(This is a design guideline spec. It's the responsibility of the Design/Installation team to develop project specific specifications to meet the project requirements.)

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 GENERAL

1.1 SUMMARY

A. Subject to the General and Special Conditions, this section shall specify.

B. Section Includes:

1. This Section includes all the backbone cable specifications for the installation of a Structured Cabling System (SCS) for the purpose of supporting voice and data communications.

C. Related Sections:

1. Div 01
2. Section 270000 Communications
3. Section 270526 Grounding and Bonding for Communications Systems
4. Section 270528 Interior Pathways for Communications Systems
5. Section 270543 Exterior Pathway for Communications Systems
6. Section 270553 Identification for Communications Systems
7. Section 271100 Communications Equipment Room Fittings
8. Section 271500 Communications Horizontal Cabling
9. Section 272100 Data Communication Network Equipment

1.2 SYSTEM DESCRIPTION

A. All backbone cables connecting MDF's to IDF's shall utilize armored Singlemode Fiber (SMF). Strand count shall be minimum of 24-strand to each IDF room, and 12-strand to each wall-mounted IDF cabinet. Final fiber routes and strand counts shall be reviewed and approved by HITS representative during the design phase.

B. If MPOE is located in a separate room, the backbone cable from MPOE to the MDF room shall include a minimum of one (1) 24-strand singlemode fiber cable.

C. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing, unless otherwise specified, in performing the following operations recognized as necessary for the installation, termination, and labeling of copper backbone infrastructure as described on the Drawings and/or required by these Specifications.

D. Approved cable manufacturers are Corning for fiber cables . All fiber cables shall be singlemode, unless noted otherwise. All fiber

E. There shall be no proprietary connectivity parts, each cable manufacturer shall use connectivity parts associated with their respective "partners". All connectivity be in a nonproprietary "keystone" style footprint. Jacket color shall be yellow for Singlemode fiber (black for OSP cables).

1.3 REFERENCES

A. REFER TO SECTION 270000

1.4 SUBMITTALS

A. Refer to section 270000

B. Cable Pulling Plan

1. The contractor shall submit a cable pulling plan prior to installation.

2. Submittal requirements:

a. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.

b. Indicate contents of each conduit.

c. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.

d. Include detail and schedule showing the construction sequence of communications rooms.

e. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the engineer.

C. Splice Plan

1. The contractor shall submit shop drawings indicating the intended cable splice points, mounting method and equipment list prior to installation. **Generally speaking, splice is not allowed on backbone fiber cables between patch panels. Obtain approval from HITS if standard variance is required due to special field conditions.**

D. Cable Testing Plan

1. Refer to Section 270000

E. Cable Testing Reports

1. Refer to Section 270000

1.5 QUALITY ASSURANCE

A. Refer to section 270000

B. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to section 270000

B. Storage temperature range: -40°F to 149°F (-40°C to 65°C)

C. Fiber cables shall be shipped on reels in lengths as specified with a minimum overage of 10%:

1. The cable shall be wound on the reel so that unwinding can be done without kinking the cable.

2. Two meters of cable at both ends of the cable shall be accessible for testing.

a. All fiber shall be tested on the reel for continuity and distance compliance before installation.

3. Each reel shall have a permanent label attached showing length, cable identification number, cable size, cable type, attenuation, bandwidth, and date of manufacture.

a. Labels shall be water resistant and the writing on the labels shall be indelible.

1.7 PROJECT/SITE CONDITIONS

A. Refer to section 270000

1.8 WARRANTY

A. Refer to section 270000

1.9 MAINTENANCE AND SUPPORT

A. Refer to section 270000

PART 2 PRODUCTS

2.1 ACCEPTABLE FIBER CABLE MANUFACTURERS

A. Product Manufacturer
   1. Corning

B. Indoor Plenum OS2 Singlemode Fiber Cables
   1. Corning # 012E88-33131-A3 (12F)
   2. Corning # 024E88-33131-A3 (24F)
   3. Corning # 048E88-33131-A3 (48F)

C. Indoor/outdoor rated OS2 Singlemode Fiber Cables
   1. Corning # 012EWP-T4101DA3 (12F)
   2. Corning # 024EWP-T4101DA3 (24F)
   3. Corning # 048EWP-T4101DA3 (48F)

D. Fiber Duplex Patch Cables (Type SM)
   1. Corning # 040402R5120003M (3M, LC to LC Duplex, OS2)

E. Fiber Termination Panels
   1. Corning # CCH-CS12-A9-P00RE (12F, LC, UPC, Duplex)
   2. Corning # CCH-CS24-A9-P00RE (24F, LC, UPC, Duplex)

F. Fiber Termination Shelf (Rack-Mounted)
   1. Corning # CCH-01U (1RU)
   2. Corning # CCH-02U (2RU)
   3. Corning # CCH-03U (3RU)
   4. Corning # CCH-04U (4RU)

G. Labeling
   1. Refer to section 270000

H. Firestopping
   1. Refer to section 270000

2.2 FIBER BACKBONE CABLING

A. Fiber General Requirements
   1. Fiber shall be certified to meet all parts of TIA-455 and comply with TIA-492, ANSI/ICEA S-83-596 and ANSI/ICEA S-83-640 and the NEC.
   2. Fibers shall have D-LUX coating or approved equivalent to ensure color retention, minimize micro bending losses and improve handling. The coating shall be mechanically strippable.

3. Cable installed in plenums or air-handling spaces shall meet UL 910 and shall be marked OFNP (optical fiber non-conductive plenum) in accordance with the NEC.
    a. Plenum Fiber rated cable consisting of multiple fibers shall have a Plenum PVC outer jacket.
        1) Each group of fibers shall have a color-coded Low Smoke PVC buffer.
        2) The buffered fibers are organized in subunits of fibers, reinforced with aramid yarn for extra strength and surrounded with a color-coded low smoke tube.
    b. Within the premises, all fiber shall be placed in plenum rated innerduct the entire length of the cable for protection. Use manufacturer plenum rated couplings for all connections.
4. Riser cable shall meet UL 1666 and be marked OFNR (optical fiber nonconductive riser) in accordance with the NEC.
    a. Non-plenum, riser rated cable consisting of multiple fibers, shall have an orange, Polyvinyl Chloride (PVC) outer jacket.
5. OSP (Outside Plant) Fiber
    a. Stranded loose tube dielectric fiber cable shall be utilized for underground conduit, direct buried, or aerial applications.
    b. Underground cable, including cable installed in conduits or duct banks, shall contain an additional moisture barrier in the form of a flooding compound.
6. Fiber conductors shall follow standard color code schemes. Fiber numbers and binders shall correspond to the following color codes:
    a. Fiber/Binder No. 1 – blue
    b. Fiber/Binder No. 2 – orange
    c. Fiber/Binder No. 3 – green
    d. Fiber/Binder No. 4 – brown
    e. Fiber/Binder No. 5 – slate
    f. Fiber/Binder No. 6 – white
    g. Fiber/Binder No. 7 – red
    h. Fiber/Binder No. 8 – black
    i. Fiber/Binder No. 9 – yellow
    j. Fiber/Binder No. 10 – violet
    k. Fiber/Binder No. 11 – rose
    l. Fiber/Binder No. 12 – aqua
7. Cable Minimum Bending Radius:
    a. During Installation: 20X cable diameter
    b. After Installation: 10X cable diameter
8. Operating temperature range: -76°F to 185°F (-60°C to 85°C)

B. Singlemode Fiber Requirements
1. Fibers shall have dual wavelength capability, transmitting at 1310 and 1550 nm ranges.
2. 8.3 µm core
3. 125 µm ± 1 µm cladding diameter
4. Cladding non-circularity: = 1%
5. Core/cladding concentricity error: = .5 µm

6. Colored fiber diameter: 254 µm ± 7 µm
7. Maximum Attenuation: 1.0 dB/km at 1310 and 1550 nm (inside premises) and 0.4 dB/km at 1310 and 1550 nm (OSP)
8. Minimum Bandwidth: 20 GHz
9. The mechanical and environmental specifications for OSP fiber cable shall be in accordance with ANSI/ICEA S-87-640. OSP fiber cables shall be of a water-block construction and meet the requirements for compound flow and water penetration as established by ANSI/ICEA S-87-640. Outdoor cable shall have minimum pull strength of 2670 N (600 lbf).

2.3 FIBER PATCH CABLES

A. Fiber patch cables shall be provided based on the strand count of the backbone fiber cables installed. The quantity of the duplex patch cord shall be equal to 1/3 of the strand count of the fiber run (for each 24-strand fiber cable run provide 8 duplex fiber patch cords). Verify exact quantities and lengths with COH prior to placing orders.

B. Provide the appropriately-rated (matched to the installed cable plant) Modular Patch Cords for the appropriate location and equipment.

C. Singlemode patch cables shall be a stepped-index 8.3 µm core with a 125 µm cladding.

D. Duplex LC connectors shall meet the following specifications:

1. Made and warranted by the manufacturer of the cabling system installed in this project and shall meet or exceed patch cord specifications as outlined in TIA standards.
2. Patch cords shall be in original packaging when presented to the COH.

E. Aramid yarn and a jacket of flame-retardant PVC shall cover the fiber cladding.

F. Singlemode patch cable additional requirements:

1. Return Loss: -50 dB maximum
2. Mated Connector Loss: $\mu = 0.35$ dB, $\sigma = 0.2$ dB
3. Connection Repeatability: 0.20 dB maximum changes per 200 re-connects.

G. The Singlemode connector (visible portion) and adapter/outlet shall be identified by the color blue.

2.4 LABELING

A. Refer to Section 270553.

PART 3 EXECUTION

3.1 EXAMINATION

A. Refer to Section 270000

B. Verify the following before proceeding:

1. Conduits, cable trays and pull boxes are properly installed following section 270528
2. Backboards in communications rooms are properly installed following section 271100
3. Grounding system is properly installed and tested following section 270526
4. Liquid-carrying pipes are not installed in or above voice and data system communications rooms.
    a. Do not proceed with installation in affected areas until removed.

3.2 PREPARATION

A. Refer to section 270000

3.3 FIBER INSTALLATION

A. Fiber Cable Installation

1. Fiber cable shall be installed in innerduct from near end termination point to far end termination point.
    a. Only UL-approved plenum-rated innerduct shall be installed in all plenum areas.
    b. Metallic conduit may be used in lieu of innerduct in plenum-rated ceilings if it is bonded and grounded correctly.
2. Only technicians certified by the product manufacturer shall perform terminations.
    a. Terminations shall be made in a controlled environment.
    b. Cables may be assembled off-site, although testing must be completed with the cable in its final installed condition.
    c. Test optical fiber on the reel for distance and continuity verification before installation.
3. At each location where fiber cable is exposed to human intrusion, it shall be marked with warning tags.
    a. These tags shall be yellow or orange in color, and shall contain the warning "CAUTION FIBER OPTIC CABLE".
    b. The text shall be permanent, black, block characters, and at least 0’-.1875” high.
    c. A warning tag shall be permanently affixed to each exposed cable or bundle of cables, at intervals of not less than 5’-0”.
    d. Any section of exposed cable that is less than 5’-0” in length shall have at least one warning tag affixed to it.

B. Fiber Distribution Center

1. Contractor shall provide sufficient spare adapter plates to fill the appropriate-sized FDC.

3.4 FIBER TERMINATION AND SPLICING

A. Interconnect Units and Distribution Shelves

1. Modular in design and used in fiber interconnection, cross-connection, and splicing applications
2. 1’-7” (19”) rack-mountable
3. Accept 12-strand, 24-strand, 48-strand or 72-strand terminations
4. COH approved industry standard connector

B. Splicing and closures

1. Fiber splice modules shall be utilized for all OSP terminations.
2. The link shall consist of:
    a. Fiber cable
    b. Splice
    c. Splice tray holder/closure
    d. Fiber panel/coupler
    e. Pre-manufactured fiber pigtail with pre-polished fiber connector
    f. Fiber jumper to connect the pigtail-coupled link to the appropriate electronic switch

C. Fiber Fusion Splice

1. Fusion splices shall be mounted in protective trays within the closure.
2. Fusion splices shall not exceed a maximum optical attenuation of 0.3 dB when measured in accordance with ANSI/TIA-455-34, Method a (factory testing) or ANSI/TIA-455-59 (field testing).
    a. Fiber splices shall have a minimum return loss of 26 dB for Singlemode
        1) Minimum Singlemode return loss for broadband analog video (CATV) applications is 55 dB.
3. **All backbone fiber cables terminations shall utilize pigtail splice cassette and fusion spliced to the main fiber cable run. No field termination is allowed.**

3.5 INSTALLATION REQUIREMENTS

A. All installation shall be done in conformance with ANSI/TIA-568-B standards, BICSI methods, and industry standard installation guidelines.
    1. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.
    2. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.
    3. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

B. The Contractor shall provide service loops for cables terminating in the communications rooms.
    1. A 20’-0” service loop shall be provided at each end and secured in a neat and standards-compliant manner above the equipment racks or cable trays unless specified otherwise.
    2. This allows for future changes or expansion without installing new cables.

C. Documentation
    1. All cable inventory data documentation shall be submitted in format coordinated with and approved by COH so that data can be incorporated into existing databases.
    2. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.
    3. Complete cross connect documentation is required. It shall include detailed documentation of each pair of all copper backbone cable and strand of fiber.

3.6 FIELD QUALITY CONTROL

A. Refer to section 270000

3.7 FIBER POST-INSTALLATION TESTING

A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete and proper test measurements of the installed fiber cabling.

B. Contractor shall have successfully attended a fiber testing training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof.

C. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing.
    1. Any testing performed on incomplete systems shall be redone on completion of the work.

D. Dust caps shall be placed on fiber endfaces or adapters for each optical fiber link after all testing is complete on the fiber link.

E. Pre-test Submittals

1. Manufacturers catalog sheets and specifications for the fiber cable field-test instruments including
    a. OLTS (Optical Loss Test Set)
    b. OTDR (Optical Time Domain Reflectometer)
    c. End-face inspection capture device
2. A schedule (list) of all fiber cables to be tested
3. Fiber testing training program certificate
4. Sample test reports

F. Fiber testing standards

1. The Contractor shall meet or exceed the following standards and guidelines:
    a. ANSI/TIA-568-C.0 Optical Fiber Transmission/Test Requirements, and Annex E: Optical Fiber Field Test Guidelines (Tier 2)
        1) Tier 2 testing is a higher level of testing that provides qualitative measures of the installed condition and performance of the cabling system
    b. ANSI/TIA-568-B.3 Optical Fiber Cabling Components Standard
    c. TIA/TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
2. Singlemode requirements
    a. ANSI/TIA-526-7, Method A.1: Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant-OFSTP-7
3. The cable installers shall have a copy of these references in their possession and be familiar with the contents

G. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the optical fiber testing with other applicable trades.

H. In addition to the test regiment detailed in this document, the contractor shall notify the COH of any additional tests that are deemed necessary to guarantee a fully functional system.

1. The contractor shall carry out and record any additional measurement results at no additional charge.

I. The contractor shall provide all test measurement results two (2) weeks prior to substantial completion in spreadsheet format and native file format from the test instrument.

1. Software shall also be provided to view the native results.

J. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

1. A visible fault locator (VFL) normally uses a Class 2 or 3 light source and should not be directly viewed.
2. Safe usage of the tool requires indirect viewing of the light source by pointing the end of the fiber at an adjacent surface (or introducing another surface in front of a fixed mounted connector) until the presence of light is determined.

K. Link attenuation measurement and allowance calculation

1. The measured link attenuation shall be less than the link attenuation allowance. The link attenuation allowance is calculated as:

a. Link Attenuation Allowance (dB) = Cable Attenuation Allowance (dB) + Connector Insertion Loss Allowance (dB) + Splice Insertion Loss Allowance (dB)
    1) Connector Insertion Loss Allowance (dB) = Number of Connector Pairs X 0.4dB
    2) Splice Insertion Loss Allowance (dB) = Number of Splices X 0.15dB
    3) Cable Attenuation Allowance (dB) = Maximum Cable Attenuation Coefficient (dB/km) X Length (km)

L. Fiber Testing Requirements

1. All installed fiber links shall be field-tested and pass the following tests:
    a. OLTS (Optical Loss Test Set) length and dual wavelength attenuation
    b. OTDR (Optical Time Domain Reflectometer) traces and event tables
    c. Image captures of connector end-faces
2. OLTS (Optical Loss Test Set)
    a. The length and attenuation of each installed fiber link shall be measured and documented.
    b. System loss measurements requirements:
        1) 1310 and 1550 nanometers for Singlemode
    c. Reflective events (connections) shall not exceed 0.75 dB.
    d. Non-reflective events (splices) shall not exceed 0.3 dB.
    e. The acceptable link attenuation for Multi-mode horizontal fiber is based on the maximum distance of 295’-0”.
    f. A horizontal link in a network with a consolidation point may be tested using a fixed upper limit for attenuation of 2.75 dB.
    g. Optical sources shall be turned on for a minimum of 5 minutes prior to referencing.
    h. Fiber links shall be measured and reported for attenuation in each direction and attenuation bi-directionally (averaged in both directions)
    i. Polarity shall be verified for duplex connector systems
    j. Mandrels
        1) Mandrels shall be used when testing attenuation of Multi-mode fiber cabling
        2) Where mandrels are used, secure the mandrel to the light source by some means such as a cable tie or tape.
        3) Care should be taken to ensure that the fiber jacket is not deformed or damaged when using a cable tie or tape.
        4) The light source shall be referenced to the meter a minimum of twice daily (i.e., in the morning and noon).
3. OTDR (Optical Time Domain Reflectometer)
    a. An OTDR trace shall be taken of each fiber link in one direction to ensure uniformity of cable attenuation and connector insertion loss
    b. Testing shall consist of a bi-directional end to end OTDR trace performed per TIA 455-61
    c. Individual connector, splice and fiber insertion loss shall be evaluated using the OTDR trace.
    d. Fibers shall be inspected at 250X for Multi-mode and 400X for Singlemode
4. End-face Image Capture
        1) An image of each fiber optic connector end-face shall be taken, recorded and provided as part of the records.

5. Maximum Attenuation
    a. Singlemode ISP (inside) 1.0 dB/km at 1310 nm and 1550 nm
    b. Singlemode OSP (outside) 0.5 dB/km at 1310 nm and 1550 nm
6. Test Cords (Jumpers)
    a. Testing of the cabling shall be performed using high-quality test cords of the same fiber type and core size as the cabling under test. Use a single patch cord reference for fiber testing.
        1) OLTS test cords shall be between 3’-3” (1m) and 16’-4” (5m).
        2) OTDR testing shall be approximately 328’-0” (100m) for the launch cable and at least 82’-0” (25m) for the receive cable. . OTDR testing shall be Bidirectional with Pigtails installed.
    b. The test jumper, the adapters, and fiber under test shall be cleaned immediately prior to each fiber being tested.
        1) After cleaning, cleaning solutions shall be given sufficient time to evaporate (approximately 30 seconds) prior to the mating of fiber test jumper to the fiber under test.
7. Test Failure
    a. Any fiber link that fails these requirements shall be diagnosed and corrected.
    b. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements
8. Acceptable Testers
    a. Fluke DTX CableAnalyzer
    b. COH Approved equivalent

M. The COH or the COH’s representative shall be invited to witness, review or both witness and review field-testing.
1. The COH or the COH’s representative shall be notified of the testing start date, five (5) business days before testing commences.
2. The COH or the COH’s representative will select a random sample of 5% of the installed links and test that sample.
    a. The measured results obtained from the random sample shall be compared to the data provided by the contractor.
    b. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor under supervision of the COH or COH’s representative shall repeat 100% of the testing at no cost to the COH.

N. Test Results
1. The detailed test results documentation data is to be provided in an electronic database for each tested fiber strand and shall contain the following information:
    a. Identification of the customer site as specified by the end-user
    b. Name of the test limit selected to execute the stored test results
    c. Name of the personnel performing the test
    d. Date and time the test results were saved
    e. The manufacturer, model and serial number of the test instrument.
    f. The version of the test software and the version of the test limit database held within the test instrument.
    g. Fiber identification number

h. Length for each optical fiber
i. Index of refraction used for length calculation when using a length capable OLTS.
j. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
k. Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
l. Length for each optical fiber as calculated by the OTDR
m. Overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
n. Circuit IDs reported by the test instrument should match the specified label ID

3.8 CLEANING

A. Refer to section 270000

3.9 LABELING

A. Refer to Section 270553

3.10 GROUNDING AND BONDING

A. Refer to Section 270526.

3.11 ACCEPTANCE

A. Refer to Section 270000.

END OF SECTION 271300