASTM E-119 (NFPA-251 and UL-263) standards. The Contractor shall notify the Associate, Architect & Owner in writing of all existing non-compliant conditions for resolution. The presence of existing non-compliant conditions will not exempt the Contractor from meeting the installation fire rating requirements.

14. The Contractor shall provide through penetration firestops as per ASTM E-814 and UL-1479. Firestop assemblies and systems shall have been tested by UL and meet the rating criteria, as published in the UL Fire Resistance Directory. The Contractor is referenced to the EIA/TIA-569A, Appendix A, Firestopping and the 9th edition of the BICSI Telecommunications Distribution Methods Manual (TDMM) for
general guidelines and an overview of firestop technology and methods. Contractor shall consult individual manufacturer's instructions for specific application details.

15. Openings around cable trays, cable channels, conduits or in sleeves penetrating fire-rated floor slabs, walls, partitions, ceilings or smoke partitions, shall be sealed at both sides of the partition. Pack openings with calcium silicate blocks, 3M Brand Fire Barrier Caulk "CP25" and Putty "303", 3M Brand Series 7902/7904 systems for floor and walls, Nelson Flame Seal System, or Associate accepted material having the same fire-rating as the floor or wall penetrated. Fiberglass is not acceptable.

16. All firestopping systems shall be of a single manufacturer, as manufactured by 3M, Nelson, Specified Technologies, Hilti or Associate approved equal. Contractor shall submit cut sheets with authority having jurisdiction approval to the Associate for review and acceptance.

17. All items of voice and data equipment, including racks, cables, fiber optic conductors and their respective terminations, shall be identified and labeled as indicated on the detailed Engineering Drawings and documents, and/or according to EIA/TIA-606A standard. Cable identification shall be by means of permanently applied, pre-printed wraparound wire markers (i.e. "Brady-Wrap" B-292, LAT-18, or LAT-19 self-laminating markers or Associate approved equal). These labels must withstand the requirements of UL969 as outlined in the EIA/TIA-606A standard. All interbuilding and backbone subsystem cables shall be labeled at each end. Additional cable labeling shall be required at intermediate locations, such as in pull boxes or where cables pass between floors through sleeves in a riser.

18. The Contractor shall label all cross-connect wiring blocks with pre-printed color-coded labels. Labels shall be printed with the associated user identification numbers as indicated on the detailed Engineering Drawings and documents. All cables must be terminated and labeled in sequential alphanumeric order on the cross-connect wiring blocks.

19. The Contractor shall install a permanent engraved laminated phenolic nameplate on each distribution rack frame or equipment cabinet. The nameplate shall be engraved with the distribution frame rack designation as indicated on the drawings (e.g. "IDF-5E Rack 02"). The nameplate shall have 5/16" high black gothic letters on a white background, 1/2" high x length as required.

20. All 120 VAC rack or cabinet mounted power strips, dedicated power outlets, etc. in the wiring closet and Equipment Room shall be provided with a pre-printed laminated permanently affixed legend plate. The legend plate shall be printed with 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 legend plate.
21. All labeling, nameplates, legend plates, etc. with proposed text, shall be submitted to the Associate for prior approval. "Dymo Tape Writer" labels, hand written labels, single digit tape markers, etc. are not acceptable.

22. 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.

23. Freestanding 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.

24. 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 data/telecommunication 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.

25. The cable ladder installation, when specified in the data/communication room or wiring closet, 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 data/telecommunication grounding system.

26. When vertical cable organizers are specified, 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. It is strongly suggested that the power for the power strips 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 indicated. The duplex receptacle is to be split with a dedicated circuit to each receptacle, as indicated.

27. The data/communication 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, keyswitch unit (KSU) equipment, private branch exchange (PBX) 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.

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

29. 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.

30. 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.

31. All interbuilding backbone cables, telephone riser and tie cables shall enter the wall
mounted cross-connect distribution frame at the bottom right.

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

33. Voice Riser cables shall be arranged on the cross-connect fields in numerical order by cable pair.

34. Total cooperation, coordination and communication between the different contractors, the Owner and the Associate is required for the timely scheduling and completion of all elements and components of the total installation. 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.

35. 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 data/telecommunication 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.

36. All racks, cabinets, and raceways shall be bonded to the data/telecommunication grounding system as per EIA/TIA-607 standard.

37. 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.

38. 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.
39. The Contractor shall remove at his expense, all unusable, unacceptable, or otherwise unapproved cables from the installation, no cable shall be abandoned in place without written approval of the Associate. Depending on the scope of the project cable removal shall be discussed as part of bid to determine the extent and cables to be removed.

40. Provide a minimum of one (1) meter (39") of service slack in each fiber optic conductor at each termination or splice. Slack to be coiled on the fiber storage spacer rings provided.

C. OUTDOOR/AERIAL CABLE INSTALLATION:

1. When utilizing utility company pole lines for aerial cable installations, specifications and requirements of the utility company may supersede the requirements of the drawings and specifications herein, as applicable. In either case, the more stringent specification shall prevail.

2. Outdoor/aerial cable is not normally a self-supporting. It must be supported by a messenger wire with cable lashing unless otherwise noted.

3. Provide pole protection on each non-metallic pole by means of a #6 AWG copper conductor fastened to the pole from top to bottom. Each pole grounding conductor serves as the ground path for the shield cable above and the messenger wire, and must be grounded at the pole base by means of a 5/8" diameter by 8'-0" copperweld ground rod. Minimum messenger diameter by 8'-0" copperweld ground rod. Minimum messenger diameter 3/8". See Figure 1 for a typical interbuilding aerial installation detail.

4. When metallic poles are used, the pole may serve as the ground conductor if it is suitably grounded at the base and if the messenger wire and shield cable are bonded to the pole.

5. Power lines can provided shielding for the communication lines, in lieu of a shield cable above. Shield cable shall be a 3/8" diameter utility grade, galvanized, 7-strand messenger cable. Shield cable to be located 1M (3.3 feet) minimum above the data/communication cable messenger.

6. When data/communication cables are run jointly with power cables on the same pole line, the messengers should be bonded to the multi-grounded neutral. The multi-grounded neutral may be used in lieu of the earth driven ground rod and pole grounding wire, provided the installation meets requirements of the ground potential difference and ground patch resistance tests. Bond all ground points to the power company multi-grounded neutral.

7. In order to meet requirements of the ground potential difference and ground path resistance tests, it may be necessary for the Contractor to install a buried
counterpoise ground wire below the frost line along the length of the pole line. The counterpoise to be #6 AWG or larger copper conductor and should have all pole grounds and building grounds bonded to it.

8. Aerial installation of 62.5/125 um multi-mode or 8.3/125 um single-mode fiber optic cable shall utilize a 3/8” diameter, grade 180 high strength, galvanized, 7-strand steel messenger shall be used with preformed line products, “LR” Series, galvanized steel lashing rods. Pole spacing shall be no greater than 50M (164 feet). Pole grounding conductor, ground rod, shield cable, messenger, cable sheath and armor to be bonded, as with copper media installation, for lightning protection.

D. UNDERGROUND CABLE INSTALLATION:

1. The recommended procedure for installing interbuilding data/communication cable is in underground ductbanks. Conduit duct banks shall be as per the drawings, specifications and contract documents herein.

2. The underground conduit for all data/telecommunication outdoor cable must be dry and waterproof, with the ductbank high in the middle and slopping in both directions towards the manholes for drainage. Manholes shall be provided with positive drainage.

3. Ductbanks shall be a minimum 36” below grade or below frost line. Bond metallic conduit, if used, to the grounding system at each end.

4. A minimum #6 AWG or larger ground conductor shall be run through new ductbank conduit and bonded to the grounding system at each end, and grounded by way of a 5/8” diameter by 8’-0” copperweld ground rod in each manhole.

5. It is recommended that, where possible, the conduit ductbank be dedicated to interbuilding data/communication cable systems and Class 2 and Class 3 remote control signaling and power limited circuit use only.

6. Where the ductbank cannot be dedicated as above, the ductbank and manhole system shall not accommodate power and control circuits rated over 300V. All cables passing through manholes shall have an insulation voltage rating equal to that of the highest voltage rating required. Interbuilding data/communication cables in a manhole containing Class 1, electric lighting and/or power conductors or cables shall be separated by means of a brick, concrete or tile partition, per N.E.C. Article 800.

7. When and where indicated on the engineering drawings, the ductbank should consist of four or more 4” conduit reserved for interbuilding data/communication cable use between manholes and a minimum of two 4” conduits entering the buildings. “Inner duct” of appropriate sizes should be installed in the 4” conduits as required to subdivide and compartmentalize the conduit to allow fullest utilization for present and future requirements. Conduit ductbank should be laid out with a
minimum of 3” concrete separation between conduits and an overall 3” thick minimum concrete encasement. Ductbank to be steel reinforced where passing under paved areas or subject to vehicular traffic and extending 5’-0” beyond on either side.

8. Metallic conduits shall be bonded across manholes, and grounded by means of a 5/8” diameter by 8'-0” copperweld ground rod in each manhole. Bond the manhole cover frame and all other conductive manhole components to the ground rod, utilizing a #6 AWG minimum bonding conductor.

9. The following pertains to all concrete encased ductbanks; as soon as the ductbanks are poured, and before the concrete sets up, blow a Greenlee type piston through each conduit and leave a 1/8” nylon pull cord in each conduit.

10. A 1/8” diameter nylon or polypropylene pull rope shall be installed in all conduits and inner ducts.

11. Where and when indicated on the engineering drawings, Contractor to provide, at each manhole, sufficient slack in each data/communication cable for a 15’-0” service loop above the opening. Slack cable to be Figure 8 coiled, tied, tagged and hung off the bottom on rack hooks.

12. Splices shall only be made in manholes, handholes and at approved designated locations. All cable runs are to be installed as single continuous pulls from building termination to building termination. No “in-line” connections will be permitted, splices shall be permitted as indicated on the drawings only, unless otherwise noted or with Associate’s written approval. Splice enclosures shall be supported up on the cable rack off the bottom, and identified by cable number or as indicated.

13. All data/communication cables passing through a manhole shall be tagged with a permanent type tag within 12” of each conduit entrance. The permanent tag shall be a laminated plastic or stamped metal type, attached to the cable with plastic cable ties or metal straps. Cable tag shall be submitted to the Associate for prior approval.

E. TUNNEL SYSTEM CABLE INSTALLATIONS:

1. Tunnel systems shall be dry and have provisions for positive drainage. Raceway in the tunnel system should be enclosed conduit or appropriate cable tray system per N.E.C. Article 318.

2. Where and when indicated on the engineering drawings, one or more cable trays should be dedicated for data/telecommunication, Class 2, Class 3, remote-control, signaling and power limited circuits use only. Where the tray cannot be dedicated, the tray shall not accommodate power and control circuits rated over 300V, and an approved partition shall be provided to separate the above cables from Class 1, electric lighting and/or power conductors. Separation shall be no less than 2’.
Cable fill of the tray section shall not exceed 50%.

3. A minimum #6 AWG or larger ground conductor shall be run through the tray and bonded to the tray sections and to the grounding systems at each end.

4. Metallic conduits shall be bonded to the grounding systems at each end.

5. Splices shall only be made in designated areas as indicated on the drawings. All cable runs are to be installed as single continuous pulls from building termination to building termination. No “in-line” connections will be permitted, splices shall be permitted as indicated on the drawings only, unless otherwise noted or with Associate’s written approval. Splice enclosures shall be supported on appropriate structure external to the cable tray as approved by the Associate.

6. Cable tray and conduits for interbuilding data/communication cables in a tunnel system should be a minimum of 12” from the floor to facilitate cleaning of refuse and water removal and to allow ample air circulation.
F. MISCELLANEOUS:

1. Cable Marking and Labeling:
   a. All interbuilding data/communication cables, upon entering a building and at other appropriate locations (e.g.: each end, entrance point, splice, termination, manhole, etc.) as directed by the U.T. Telcom Department, shall be tagged with a permanent type tag within 12" of each conduit entrance. The permanent tag shall be a laminated plastic or stamped metal type, attached to the cable with plastic cable ties or metal straps. Cable tag shall be submitted to the Associate for prior approval.

2. Flooded Cables:
   a. All flooded or "filled" cables shall be sealed as per the manufacturer's procedures and specifications and/or Associate approved procedure and method.

3. Exterior/Emergency Telephone Enclosure Installation:
   a. Furnish and install, as indicated on the Site Plans, a freestanding emergency phone enclosure: "Code Blue I-s", ADA compliant, vandal resistant, pedestal unit with lighted faceplate, 360° high visibility Code Blue beacon, 70W HPS area light fixture and a high powered blue strobe, 12.75" Dia. x 9'-0" High x 0.25" steel plate construction, safety blue finish, white "EMERGENCY" lettering, 277VAC-120VAC stepdown transformer, phone line and AC surge suppression, Series CB-3100 speakerphone.
   b. Exterior phone protection shall be a Systimax #110ANA1-06 multi-pair building entrance protector panel, with standard service general purpose gas tube protector modules #3B1-EW, located within 5-0" of the building entrance point.
   c. Exterior phone feeder cable to be a direct burial 6-pair, 24 AWG, filled core, RUS PE-39 rated "SEALPIC-F" with shielding as manufactured by Essex or Associate approved equal.
   d. Furnish and install, as indicated on the plans, at housing unit main entrances, a combination intercom/emergency phone. The unit shall be flush mounted, two (2) button (one intercom, one emergency phone), NEMA-3R weatherproof, 14 gauge stainless steel construction: Code Blue Model "CB IV-S", line powered with Series CB-3100 speakerphone and keypad. Provide a recessed rust proofed steel enclosure, as required.

G. SYSTEMS TESTING AND VERIFICATION:

1. General:
a. 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:

1) Continuity check of all cable, all pairs, checking for opens and shorts.

2) Determining and recording all cable lengths.

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

4) 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.

5) Test equipment model and serial number.

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

7) Completing test all data/telecommunications and fiber optic cables installed and terminated by the Contractor, including but not limited to horizontal U.T.P. voice and data cables, multi-twisted pair trunk, riser and tie cables, coaxial CATV and computer cables, and multimode/single-mode fiber optic cables as described herein.

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

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

2) Establish a base standard criteria against which the completed installation can be tested and compared to in the future, to facilitate troubleshooting and maintenance.
c. The Contractor shall provide shop drawings and/or catalog sheets describing the test equipment proposed to be utilized for the Associate’s review.

d. 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.

e. The Contractor shall prepare complete cable test reports for all installed cables for review and acceptance by the Associate prior to acceptance of the cabling installation.

f. A copy of the completed and reviewed cable test reports shall be enclosed in clear vinyl protective covers and posted in the building service entrance protection equipment area and/or as directed by the Owner/Associate for use and reference by the Owner.

g. It is strongly recommended that the Contractor 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.

2. **100 OHM Multi-Twisted Pair Telephone Exchange Cable Systems:**

   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. **100 OHM Multi-Pair Category-5, 5e O.S.P. Broadband Cable Systems:**

   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.

   b. 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. The Fluke (Micro Test) “Omni Scanner II”, Agilent Technologies
"Wire Scope-350", Fluke "DSP-4100", Fluke "DTX" or Associate approved equal with two-way injector for Adjacent and Remote “NEXT” testing shall be utilized for verification testing of cable.

c. Cable installations shall be fully tested and verified in accordance with EIA/TIA-568-B1, -B2, Level III or higher accuracy standards for Category-[5] [5e] permanent link performance. Written descriptions of the proposed calibration and testing procedures shall be submitted to the Associate for prior approval before beginning any testing.

d. The Contractor and his representative Technician shall demonstrate to the satisfaction of the Associate, a thorough knowledge and understanding of the test equipment to be utilized, and a proficiency in its operation. The Contractor shall provide a written detailed test equipment set-up procedure, indicating what and how all test parameters are entered into the tester equipment, factory default settings are not acceptable. 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.

e. 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, tied, etc.

f. 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.

g. 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

h. A copy of the final completed and reviewed cable test reports shall be enclosed in clear vinyl protective covers, and/or bound in a three-ring binder and posted in the wiring closet and/or as directed by the Associate

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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.

h. A copy of the final completed and reviewed cable test reports shall be enclosed in clear vinyl protective covers, and/or bound in a three-ring binder and posted in the wiring closet and/or as directed by the Associate
for use and reference by the Owner.

i. The Contractor shall recognize that the available programmable microcomputer based automatic scanner 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.

j. The Contractor shall reproduce the sample test forms included here-in or an Associate approved equal. The test report forms shall be completely and legibly filled out, dated, and signed by the person performing the tests and inspections. The completed forms shall be submitted to the Associate for review and acceptance.

4. 75 OHM Broadband Coaxial Cable Systems:

a. All broadband 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 microcomputer 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 ±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. With the broadband coaxial cable disconnected at both ends, test the resistance between the aluminum cable sheath and ground. Any short or low resistance between the aluminum sheath and ground shall be considered to be an indication of damage to the cable. The source of the short or low resistance to ground shall be identified and reported to the Owner/Associate. The condition shall be corrected and/or repaired, or the cable replaced as directed by the Owner/Associate at the Contractor's expense.

d. The Buckeye CableSystems, Inc. representative shall sign-off the Test Report Form acknowledging acceptance of the cable from the Contractor.

5. 62.5/125 um Multimode and 8.3 um Single-Mode Fiber Optic Cable Systems:

a. All fiber optic cables shall be fully tested for continuity and attenuation, utilizing a fiber optic power meter and fiber optic LED/laser light source. The fiber optic test equipment shall be capable of testing multimode and/or single-mode fiber cable. The LED light source shall only be utilized for 850 nm testing.

b. The fiber optic test equipment shall consist of the Siecor Handheld Fiber Optic Power Meter, Model #OTS-210-55/SC with electronic microcontroller providing automatic self-testing and data storage and the Siecor Handheld Fiber Optic LED/Laser Light Source, Model #OS-301D or Associate approved equal. The 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.

c. Fiber conductor shall be tested with the cable completely installed and in final placement, with connector installed and polished out. The "ST" and/or "FC/PC" connectors shall be inspected for proper termination techniques, workmanship, labeling, etc. and 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. Attenuation shall be recorded for each fiber at 850 and 1300 nm for multimode fiber optic cable, and at 1310 nm and 1550 nm for single-mode fiber optic cable. The measurements shall be recorded to the nearest 1/100th dB. Fiber optic cable link test procedures shall be based upon
EIA/TIA-568-B3 Annex "H" standard procedures. "Reference dB" is defined as the recurring loss associated with test equipment connections, test fiber optic jumper cords, and connections to the fiber optic cable under test. Many manufacturers of test equipment provide a means to "O", "Null" or "Tare" out, this reference dB loss from the test results. The technician performing the fiber optic verification tests should periodically check and verify the reference dB loss. It is highly recommended that the Contractor provide his fiber optic test equipment with special high quality, high performance, low loss fiber optic jumper cords for the purpose of obtaining the most accurate and consistent test results. All fiber optic "ST" and/or "FC/PC" connectors and couplers shall be thoroughly cleaned before and after testing, and dust caps installed after the test procedures have been completed.

f. 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
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)

g. 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 ANSI/EIA/TIA-526-14A, Method A.1. 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 ANSI/EIA/TIA-526-7, Method B. (NOTE: It is recognized by the Associate that this specification is much more stringent than the EIA/TIA-568-B3 Annex "H" standard.) Reflection shall be ≥ 45dB. The Contractor shall provide written descriptions of the proposed calibration and testing procedures to the Associate, for prior approval before beginning any testing.

h. Copies of the fiber optic cable testing and inspection results shall be provided in hard copy (printed form) and/or soft copy (CD-ROM or diskette) form. Test reports provided in diskette form shall include a copy of the appropriate software for managing the reports in a CSV file format or Windows-based program. Where the Contractor submits cable test verification reports generated by the microcomputer based tester, the submittal shall include a cover letter and/or cover sheet, providing all additional required information not available on the print outs or the Contractor shall complete Test Report Form 4, included herein or Associate approved equal.

i. With the Associate's approval and/or at the Associate's option, all fiber optic cable shall be tested for continuity and optical attenuation losses utilizing a fiber optic time domain reflectometer (OTDR). The fiber optic test results from the OTDR shall be submitted in both hard and soft copy (printed and CD-ROM) formats. Soft copy formatted submittals shall include Microsoft Windows data base management software preloaded with the cable test results. All fiber optic cable tests shall be performed utilizing a Siecor Model 383 OTDR or Associate approved equal. 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 all information requested, including the "Pass-Fail" test parameters as indicated in Items "a" through "q" above. Provide OTDR generated trace diagrams in addition to the generated test report in lieu of Test Report Form 4.
6. **Intrabuilding Data/Telecommunications Grounding Systems:**
   a. See Section 16453 for telecommunications grounding systems testing procedures and reporting requirements.

7. **Interbuilding Data/Telecommunications Grounding Systems:**
   a. Upon completion of the cable installation, the Contractor shall perform complete ground potential difference and ground path resistance tests. Cable tests shall include, but not be limited to:

   1) Continuity checks on each cable, checking for “opens” in and “shorts” between conductors, as well as “shorts” to ground.
   2) Cable run length.
   3) Loop resistance readings.
   4) Polarity.
   b. Unless noted otherwise, tests shall be performed with connectors, termination hardware, building entrance protection equipment (less plug-in protection modules), or surge protection installed.
   c. See the enclosed “Ground Potential Difference and Ground Path Resistance Measurement Procedure” Diagram and Report, Figure 5a, b and c.
   d. Ground potential difference and ground path resistance measurements shall be taken on each interbuilding cable. If voltage, resistance and current values are acceptable, record the measurements on Figure 5b reproductions. Only one cable measurement shall be shown on a form.

8. **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.

9. **Cabling Test Reporting Forms Included:**
   a. Form 2 – 100 OHM Multi-Twisted Pair Test Report
b. Form 3 – Coaxial Cable Test Report

c. Form 4 – Fiber Optic Test Report

d. Figure 5a – Ground Potential Difference and Ground Path Resistance Measurement Procedure

e. Figure 5b – Ground Potential Difference and Ground Path Resistance Measurement Diagram

f. Figure 5c – Ground Potential Difference and Ground Path Resistance Measurement Report

g. Figure 6 – Typical Interbuilding Aerial Installation

H. SUBMITTALS:

1. Record Drawings:

a. 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, coaxial cable system splitter and tap locations with dB values and signal levels indicating system loading and balancing, etc.

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

2. Cabling System Instruction Manuals:

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

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

2) Second Page: Index of Contents

3) Third Page: Introduction to first section containing a cross-reference to the equipment schedule and cable schedule.
4) 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.

5) 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.

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

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

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

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

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

* [Reference “Annex-G” for submittal requirements. Listings, Schedules, etc.]

END OF SECTION 16731
FIGURE 5a

GROUND POTENTIAL DIFFERENCE AND GROUND PATH RESISTANCE MEASUREMENT PROCEDURE

1. Ensure that the protection equipment in building No. "A" is grounded and inter-building cables are attached. Ground the protection equipment in building No. "B", but do not attach cables at this time.

2. In building No. "B", measure the voltage between the incoming inter-building cable shield and the protection equipment ground terminal. The voltage must be no greater than that shown on the chart in Figure 5c for the length of the run. If the voltage is greater determine the source and correct the condition before proceeding to step 3.

3. Measure the resistance between the inter-building cable shield and the protection equipment ground. The resistance must be no greater than that shown on the chart in Figure 5c.
   
   A. If the resistance is greater, measure the individual segments of the grounding system to determine the source of the high resistance and correct the condition.

   B. It may be necessary to select another ground point, or to install a bonding conductor between grounds. Figure 5b shows a typical grounding scheme and resistance values for components of the measurement path. Measure the voltage as described in step 2.

   C. If resistance and voltage values are acceptable, record with distance on Figure 5c and continue with step 4.

4. Connect the inter-building cable shield to the protection equipment in building No. "B". Measure the current on the grounding lead for the protection equipment. The current should be 1.0 amp or less if the measurements in steps 2 and 3 were acceptable.

   A. If the current is greater than 1.0 amp, go back to step 2, re-measure the voltage and resistance, determine the problem source and correct the condition.

   B. If the voltage, resistance, and current values are acceptable, record the measurements on Figure 5c and post adjacent to the inter-building cable entrance, close to the protection equipment.

5. Complete connecting the inter-building cables to the protection equipment in building No. "B".
TOTAL RESISTANCE IS THE SUM OF THE RESISTANCES OF INDIVIDUAL SEGMENTS OF THE PATH OR:

\[ R_t = R_1 + R_2 + R_3 + R_4 \]

WHERE:

- \( R_t \) = TOTAL LOOP RESISTANCE
- \( R_1 \) = OUTDOOR CABLE SHIELD RESISTANCE (1.75 OHMS / 305M [1000ft] TYP., VERIFY)
- \( R_2 \) = COUNTERPOISE OR SHIELD WIRE RESISTANCE (0.4 OHMS / 305M [1000ft] APPROX. FOR 4AWG [#6 AWG] TYP., VERIFY)
- \( R_3 \) = PROTECTION EQUIPMENT GROUND TO POWER GROUND RESISTANCE (\( \leq 0.1 \) OHMS, VERIFY)
- \( R_4 \) = PROTECTION EQUIPMENT GROUND TO POWER GROUND RESISTANCE (\( \leq 0.1 \) OHMS, VERIFY)

TOTAL RESISTANCE SHOULD NOT EXCEED THAT SHOWN IN FIGURE 5c FOR THE LENGTH OF THE RUN.

**FIGURE 5b:**  GROUND POTENTIAL DIFFERENCE AND GROUND PATH RESISTANCE MEASUREMENT DIAGRAM
CABLE IDENTIFICATION: ______________________
CABLE TYPE: ______________________
LOCATION: ______________________ TO ______________________

CLOSED LOOP CURRENT = _________ AMPS

NOTE:
OPEN LOOP POTENTIAL NOT TO EXCEED 1.0 VOLT AC
CLOSED LOOP CURRENT NOT TO EXCEED 1.0 AMP
OPEN LOOP RESISTANCE NOT TO EXCEED 7.0 OHMS

FIGURE 5c: GROUND POTENTIAL DIFFERENCE AND GROUND PATH RESISTANCE MEASUREMENT REPORT
TYPICAL INTER-BUILDING UNDERGROUND INSTALLATION FIGURE 7a

MANHOLE - PLAN VIEW

MANHOLE - ELEVATION VIEW

E.L.L.W. #1810-HR20 HEAVY DUTY HIGHWAY RATED FRAME AND BOLTED COVER, "COMMUNICATIONS"

UNISTRUT RACKING IRONS (TYP. OF 8)

PULLING IRON (TYP. OF 4)

PULLING IRON (TYP. OF 4)

12"DIA x 4"DP SUMP HOLE W/ 2" DRAIN

UNISTRUT RACKING IRONS (TYP. OF 8)

SUMP PIT

SCALE: NONE
TYPICAL DATA/TELECOMMUNICATION DUCT DETAIL

TYPICAL INTER-BUILDING UNDERGROUND INSTALLATION FIGURE 7b

SCALE: NONE
(SHEET 2 OF 2)
APPENDIX “A’ – OWNER/ASSOCIATE APPROVED MATERIAL LIST

A. CABLE

<table>
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<tr>
<th>Description</th>
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<th>Notes</th>
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<td>1)</td>
</tr>
<tr>
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</tr>
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<td>25-Pair, Type &quot;BKMA&quot;, OSP &quot;Voice Feeder&quot;</td>
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<td>1)</td>
</tr>
<tr>
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<td>#20-108-42</td>
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<td>Superior Essex</td>
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NOTES: 1) Or Associate approved equal by General Cable or Associate and Owner approved Hubbell Partner equal, offered as a voluntary alternate.
### A. CABLE (continued)

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<td>Superior Essex</td>
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</table>

### NOTES: 1) Or Associate approved equal by General Cable or Associate and Owner approved Hubbell Partner equal, offered as a voluntary alternate.
A. CABLE (continued)

1/2" Dia. 25 OHM Broadband Coax Feeder
Comm Scope #P-3-75-500-JCASS

1" Dia. 25 OHM Broadband Coax Feeder
Comm Scope #QR-860-JCASS

12-Strand Multimode, 24-Strand Singlemode, OFNR, I/O, 900 um HYBRID
Superior Essex #23036HF00 2) 3) 4)

12-Strand Multimode, 24-Strand Singlemode, OFNP, I/O, 900 um HYBRID
Superior Essex #24036HF00 2) 3) 4)

24-Strand Multimode, 12-Strand Singlemode, OFNR, I/O, 900 um HYBRID
Superior Essex #23036HF00 2) 3) 4)

24-Strand Multimode, 12-Strand Singlemode, OFNP, I/O, 900 um HYBRID
Superior Essex #24036HF00 2) 3) 4)

NOTES: 2) Minimum order quantity is 3,280 feet for custom HYBRID cable designs, specify multimode and singlemode strand counts.


4) First digit "2" indicates non-water blocked, for dry water blocking construction, change first digit from "2" to "W".

B. SPLICE ENCLOSURES, MODULES AND TERMINATIONS

Vault and riser splice enclosures (copper) 3M Type "K and B", sized as required by the Contractor.

Aerial and underground pressurized splice enclosure (copper) 3M Type "50/51P" Series, sized as required by the Contractor.

Fiber optic splice enclosure, 3M Type 2178-L/S, sized as required by the Contractor.

24-Port Unloaded Patch Panel
Hubbell #UDX24E 1)

48-Port Unloaded Patch Panel
Hubbell #UDX48E 1)

19" Rear Cable Management Bar
Hubbell #MCCSWB19 1)

Fiber Optic Rack Mount Panel, 6-6 Pack
Hubbell #FCR350SP36 1)

Fiber Optic Wall Mount Panel, 4-6 Pack
Hubbell #FCW12SP 1)

NOTES: 1) Or Associate and Owner approved equal by Levitron, offered as a voluntary alternate.
B. SPLICE ENCLOSURES, MODULES AND TERMINATIONS (continued)

Unloaded 6 Pack Adapter Panel, ST/FC-PC Hubbell #FSPST6X 1)
Fiber Optic Splice Panel – 2 Tray Hubbell #FSS01 1)
Fiber Optic Splice Enclosure – 6 Tray Hubbell #FCR350SE 1)
24 Fiber, Fusion Splice, Splice Tray Hubbell #STRAY 24F 1)
24 Fiber, Mechanical Splice, Splice Tray Hubbell #STRAY 24M 1)

NOTES: 1) Or Associate and Owner approved equal by Levitron, offered as a voluntary alternate.

C. BUILDING ENTRANCE PROTECTION AND MODULES

6-Pair Type 110ANA Systimax #110ANA1-06 Com Code #105-736-482
25-Pair Type 110ANA Systimax #110ANA1-25 Com Code #105-736-490
50-Pair Type 190 Systimax #190A1-50 Com Code #102-995-073
100-Pair Type 190 Systimax #190A1-100 Com Code #102-995-099
Protector Module – Gas Tube W/O Heat Coils Systimax #3BI-EW Com Code #104-410-147
Protector Module – Gas Tube W/O Heat Coils Systimax #4BI-EW Com Code #104-401-856
Protector Module – Solid State W/O Heat Coils Systimax #3CIS Com Code #105-514-756
Protector Module – Solid State W/ Heat Coils Systimax #4CIS Com Code #104-386-545
Protector Module – Solid State W/ Heat Coils 75 VOC Systimax #4C35-75V Com Code #105-581-086
Protector Module – Shorten, Dummy Systimax #3BID Com Code #106-209-224
C. BUILDING ENTRANCE PROTECTION AND MODULES (continued)

25-Pair Splicing Modules
3M #MS² 4000 TR or
4000 DWP/TR W/ Sealant Box As Required

50-Pair "66MI-50 Block"
Siemen No. #S66M1-50, Mounted on a "89B Bracket"
Siemen #S89B

END OF APPENDIX “A”