1.1 Scope of work

1.1.1 The extent of the Interbuilding Fiber Optic Cabling Installation (The Project) will include the following as shown on the Drawings or as Specified herein.

1.1.2 Installation, testing, labeling and documentation of new interbuilding fiber optic communication cable between buildings as specified herein and on the Drawings.

1.1.3 The installation environment will include existing BDFs, existing underground concrete encased duct, existing direct-buried conduit, existing utility tunnel pathways, as well as areas of Purdue University property which will require directional boring, and/or trenching to facilitate direct burial of cable and conduit to be completed by the Contractor. The Contractor shall not be responsible for the installation of concrete-encased ducts, or utility tunnels.

1.1.4 The Contractor shall be responsible for: placement of cable, attachment cable to support devices within the utility tunnel system and underground structures, placement of conduit, metallic pull-boxes (NEMA Type 3R), furnishing fiber optic splice closures and performance of splices, installation of termination hardware and enclosures, termination of individual fiber strands, labeling, testing and documentation of the work.

1.1.5 The Contractor shall be responsible for the provision of grounding and bonding materials, duct plugs, and fire-stopping materials as appropriate. Other incidental hardware and appliances, necessary for the proper performance and operation of the communication cable system, which are consistent with the practices of underground cable installation, are to be provided by the Contractor at no additional charge to the Owner.

1.2 Coordination

1.2.1 Contractor shall coordinate the work specified in this Section with the work in other parts of the Contract document.

1.2.2 Plans in general are diagrammatic. It is the full responsibility of the Contractor to be familiar with the location of equipment involved under the work of other trades to eliminate conflicts between the fiber optic cable installation and the work of other trades.

1.2.3 All questions and issues with regard to coordination shall be directed to the Purdue IT Infrastructure Services Representative.

1.3 Submittals

1.3.1 All submittals for substitutions shall be made to the Purdue IT Infrastructure Services Representative.

1.3.2 The Contractor shall submit a cable pulling plan for all fiber cables that includes, but is not limited to, the following:
   - Each cable run and route.
   - Date and duration of the pull.
   - Pulling methodology and equipment setups.
   - Pulling tension calculations for each pull in the run.
   - Safety issues and precautions to be taken.

1.4 Quality Assurance

1.4.1 Verification: The Owner will maintain inspection personnel on the job site. It is incumbent upon the Contractor to verify that the installation and material used has been inspected before it is enclosed within building features, or otherwise hidden from view. The Contractor shall bear costs associated with uncovering or exposing installations or features that have not been inspected.
1.5 Substitutions

1.5.1 Submit requests for substitutions within 10 days of contract award, or sooner if required to maintain the construction schedule.

1.5.2 The Contractor must submit sufficient information to show that a proposed substitute is equivalent to the item specified. Acceptance of substitutions is at the discretion of the Purdue IT Infrastructure Services Representative; this Representative reserves the right to determine suitability of the substitute product and reject any and all materials submitted for substitution. All substitute products and materials must be approved for substitution by the Purdue IT Infrastructure Services Representative in writing prior to installation. Products rejected or otherwise judged unsatisfactory by the Purdue IT Infrastructure Services Representative will not be authorized for use in completing the Work. Any unapproved products discovered as part of the installation will be removed and replaced with Purdue IT Infrastructure Services Department-specified and approved products at the Contractor's expense.

1.5.3 Project Drawings may be based on equipment configuration of a particular manufacturer. If a substitution is approved, the Contractor shall make changes needed to accommodate the substitution at no expense to Purdue University, including work under other divisions.

1.6 Intent of the drawings and specifications

1.6.1 Where specified only by reference standards, select any product meeting standards by any manufacturer.

1.6.2 Where specified by naming several products or manufacturers, select any product and manufacturer named that meets the specified requirements. Other products and manufacturers will not be considered.

1.6.3 Where specified by naming one or more products or manufacturers, but indicating "or equivalent" after specified listing, the specified product is the preferred quality standard. The Contractor may submit a request for another product for acceptance.

1.6.4 Where specified by naming only one product and manufacturer: “There is no option and no substitution” will be allowed.

1.7 Communication

1.7.1 It is Purdue’s expectation that the A/E of Record will work jointly with Purdue’s Telecommunication representatives to address specific technical issues and Owner requirements.

1.7.2 All questions, deviations, comments concerning guideline(s) interpretation, content, and/or use must be submitted in writing to the Project Manager for approval.

1.7.3 No deviations from these guidelines shall be incorporated into the project without written approval from the Project Manager and Purdue Telecommunications representative.

PART 2 PRODUCTS

2.1 General

2.1.1 The materials and products specified herein reflect the minimum acceptable standards of fabrication and manufacture.

2.1.2 All materials and products supplied by the Contractor and specified herein are to be new, unused, of first quality and in original packaging or shipping containers.

2.1.3 All unused cables purchased for this project longer than 500ft will be surrendered to the Purdue IT Infrastructure Services Department.

2.2 Outside Plant Fiber Optic Cable
2.2.1 The Project will require the installation of outside plant single-mode (SM) and/or Laser-Optimized Multimode (LOMM) fiber optic cable in various outside plant environments. Acceptable manufacturers must utilize Corning Glass Core. These include CommScope, Corning, General Cable, Superior Essex, or owner-approved equals.

2.2.1.1 Optical Characteristics – Single-mode fiber optic cable

- Fiber optic glass core must be manufactured by Corning
- 8.3µm/125µm single-mode optical fibers
- Attenuation:
  - 0.35dB/km @ 1310 nm
  - 0.25dB/km @ 1550 nm

2.2.1.2 Optical Characteristics – 50µm/125µm multimode optical cable

- Fiber optic glass core must be manufactured by Corning
- Attenuation:
  - 3.5 dB/km @ 850 nm;
  - 1.0 dB/km @ 1300 nm
- Bandwidth:
  - 160 MHz/km @ 850 nm
  - 500 Mhz/km @ 1300 nm

2.2.1.3 Mechanical Specifications

- Maximum tensile loading:
  - Installation: 2700 N (600lb/ft)
  - Long term installed: 890 N (200lb/ft)
- Operating Temperature:
  - Storage: 40°F to +70°F (-40°C to +158°C)
  - Long Term: 40°F to +70°F (-40°C to +158°C)
- Minimum bend radius (12 and 48 strand armored fiber optic cable):
  - Loaded: 8.9 inches
  - Installed: 6.0 inches
- Minimum bend radius (12 and 48 strand all-dielectric fiber optic cable):
  - Loaded: 7.0 inches
  - Installed: 4.6 inches

2.2.1.4 Mechanical Construction – armored fiber optic cable for direct-buried installation. Construction shall conform to Single Sheath/Single Armor Cable.

2.2.1.5 Mechanical Construction – cables entering a building beyond 50’ shall be rated for indoor/outdoor installation.

2.2.1.6 Fiber strand counts for each cable type as specified herein or on the Drawings.

2.2.1.6.1 All dielectric fiber optic cable for installation within underground facilities.

2.2.1.6.2 Armored fiber optic cable for direct-buried installation.

2.2.1.6.3 All dielectric fiber optic cable for installation within buildings shall be rated for indoor/outdoor use.

2.2.1.7 Color codes for fiber optic cable
2.2.1.7.1 Cable shall be assembled to ensure that no more than 12 fiber strands occupy each buffer tube.

2.2.1.7.2 Buffer tubes and individual strands shall be color coded as follows:

<table>
<thead>
<tr>
<th>Number</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blue</td>
</tr>
<tr>
<td>2</td>
<td>Orange</td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
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<tr>
<td>4</td>
<td>Brown</td>
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<td>5</td>
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<td>10</td>
<td>Violet</td>
</tr>
<tr>
<td>11</td>
<td>Rose</td>
</tr>
<tr>
<td>12</td>
<td>Aqua</td>
</tr>
</tbody>
</table>

2.3 Fiber Optic Connectors

2.3.1 For all fiber optic terminations, Type SC connectors, as specified in TIA/EIA 568A shall be used.

2.3.2 Single-mode connectors:
- Corning #95-200-42 Ultra-polished Unicam SC connector

2.3.3 Laser Optimized Multimode connector
- Corning #95-050-41 Laser Optimized Unicam SC connector

2.4 Fiber Optic Loose Tube Cable Furcation Kit

2.4.1 Corning Buffer Tube Fan-Out Kit – 12 fiber, indoor and outdoor cable.
- Corning #FAN-BT25-12 for installation into CCH connector modules and WIC enclosures.

2.5 Fiber Optic Termination Enclosures and Associated Hardware

2.5.1 Pre-Connectorized Corning #CCH-04U with 288-strands of fiber with LC connectors and (1) 200ft 288-Strand stub for splicing.
- Corning #CH4U86224A9-WF001B

2.5.2 Pre-Connectorized Corning #CCH-04U with 288-strands of fiber with LC connectors and (2) 200ft 144-Strand stubs for splicing.
- Corning #CH4U86224A9-WF002B

2.5.3 Pre-Connectorized Corning #CCH-02U with two (2) 24-strands of fiber with LC connectors and two (2) 32ft 24-Strand stubs for splicing.
- Corning #CC248101259-CF002B

2.5.4 Wall mounted enclosures at each end point (i.e., BDF and IDF) shall be:
2.5.4.1 One (1) Corning Cable Systems #WIC-02P per 12/24-strand multimode or single-mode fiber optic cable. Enclosures for laser optimized multimode fiber to be complete with laser optimized multimode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-E7. Enclosures for single-mode fiber are to be complete with single-mode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-59.

2.5.4.1 One (1) Corning Cable Systems #SPH-01P per 12-strand multimode or single-mode fiber optic cable. (1) Corning Cable Systems #SPH-02P per 24-strand multimode or single-mode fiber optic cable. Enclosures for laser optimized multimode fiber to be complete with laser optimized multimode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-E7. Enclosures for single-mode fiber are to be complete with single-mode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-59.

2.5.5 Rack mounted enclosures at the BDF shall be:

2.5.5.1 One (1) Corning Cable Systems #CCH-02U housing at the top of the equipment frame for OSP fiber optic termination for 48-strand fiber or less. Enclosures for multimode fiber are to be complete with multimode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-E7. Enclosures for single-mode fiber are to be complete with single-mode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-59.

2.5.5.2 One (1) Corning Cable Systems #CCH-04U housing at the top of the equipment frame for OSP fiber optic termination for more than 48-strands of fiber. Enclosures for multimode fiber are to be complete with multimode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-E7. Enclosures for single-mode fiber are to be complete with single-mode connector panels with SC adapters, Corning Cable Systems #CCH-CP12-59.

2.5.5.3 One (1) Corning Cable Systems #CJP-02U fiber wire management shall be installed directly below the CCH panels for fiber management.

2.5.6 Purdue IT Infrastructure Services Representative shall provide size and location for mounting enclosures if not shown on drawings.

2.6 Fiber optic fusion splices shall be performed in underground facilities, therefore splice enclosures designed for use in an outside plant environment shall be used.

2.6.1 Preformed Line Products #8006561, 8.5”x22.0” Coyote splice enclosure with Preformed Line Products #80805105 end cap(s).

2.6.1.2 Preformed Line Products #8006560, 6.0”x22.0” Coyote splice enclosure with Preformed Line Products #80805105 end cap(s).

2.6.1.3 Preformed Coyote Fiber Optic Splice Closures Kits, sized as required for the maximum fiber count within the splice case including distribution fibers.

2.6.1.3.1 Preformed Line Products #8001127 low profile splice trays shall be used with Preformed Line Products fiber optic splice closures. Splice only 24 fibers per splice tray (no exceptions, unless with written approval prior to installation).

2.6.1.3.2 Preformed splice trays are to be labeled with a permanent black (Sharpie) marker on the front face of each splice tray indicating fiber count.

2.6.1.4 Support bracket kits for a Preformed Line Products Splice Case, sized as required for fiber count. Preformed Line Products #8003279 will support the splice case in maintenance holes, handholes and vaults.

2.6.1.5 Utilize Preformed Line Products #8003717 heat shrink splice protector for each fiber that has been fusion spliced.
2.7 Innerduct

2.7.1 Innerduct will be installed in specified ducts as indicated herein. Innerduct shall be either:

2.7.1.1 Molded in yellow polyethylene and be of smooth walled configuration. Each innerduct placed by the Contractor shall have a one-quarter inch polyethylene pull rope placed within the innerduct secured at each end.

2.7.1.2 Flexible fabric type innerduct manufactured with pulling tape in all cells.

2.8 Innerduct Couplers

2.8.1 Aluminum threaded innerduct couplers to be used to join two segments of corrugated innerduct together. Non-metallic couplers are not acceptable.

2.9 Duct Plugs

2.9.1 Split Triplex Duct Sealing Plugs to be installed in 4-inch ducts containing Contractor-installed 1-1/4 inch innerducts.

2.9.2 Innerduct Sealing Plugs to be used to seal used and unused innerducts. These are to be used in conjunction with triplex duct sealing plugs.

2.10 Fiber Optic Cable Labels

2.10.1 Label each fiber optic cable with a 1/2” wide, yellow, thermal self-adhesive label with Black lettering.

2.10.2 Label each fiber optic coil along cables with a Yellow self-laminating cable marker holder.

• Panduit #SLCT-YL or Owner approved equal.

PART 3: EXECUTION

3.1 Telecommunications Installation

3.1.1 This Section describes the installation locations for the products and materials, as well as methods and Owner’s Standards associated with the Telecommunications Installation portions of the Project. These Specifications, along with the Drawings and other Owner-supplied specifications shall be followed during the course of the installation.

3.1.2 The Contractor is instructed to coordinate his efforts with other tradesmen who may be working within the same vicinity to avoid conflict, lost time and potential injury. The Owner will assist in coordination as requested or as required.

3.1.3 The Contractor is to install all materials plumb, square and in a workman-like manner.

3.1.4 The Contractor is required to supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.

3.1.5 The Contractor shall comply with all National, Indiana State, Local and Purdue University Codes and Standards during the course of installation. Should any portion of these Specifications conflict with said Codes, the Contractor is to cease work on that particular aspect of the Project and notify the Owner immediately.

3.1.2.1 Fixed facility locations shown on the Drawings are based upon the latest design information available at the time this Specification was prepared. The Contractor shall conduct field inspections to determine the actual as-built locations of conduits, manholes,
3.1.3 All telecom rooms, underground structures (include utility tunnels), conduit and
manhole systems, handholes and related infrastructure shall be kept as clean as possible
during installation. Labor required for any cleaning work shall be provided by the
Contractor.

3.1.3.2 Telecom rooms, underground structures (include utility tunnels), conduit and manhole
systems, handholes and related fixtures, shall be thoroughly cleaned, flushed out, or
blown out before the installation is offered to the Purdue IT Infrastructure Services
Department for acceptance.

3.1.3.3 Temporary Work. Temporary labels, temporary protection and related items shall be
removed and the entire installation left in a clean, usable condition.

3.2 Fiber Optic Innerduct Installation

3.2.1 All ducts and conduits intended for use as a pathway will be blown out with
compressed air or brushed out to remove dirt, water, and other residue prior to cable and
innerduct installation.

3.2.2 Innerduct in utility tunnel shall be mounted on dedicated 6M strand messenger.

3.2.2.1 The Contractor shall install 3 innerducts within any of the 4-inch conduits used for
communication cable installed during this Project. Innerduct will be provided by the
Contractor as required, under the following conditions:

3.2.2.2.1 There is no existing innerduct installed in the conduit.

3.2.2.2.2 There is no existing cable installed in the conduit.

3.2.2.2.3 Multi-cell duct is not available as a pathway.

3.2.2.2.4 3 innerducts will be installed in any duct which is to hold any combination of:
1, 2 or 3 cables.

3.2.2.2.5 Innerduct will not be installed in any duct which does not carry cable installed
in conjunction with this Work.

3.2.2.2.6 Innerduct is not to be installed within empty conduits slated for future use or
expansion.

3.2.2.3 Innerducts will be cut to allow approximately 6 inches of excess material to extend
beyond the end of the duct.

3.2.2.4 Innerducts are to be contiguous sections end to end. If it is absolutely necessary to
splice innerduct together, use aluminum couplers as specified herein.

3.2.2.5 Secure innerduct pull-ropes by cutting a slit into the excess duct and wedging the pull-
rope in the slit. Tie off excess slack around the duct.

3.2.2.6 Install a triplex duct plug into each end of the duct used according to the
manufacturer’s instructions.

3.2.2.7 Install a simplex duct plug over the cable and secure the plug as instructed by the
manufacturer.

3.2.2.8 Install a blank plug in unused innerducts.
3.3.1 Where required as part of the installation, the Contractor shall perform fusion splices of fiber cable.

3.3.1 Prior to sealing spliced cables into a fiber optic splice enclosure, the Contractor shall perform a power meter testing and OTDR testing on each individual fiber as described in herein. The attenuation measurement is to be compared to the link loss calculation for the segment in question. Measured attenuation through the splice is not to exceed 0.2 dB. Splices that exceed this level will be broken, re-spliced and retested by the Contractor until the minimum reading is attained.

3.3.2 After performing the fusion splice, the splice technician shall examine each splice under a 100X power microscope. Splices with a “neck-down” (narrowing) effect, with an oversized bulge at the splice location, or which contain gas bubbles, dirt, or other aberrations shall not be acceptable.

3.3.3 The spliced fibers are to be installed within a fiber optic splice tray according to the manufacturer’s specifications.

3.3.4 The fiber optic splice closure will be sealed to be air-tight as specified by the manufacturer. No encapsulant shall be injected into closures after splices are completed. Sealed closures are to be secured to the wall of the manhole using appropriate hardware.

3.3.4.1 Upon entering the BDF, the fiber optic cable shall be routed to the termination location as shown on the drawings.

3.3.4.2 A length of 25 feet of slack cable shall be coiled just outside the building while maintaining a minimum of 2 times the minimum bend radius. The cable shall be secured to the BDF wall or other specified location using Velcro cable-wrap brackets.

3.3.4.3 The end of the cable, shall be routed to the wall mounted enclosure of frame mounted for furcation and termination. Leave 6ft of buffer tube in the fiber optic enclosures. Secure the cable to the wall or equipment frame using Velcro cable wraps.

3.3.5.1 Prior to termination, fiber optic cable strands will be furcated (fanned out) using the specified furcation kits and using the procedure specified by the manufacturer.
3.3.6.1 Where specified, the Contractor shall terminate the individual fiber strands with SC-type connectors according to the manufacturer’s specifications.

3.3.6.2 Upon final testing, mated-pair connector attenuation shall not exceed 0.75 dB. Connectors which exceed this level of attenuation shall be cleaned and retested. If they continue to exceed the limit, they shall be cut off and re-terminated by the Contractor.

3.3.6.3 Terminated fibers shall be installed within a wall mounted fiber enclosure or a frame mounted fiber enclosure as specified on the Drawings.

3.3.7.1 Loop the fiber once around the manhole or handhole in addition to a coil as shown on drawings or as specified herein.

3.4 Fiber Optic Cable Testing

3.4.1 Scope of Work - Work covered by this Paragraph shall consist of furnishing labor, equipment and supplies unless otherwise specified, and in performing the following operations recognized as necessary for the successful testing and verification of the installation of the Fiber Optic cable plant described on the Drawings and required by these specifications. All Fiber testing shall conform to the latest TIA specifications. In addition, the Contractor shall:

3.4.1.1 Verify through Optical Time-Domain Reflectometer (OTDR) testing as well as visual inspection of manufacturers testing results utilizing a Fluke OTDR, the quality of the fiber optic cable being installed.

3.4.1.2 Verify through power meter testing the attenuation of all point to point fiber optic strands using a Fluke Networks Power Meter and Source.

3.4.1.3 Verify through OTDR testing the integrity of the point-to-point connections utilizing a Fluke OTDR, the final installed connector-to-connector length of the fiber optic strands.

3.4.1.4 Verify through visual inspection of all fiber optic cable termination locations on Drawings, the integrity of the workmanship and the operability of the fiber optic media.

3.4.2 Contractor Responsibility; the Contractor shall:

3.4.2.1 Coordinate a meeting with Purdue IT Infrastructure Services Department to discuss testing procedures, equipment, documentation, etc. to verify to the owner a complete understanding of requirements and schedule.

3.4.2.2 Complete quality control inspection and testing per this Specification.

3.4.2.3 Maintain fiber optic test technicians qualified to operate the test equipment (to be used) on the job site during testing.

3.4.2.4 Maintain test equipment in current calibration during testing operations.

3.4.2.5 Notify the Purdue IT Infrastructure Services Representative 48 hours in advance when work, technicians and equipment are prepared for Acceptance tests and inspections. Coordinate testing with the Purdue IT Infrastructure Services Representative beforehand to avoid delays in the Project schedule.

3.4.2.6 Maintain electronic file of tests pertinent for each fiber run and upon completion of testing, assemble and certify a final test report.

3.4.2.6 Maintain safety procedures and discipline when test equipment is emitting optical energy.
3.4.3.1 Contractor will submit specification sheets for the test equipment to be utilized for approval to the Purdue IT Infrastructure Services Department prior to commencement of testing.

3.4.3.2 Calibration

3.4.3.2.1 The Contractor is to ensure all test instruments are calibrated to provide measurements within stated accuracy.

3.4.3.2.2 Visible, dated calibration labels will be affixed to test instrumentation. Calibration will have been performed within 12 months of current testing operation.

3.4.3.2.3 The Contractor shall be prepared to present accurate records that indicate the calibration history of the equipment. The records should include the date and results of instruments calibrated or tested.

3.4.4 Acceptance Procedures:

3.4.4.1 Purpose: The following acceptance practices will be followed to ensure that should the incorrect products be received, should damage to the cable have occurred during shipping and handling; the Contractor can reorder replacement materials as soon after determination of the product’s unsuitability as possible to minimize the impact to the installation schedule.

3.4.4.2 The Contractor shall visually inspect fiber optic cable reels for damage upon receipt from the shipper.

3.4.4.3 Part numbers on cable reel shipping labels, bills of lading, invoices, etc., shall be compared to the original order.

3.4.4.4 Cable lengths should be verified.

3.4.4.5 The manufacturer’s OTDR measurement records received with the shipment shall be examined to ensure compliance with stated attenuation performance.

3.4.4.5.1 The Contractor will either accept and guarantee the OTDR and loss measurements provided with the cable or will make their own test before acceptance.

3.4.4.5.2 The OTDR readings will be provided for all the fibers in each spool of fiber optic cable. Readings will be taken at the 850 nm, 1300 nm windows for multi mode fiber and 1310 nm, 1550 nm windows for single-mode fiber.

3.4.4.6 The Contractor will retain the manufacturer’s test data and provide it, along with all other specified test documentation to the Purdue IT Infrastructure Services Department at the completion of the Project.

3.4.4.7 The following test procedures will be performed for all fiber optics cable installations. No variance can be obtained without a request to the Purdue IT Infrastructure Services Department explaining the reasons for the request. Verbal approvals will not be accepted or provided.

3.4.5.2 All readings will be taken end to end (SC to SC) in both directions on every fiber terminated at both ends, without exception.

3.4.5.3 Fiber optic cable that is left un-terminated at both ends shall be tested using a launch cable and bare fiber adapter.

3.4.5.4 Fiber optic cable that is left un-terminated at one end shall be tested at the connector end using an OTDR.

3.4.5.5 The Purdue IT Infrastructure Services Department is to be notified at least 48 hours prior to testing to allow 100% observation at the Owner’s discretion. If the Purdue IT
Infrastructure Services Representative confirms their intention to observe, a reasonable starting time will be agreed upon. Should the Representative not be present at the scheduled commencement time, the Contractor may begin testing as scheduled.

3.4.6 Maximum Acceptable Attenuation Values (Table 2)

<table>
<thead>
<tr>
<th>Fiber Type</th>
<th>Test Wavelength</th>
<th>Mated Pair Connector Loss (each)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50/125 Multimode</td>
<td>850nm</td>
<td>0.75 dB</td>
</tr>
<tr>
<td>50/125 Multimode</td>
<td>1300nm</td>
<td>0.75 dB</td>
</tr>
<tr>
<td>Single-mode</td>
<td>1310nm</td>
<td>0.75 dB</td>
</tr>
<tr>
<td>Single-mode</td>
<td>1550nm</td>
<td>0.75 dB</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiber Type</th>
<th>Test Wavelength</th>
<th>Fusion Splice Loss (each)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50/125 Multimode</td>
<td>850nm</td>
<td>0.3 dB</td>
</tr>
<tr>
<td>50/125 Multimode</td>
<td>1300nm</td>
<td>0.3 dB</td>
</tr>
<tr>
<td>Single-mode</td>
<td>1310nm</td>
<td>0.3 dB</td>
</tr>
<tr>
<td>Single-mode</td>
<td>1550nm</td>
<td>0.3 dB</td>
</tr>
</tbody>
</table>

3.4.7 Optical Time-Domain Reflectometer (OTDR) Testing

3.4.7.1 After all terminations have been completed; tests will be conducted using an OTDR prior to testing with a power meter set (optical light source and optical meter). Contractor will test insertion loss of 850 nm and 1300 nm for Multimode cable; and at 1310 nm and 1550 nm wavelengths for Single-mode cable, for both directions through each connector pair using the OTDR. Use of an OTDR determines overall length and pinpoints loss locations along the segment being tested by indicating their distances from the source. The Contractor will use the OTDR traces to assess the span attenuation that is necessary to evaluate the final acceptance tests utilizing the power meter test set(s). The power meter test measures overall attenuation of each span; this test also determines whether terminations are not within specified quality limits.

3.4.7.2 OTDR Testing and the Span Loss Benchmark Calculation

3.4.7.2.1 Span Loss Benchmark Calculation. The estimated attenuation (loss) must be calculated for each fiber segment to determine a comparison value for the actual readings during the power meter test. This calculation is derived from the original reel tests performed at the time of cable acceptance.

3.4.7.2.1 In general, the OTDR traces must be interpreted to determine the length of each cable segment. Both ends of the span are terminated with an SC connector. In the following example the test is performed on multi-mode fiber at 850nm. At the conclusion of the test, the trace for the span (end-to-end) is interpreted as follows:

| Segment 1 is a fiber segment measured from termination-to-termination. |
|---------------------------------------------------------------|-----------------|
| Distance of Segment 1 (per OTDR trace)                       | 125 meters      |
| Pre-Installation Attenuation Acceptance Test                | 2.90 dB/km      |
Calculation: 125 m x 0.0029 dB/meter 0.36 dB

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated loss value for Segment 1:</td>
<td>0.36 dB</td>
</tr>
<tr>
<td>Mated pair connector loss: 0.75 dB (per pair)* X 2</td>
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</tr>
<tr>
<td>Maximum allowable loss for the span</td>
<td>1.86 dB</td>
</tr>
<tr>
<td><strong>The Span Loss Benchmark Calculation for this span:</strong></td>
<td><strong>1.86 dB</strong></td>
</tr>
<tr>
<td>The benchmark calculation for the span is to be compared with the reading taken on the span with the power meter in final acceptance testing.</td>
<td></td>
</tr>
</tbody>
</table>

3.4.7.3 Power Meter Testing

3.4.7.3.1 All testing done with a light source and power meter shall be done such that the loss of any cables or connections used to interface the fiber to be tested to the instruments is measured and subtracted from the total loss of the fiber optic circuit. For testing the finished installation, the instrument(s) shall be "front ended" with SC connectors so that the testing includes the interface to the SC bulkheads in the fiber termination panels.

3.4.7.3.2 After termination of all the individual fibers, power meter readings will be taken. The attenuation of readings must not be higher than the optimal attenuation loss. The optimal attenuation loss will be calculated using the manufacturer's factory certified fiber test reports (dB/km) converted to the actual installed lengths plus the attenuation losses for the SC connector of 0.75 dB per mated connector pair. The optimal attenuation losses shall be used for comparison with the end-to-end power loss test results prior to acceptance by the Purdue IT Infrastructure Services Representative.

3.4.7.3.3 If any reading is higher than 0.10 dB over the optimal attenuation loss, the Purdue IT Infrastructure Services Representative must be contacted for acceptance. If the loss is not acceptable, then the contractor must re-terminate the fiber to obtain acceptable loss levels. This will be done at the Contractor's expense. Records of fiber loss must be maintained and provided for system acceptance by the Purdue IT Infrastructure Services Representative.

3.4.7.3.4 The Purdue IT Infrastructure Services Representative is to be notified at least 48 hours prior to testing to allow 100% observation at the Owner’s discretion. If the Purdue IT Infrastructure Services Representative confirms their intention to observe, a reasonable starting time will be agreed upon. Should the Owner not be present at the scheduled commencement time, the Contractor may begin testing as scheduled.

3.4.7.4 Test Report Submittals

3.4.7.4.1 The Contractor shall submit a completed hard copy Fiber Optic Cable Test Report as well as test results on compact disk to Purdue’s IT Infrastructure Services Department for review prior to the Owner’s acceptance of the work.

3.4.7.4.2 The electronic Fiber Optic Cable Test Report shall be compiled in .flw format using the latest version of Fluke Networks Linkware.

3.4.7.4.3 Fiber optic cable test reports shall be delivered to the Purdue IT Infrastructure Services Department for loss @ 1310nm and 1550nm for all single-mode fiber strands and 850nm and 1300nm for all multimode fiber strands. Test results shall not require any proprietary software to view the results.
3.4.7.4.4 Loss budget calculation shall be shown on the Fiber Optic Cable Test Report.

3.4.7.4.5 Substantial Completion will not be given without the final test results submitted and approved by the Purdue IT Infrastructure Services Department.

3.5 As Built Information

3.6 Labeling

3.6.1 Table 3.02 C, Fiber Optic Backbone Cable Labeling Scheme

3.6.1.1 Figure 1 (below) is an example of labeling for a single-mode fiber optic cable installed between the LYNN (East Node) and the Visual and Performing Arts (PAO).

3.6.1.2 Figure 2 (below) is an example of labeling for a multimode fiber optic cable installed between The Math Sciences Building (MATH) and Hovde Hall (HOVD).

3.6.1.3 Fiber length refers to a segment of fiber without splices.

For example… the fiber length from the node to splice 1.0, the fiber length from splice 1.0 to splice 2.0, or the fiber length from splice 2.0 to the building termination

3.6.1.4 Labels are to be attached to the cable jacket along the sheath using caution not to wrinkle or fold the label.

3.6.1.5 Place labels within 12 inches of each termination. Ensure labels are positioned to allow reading without twisting the cable.

3.6.1.6 Place labels within 12 inches of each splice closure entry indicating the fiber strand count for the entry and exit cables.

- Example  FO1201, 1-48  8800’ 12/98 TERM

3.6.1.7 Labels are to indicate splice locations such as maintenance hole numbers, tunnels, or buildings.

3.6.1.2 All labeling information shall be provided by the Purdue IT Infrastructure Services Department or shown on the drawings.

3.6.1.3 Contractor to provide all materials necessary for proper labeling of cables as indicated herein.

3.6.1.4 The Contractor shall submit a completed Fiber Optic Cable Test Report to the Purdue IT Infrastructure Services Department for review prior to the Owner’s acceptance of the Work.
<table>
<thead>
<tr>
<th>Bldg ID</th>
<th>Bldg Name</th>
<th>Distance</th>
<th>Fiber Count</th>
<th>Date Placed</th>
<th>Destination Bldg ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAO</td>
<td>PAO</td>
<td>8800'</td>
<td>120, 1-48</td>
<td>5/03</td>
<td>FO 1</td>
</tr>
<tr>
<td>FO 1</td>
<td>LYNN to PAO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOVD</td>
<td>MATH to HOVD</td>
<td>414'</td>
<td>104, 97-108</td>
<td>5/96</td>
<td>FO 2</td>
</tr>
</tbody>
</table>

* 1 = Single-mode, 2 = Multimode

**Figure 1**

**Figure 2**