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SPECIFICATION NUMBER 3226

**ELECTRICAL / INSTRUMENTATION / COMMUNICATIONS
CONSTRUCTION PERFORMANCE SPECIFICATION**

Hemlock Semiconductor
Operations
Hemlock, Michigan

3226

TABLE OF CONTENTS

00000

| <u>SECTION</u> | <u>SECTION DESCRIPTION</u> |
|----------------|---|
| 00000 | TABLE OF CONTENTS |
| 13400 | BASIC INSTRUMENTATION REQUIREMENTS |
| 13419 | INSTRUMENTATION IDENTIFICATION |
| 13420 | WIRING TO INSTRUMENTS AND VALVES |
| 13490 | INSTRUMENT TESTING |
| 16000 | GENERAL ELECTRICAL CONDITIONS |
| 16020 | GROUNDING AND LIGHTNING PROTECTION |
| 16111 | CONDUIT AND ACCESSORIES |
| 16112 | CABLE TRAY |
| 16120 | WIRE, CABLE, AND ACCESSORIES |
| 16140 | WIRING DEVICES |
| 16195 | TAGGING AND IDENTIFICATION |
| 16460 | DRY TYPE TRANSFORMERS |
| 16470 | PANELBOARDS |
| 16480 | MOTOR CONTROLLERS |
| 16500 | LIGHTING |
| 16600 | CRITICAL CONTROL SYSTEMS |
| 16855 | ELECTRIC HEAT TRACING |
| 16950 | ELECTRICAL TESTING |
| 27052 | INTERIOR COMMUNICATIONS BUILDING PATHWAYS |
| 27054 | EXTERIOR COMMUNICATIONS BUILDING PATHWAYS |
| 27100 | LOW VOLTAGE COMMUNICATIONS CABLING INSTALLATION PRACTICES |
| 27110 | COMMUNICATION EQUIPMENT ROOMS |
| 27130 | COMMUNICATIONS BACKBONE CABLING |
| 27150 | COMMUNICATIONS HORIZONTAL CABLING |
| 27800 | GROUNDING AND BONDING OF COMMUNICATION SYSTEMS |
| 27900 | COMMUNICATIONS SYSTEM TESTING |

| | | |
|----------------|---|-------|
| 3226 | TABLE OF CONTENTS | 00000 |
| 28140 | ELECTRONIC SECURITY SYSTEM | |
| 28240 | CCTV SYSTEM INSTALLATION DETAILS | |
| 28320 | FIRE AND LIFE SAFETY ALARM SYSTEM – SIMPLEXGRINNELL 4100ES VERSION | |
| 28321 | FIRE AND LIFE SAFETY ALARM SYSTEM – SIEMENS XLS VERSION | |
| ATTACHMENT "A" | LIST OF REFERENCED SSG DOCUMENTS | |

END OF SECTION

PART 1 GENERAL**1.1 SECTION INCLUDES**

- A. General requirements that apply to the electrical portion of the instrumentation work.
- B. Also see requirements in section 16000 entitled "General Electrical Conditions."

1.2 SUBMITTALS

- A. Submit as-built drawings:
 - 1. Mark corrections and indicate modifications to drawings identified during construction and return to the Owner's Representative at completion of work.
 - 2. Pay particular attention to wiring revisions.
 - 3. Mark drawings using the following color code:
 - a) Red: Additions, corrections or modifications
 - b) Yellow: Deletions

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Transport instruments from the warehouse to the job site.
- B. Protect each device from physical damage, debris, and moisture intrusion from the time of removal from the warehouse to the time the installation is complete.

1.4 SEQUENCING/SCHEDULING

- A. Install instruments and accessories after heavy construction work in the area is complete.
- B. Install conduit to instruments after piping and insulating work is completed to avoid interference. Plan and review the routing with the Owner's Representative prior to installing any conduit

PART 2 PRODUCTS**2.1 NONE****PART 3 EXECUTION****3.1 EXAMINATION**

- A. Inspect instrument components at receipt for:
 - 1. Physical damage.
 - 2. Correct model numbers and tags according to the Instrument Index, specifications, and drawings.
 - 3. Cleanliness or foreign matter.
 - 4. Notify the Owner's Representative, in writing, of discrepancies in above inspections.
- B. Verify locations of non in-line instruments and instrument supports with the Owner's Representative prior to installation.

3.2 PREPARATION

- A. Pre-plan installation of instruments to avoid conflict with:
 - 1. Fireproofing materials.
 - 2. Insulation on pipe lines and vessels as indicated by Owner's Representative.
 - 3. Other obstructions
- B. Provide temporary sealing devices in instrument components for openings where moisture or other foreign matter may enter wiring or process ports.

3.3 INSTALLATION

- A. Install instrument system components to:
 - 1. Provide easy accessibility without the use of a ladder.
 - a) Exception by the Owner's Representative specific written permission.
 - b) Avoid locations obstructing walkways or access-ways.
 - 2. Provide easy accessibility for maintenance. Plan space requirements for the use of hand tools in:
 - a) Removing covers and access panels.
 - b) Calibrating and servicing.
 - c) Mounting and removing.
 - 3. Provide access space for complete installation and removal of components without disturbing other nearby devices and equipment.
 - 4. Orient readable dials to be easily seen:
 - a) Especially during adjustments to system components.
- B. Mount instruments:
 - 1. On secure and solid mounting supports as referenced in SSG Document Number 13.416.001. Verify exact location of supports with Owner's Representative prior to placement.
 - 2. From pipe stand(s) or stanchion(s):
 - a) Bolted or welded to the floor, wall, or structural steel member.
 - b) Capable of supporting associated accessories.
- C. Mount 120 VAC and 24 VDC service switches within 36 inches of instruments requiring field power. Switch specification is referenced in SSG Document Number 16.142.001. No equipment shall be energized without permission of Owner's Representative.
- D. Do not support sensing lines, service piping, conduit, or manifolds from instruments.
- E. Enclosures:
 - 1. Use all provided lifting lugs with spreader bars to avoid side loads on lugs.
 - 2. Install level and secure.

END OF SECTION

PART 1 GENERAL**1.1 SECTION INCLUDES****A. Identification requirements for instrumentation:**

1. Devices and components.
2. Wiring and tubing.
3. Terminals and terminal strips.

B. Identification techniques:

1. Temporary tagging.
2. Permanent labeling and tagging.

1.2 REGULATORY REQUIREMENTS**A. Color codes:**

1. Wire Markers: BLACK text on WHITE background
2. Device Labels: BLACK text on WHITE background
3. Cable Trays:
 - a) Standard wiring: BLACK text on WHITE background
 - b) Non-incendive system components: BLACK text on YELLOW background
 - c) Intrinsically safe system components: WHITE text on BLUE background
 - d) Intrinsically Safe Warning Labels

1.3 DEFINITIONS

- A. Temporary Tagging: Tagging used during construction.
- B. Permanent Tagging: Tagging or labeling to remain after construction is complete.
- C. Devices: Instruments and valves that involve wire connections.
- D. Components: Conduit systems, enclosures, boxes, and cable trays that are supportive to devices and instrumentation wiring.
 1. Instrumentation wiring: Wiring carrying signals for controlling and/or monitoring.

PART 2 PRODUCTS**2.1 CONTRACTOR-FURNISHED PRODUCTS****A. Temporary tagging:**

1. Cardboard tags with string ties using handwritten notes in soft black pencil.
2. Embossed self-adhesive tape, 1/8 inch high letters.

B. Permanent tagging and identification:

1. Device labels and Intrinsically Safe warning labels:
 - a) Rigid laminated plastic nameplates:
 - 1) 1/16 inch thick
 - 2) Sunlight and weather resistant
 - 3) Engraved with block letters
 - b) Embossed tape may be used with specific Owner's Representative written permission only.

c) Size labels as follows:

4) For Instruments –

Tag Height: 1.25 inches

Tag Width: 2.5 inches

Letter Height: 3/16 inch

Line of Text: 4

Options: 3/16" hole for vibration elements located on the left side centered vertically.

Line of Text as follows. (Centered horizontally and vertically)

Line 1 – Instrument Tag Number

Line 2 and 3 – Instrument Use Description

Line 4 – Relates Instrument to Major Equipment

5) For Cable Trays –

Tag Height: 2.0 inches

Tag Width: 12.0 inches

Letter Height: 1.0 inch

Lines of Text: 1

Options: none

Line Text as follows. (Centered horizontally and vertically)

Line 1 – One of these options:

INTRINSICALLY SAFE

NONINCENDIVE

STANDARD

2. Conduit system labeling:

a) Flexible plastic labels;

1) Pre-printed vinyl labels

2) Refer to SSG 16.195.004 for vendors

3) Follow this sizing chart:

(i) ¾ to 1 ¼ inch conduit, use 8 inch wide label with ½ inch letters

(ii) 1 ½ to 2 inch conduit, use 8 inch wide label with ¾ inch letters

(iii) 2 ½ inch and larger conduit, use 12 inch wide label with 1 ¼ inch letters

3. Instrument Wire & Cable Markers

a) Brady self-adhesive, computer-printable wire marking system

b) Bradysleeve™ computer-printable wire marking system

c) Typed or computer printed

C. Adhesive: DOW CORNING 795® Silicone Building Sealant

PART 3 EXECUTION**3.1 EXAMINATION**

A. Verify the nomenclature of labels and markers with the Owner's Representative before fabricating.

3.2 INSTALLATION

A. Affix labels to:

1. Devices

a) Tag to be mounted adjacent to (not on) the instrument.

b) Vibration elements: Cable tie the tag around the cable at the element and through the hole in the tag.

- c) Other Devices: Suggested mounting locations (in order of preference):
 - 1) Adjacent Steelwork
 - 2) Adjacent Conduit
 - 3) Piping Insulation
- 2. Components
 - a) Intrinsically safe circuits reading "Intrinsically Safe"
 - b) Non-incendive circuits reading "Non-incendive"
 - c) Locate intrinsically safe and non-incendive labels:
 - 1) Such that labels are easily readable from normal walk surfaces and platforms.
 - 2) Every 20 feet of straight line conduit runs and cable trays.
 - d) Locate intrinsically safe labels:
 - 1) Within six inches of valves, transmitters, ells, tees, and dead-end conduit runs
 - 2) Within two feet above and below the surfaces for conduit passing through floor and roof surfaces
 - 3) Within three feet of wall surfaces where conduit passes through the walls.
- 3. Instrumentation Wiring:
 - a) Install wire labels immediately prior to termination.
 - b) Unique labels shall be placed on each individual conductor.
 - 1) Example: FT-123456-1 On positive conductor
 FT-123456-2 On negative conductor
- B. Attach warning labels to intrinsically safe junction boxes: Install the label on the inside corner of the junction box door.
 - Tag Height: 1.5 inches
 - Tag Width: 4.0 inches
 - Letter Height: 0.25 inches
 - Lines of Text: 3
 - Options: none
 - Line Text as follows. (Centered horizontally and vertically)
 - Line 1 – WARNING
 - Line 2 – DO NOT MIX INTRINSICALLY SAFE
 - Line 3 – WIRING WITH OTHER WIRING
- C. Install laminated plastic labels on clean, dry, oil free surfaces using adhesive.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers requirements for commonly used instrument and valve wiring.

1.2 REFERENCES

- A. 13.417.002: Terminations and Wiring for Field Instruments
B. 13.412.022: Instrumentation Cable Specification (Non-Armored Twisted Pair/Triad/Quad)

PART 2 PRODUCTS**2.1 MATERIALS**

A. Instrumentation Cable

1. NEC Type per SSG Document Numbers 13.412.022 as listed above, unless otherwise specified for HSO.
2. Thermocouple to temperature transmitter wiring shall be thermocouple extension cable compatible with the thermocouple type. Thermocouple type is identified in the Construction Scope of Work Package Instrument/Electrical Installation Detail listing.
 - a) Recommended Cable (or Equal with HSC approval):
 - Type J Thermocouple extension wire : Belden part number 1000A 300V, NEC Type PLTC, PVC Jacketed, 16AWG Single Pair Cable
 - Type K Thermocouple extension wire : Belden part number 1018A 300V, NEC Type PLTC, PVC Jacketed, 16AWG Single Pair Cable

B. Voltage Levels

1. Shielded twisted pair shall not be used for 120 volt instrument circuits. Utilize building wire.
2. 600 Volt Rated cables shall be used when cables are run into enclosures containing 480 Volts

PART 3 EXECUTION**3.1 INSTALLATION**

- A. Install conduit system and cable per Section 16120 and SSG Document Number 13.417.022 except as amended below:
1. Intrinsically Safe Circuits:
 - a) Shall be separated from other circuits by 2 inches minimum or a physical divider.
 2. Non-incendive and Intrinsically Safe Circuits
 - a) Cable shall be installed in tray or conduit to the close proximity of the instrument as indicated on the Electrical Termination Details. A drip loop shall be provided at each instrument. The drip loop will be utilized to isolate conduit from process fluids.
 - b) Cables utilizing the open air wiring detail (drip loop), shall be 600 Volt rated cable.
 - c) 300 Volt rated single pair shall be connected to the instrument using Liquid Tight Flex Conduit.
 3. Splices are allowed in GUA fittings for Remke cords and solenoids that do not have terminal screws, per details.
 4. For instrument circuits utilizing 120 VAC for control, use building wire or multi-conductor cables

5. 600 Volt rated insulation shall be used in conduit and enclosures containing 480 Volt circuits. The application of areas where instrumentation circuits are in close proximity with 480 Volt circuits shall be minimized and not used with intrinsically safe circuits.
- B. For Micro Motion transmitters that are remotely mounted from the sensors and require the installation of a factory provided 9-conductor cable, the contractor is responsible to prepare the cable as per manufacturers installation instructions.

END OF SECTION

PART 1 GENERAL**1.1 SECTION INCLUDES**

- A. Testing requirements that apply to the electrical portion of the instrumentation work.

1.2 SUBMITTALS

- A. Submit completed test records on Loop Test Sheet supplied with each scope of work contract to Owners Rep within 5 days of test completion. (See attached sample).

PART 2 PRODUCTS**2.1 NONE****PART 3 EXECUTION****3.1 TESTING AND EXAMINATION****A. CONTINUITY CHECK**

1. Verify continuity of each instrument loop by doing a resistance check or ringing out each loop.
2. Replace or repair any circuit not passing continuity test.
3. Place mark in the "continuity checked" column on the Loop Test Sheet column supplied with contract.

B. TERMINATIONS SECURE

1. Verify that all wires in each loop are securely fastened to the terminals. Place mark in the "termination secure" column on the Loop Test Sheet supplied with each contract.

C. INSTALLED AS PER CONTRACT

1. Inspect installation of components for compliance with installation requirements by checking the following:
 - a) Proper Identification, labeling, and tagging.
 - b) Proper wiring connections.
 - c) Proper orientation of controls, and viewable displays and gages.
 - d) Sign and date in the "installed as per contract" column on the Loop Test Sheet supplied with each scope of work contract.

**** EXAMPLE ****

| LOOP TEST SHEET | | | | |
|------------------------|--|---|--------------------------------------|-----------------|
| TAG NUMBER | CONTINUITY CHECKED (place 'X' in this column when done) | TERMINATIONS SECURE (place 'X' in this column when done) | INSTALLED AS PER CONTRACT | COMMENTS |
| PT-101 | X | X | John Doe - 03/03/97* | |
| FT-102 | X | X | John Doe - 03/03/97* | |
| FV-102 | X | X | John Doe - 03/03/97* | |

* SIGNATURE REQUIRED

END OF SECTION

PART 1 GENERAL**1.1 INTENT**

- A. These "Performance (Quality) Specifications for Electrical/Instrumentation Construction", in conjunction with the referenced SSG documents, describe material, installation, and testing requirements for the electrical system covered within the Scope of Work Specification (or Work Request) and related drawings and documents.
- B. Conflicts that exist between the drawings, the construction specification, Scope of Work Specification and/or specification 3226 must be resolved before the close of the bid period. Any conflicts not resolved before the close of bids, the contractor shall assume the greater amount of work or largest cost. If the contractor or Owner's Representative later identify any conflicts they will be resolved by the Owner's Representative in the field at no extra charge to the Owner

1.2 CODES AND STANDARDS

- A. The electrical system shall be installed and equipment and material furnished in accordance with applicable sections of the following codes and standards. Unless specified otherwise, comply with the latest edition.
 - 1. National Electrical Code (ANSI/NFPA 70)
 - 2. National Electric Safety Code (ANSI C2)
 - 3. National Fire Protection Association (NFPA)
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. American National Standards Institute (ANSI)
 - 6. Institute of Electrical and Electronics Engineers (IEEE)
 - 7. Insulated Cable Engineers Association (ICEA)
 - 8. Underwriters' Laboratories (UL)
 - 9. Factory Mutual (FM)
 - 10. Occupational Safety and Health Act of 1970 as amended (OSHA)
- B. Where requirements contained within these specifications are more rigid than those in the referenced codes and standards, these specifications shall govern.

1.3 AREA CLASSIFICATIONS

- A. Area Classifications are as shown on the appropriate Area Classification Standard referenced in the Scope of Work Specification.
 - 1. Unclassified areas are described as "Standard" areas on these maps and within the specifications.
 - 2. Classified areas are described by the appropriate Class, Division, Group, and "T-Rating" warranted for the materials being handled and the methods of handling.
- B. Materials, equipment, and installation methods in classified areas shall be in accordance with Article 500 of the National Electrical Code and applicable standards of the National Fire Protection Association for the class, division, group, and "T-rating" specified.

1.4 EQUAL/EQUIVALENT MANUFACTURERS AND/OR MATERIALS

- A. The contractor shall submit any equivalent manufacturer's information for review a minimum of 10 days before the bid date to the Owners Lead Electrical Engineer (or designated representative) for review.
- B. Submittal of equivalent manufacturer's information does not guaranty approval.
- C. All approvals for an equivalent manufacturer will be provided to the contractor in Written Documents or included in the contract documents.

1. Contractor will include all cost associated in the substitution to not only their discipline but all disciplines effected by the change.

D. Submittal of equivalent manufacturers will not be accepted after the contract is in place.

1.5 DEFINITIONS

A. Owner: The Owner's Representative as defined in the construction contract.

PART 2 PRODUCTS

2.1 MATERIALS

A. For commodities such as cable tray, lighting fixtures, Motor Control Centers, and VFD's contact owner.

B. Labeling, Listing, and Identification

1. Equipment and materials furnished by the contractor should be "labeled" and/or "listed" for the specific purpose, environment, and/or application by Underwriters' Laboratory (UL), Factory Mutual (FM), or similar nationally recognized testing laboratory.
2. Where equipment and materials are not labeled or listed, they shall be "identified" for the specific purpose, environment, and/or application.

C. Materials to Avoid

1. Equipment and materials being furnished by the contractor for installation in process areas shall not be constructed of aluminum or aluminum alloys, unless specifically noted in this document or drawings.
2. Wire jacketing, cable ties, and similar materials furnished by the contractor for use in process areas and surrounding outdoor areas shall not be constructed of nylon.
3. Duct Tape, Masking Tape or similar SHALL NOT BE USED due to potential contamination of process materials.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation Avoidances

1. Areas directly over pumps, compressors, and similar mechanical equipment shall be kept clear of cable tray, conduit, etc., to the greatest extent possible for future maintenance access.
2. Fire protection schemes may be armed during the final stages of construction for a new facility. Avoid conditions that would trip the smoke or heat detection heads.
3. Never install motor control centers, I/O cabinets or any electrical panels on exterior walls below cable tray or similar wireway openings (to avoid liquid pathways into these types of equipment). Install cabling in a way that liquids drop off before reaching any critical electrical components.

B. Coordination

1. The Electrical Contractor shall consult with Owner's Representative for exact location of all pushbutton stations, switches, receptacles, control panels, and lighting fixtures, Disconnects, etc.
2. It is the electrical Contractors Responsibility to coordinate with each discipline working in the same area to prevent interferences and identify the appropriate installation method

C. Clearances

1. Maintain 6 feet 8 inches minimum above finished floor.
2. For corridors and walkways, maintain 8 feet minimum above finished floor.
3. For areas with switchgear or MVC's maintain 9 ft. 6 in. minimum above finished floor.

D. Floor and Wall Penetrations

1. For conduit and cable trays passing through non fire rated floors, see the following SSG documents: 16.111.002 and 16.112.009
2. For conduit and cable trays passing through fire rated floors, see the following SSG documents: 16.111.004 and 16.112.007
3. For cable trays passing through fire rated walls see the following SSG document: 16.112.007

E. Structural Steel

1. No drilling of structural steel for mounting of electrical equipment without specific written instructions.
2. Contractors engaged with performing welding of supports on the HSC site should be certified in accordance with AWS D1.1, section 4, Part C. The minimum acceptable qualifications would be Fillet tests, in the 3F & 4F positions.
3. Qualification Record (WQR) to Owners Representative of Welder Quality Representative before work begins.

F. Raceways

1. No sharing of raceways between Uninterruptible Power Supply (UPS) and Non-UPS circuits including conduit and cable tray.
2. All 480V circuits to be installed in rigid metal conduit excluding cable tray installations. Exception Rigid conduit can be substituted with EMT in some interior locations with owner's approval.
3. Each 480V circuit to be installed in separate dedicated rigid conduit when cable tray not used.

3.2 SUBMITTALS**A. Electrical Drawing Mark-ups**

1. Electrical drawings shall be marked up with any corrections or modifications that were identified during construction and returned to the Owner at the completion of work.
2. Use the following color code:
 - a) Red - Additions, corrections, or modifications
 - b) Yellow - Deletions

B. Test Reports

1. All test reports required by this specification shall be submitted to the Owner following completion of test.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

A. This section covers requirements for the following grounding and bonding:

1. Building and Structure Grounding
2. Electrical System Grounding
3. Static Grounding
4. Lightning Protection

1.2 REFERENCES

A. SSG Document Numbers

1. 16.020.004 Grounding of Dry Type Transformers, Panelboards and Associated Circuitry
2. 16.020.007 600V Class Variable Frequency Drive Shield Termination
3. 16.020.021 Ground Resistance Test and Results Submittal Form
4. 16.021.000 Grounding Materials and Details
5. 16.022.020 Equipment Static Grounding Test Method
6. 16.022.101 Static Grounding for Drums and Scale Stations
7. 16.022.102 Static Grounding for Dip Pipes
8. 16.022.110 Static Grounding of Tanks and Distillation Columns
9. 16.022.120 Static Grounding for Loading/Unloading Stations Tank Car and Truck
10. 16.022.130 Static Grounding for Dempster Tanks and Dempster Tank Stations
11. 16.023.003 Lightning Protection - Construction Specifications
12. 16.025.000 Building Steel Grounding

PART 2 PRODUCTS**2.1 MATERIALS**

A. Grounding Materials and Details per SSG Document Number 16.021.000.

PART 3 EXECUTION**3.1 INSTALLATION**

A. Basic grounding construction specifications per SSG Document Number 16.021.000.

B. Building Steel Grounding per SSG Document Number 16.025.000

1. Concrete Encased Electrode "Ufer" Method A
2. Concrete Encased Electrode "Ufer" Method B
3. Ground Rod Method

C. Static Grounding

1. Tanks and Distillation Columns per SSG Document Number 16.022.110.
2. Dip Pipes per SSG Document Number 16.022.102.
3. Dempster Tanks and Dempster Tank Stations per SSG Document Number 16.022.130.
4. Tanker Truck/ Unloading Stations per SSG Document Number 16.022.120.
5. Drums and Scale Stations per SSG Document Number 16.022.101.

D. Lightning Protection

1. Vents, Stacks, Distillation Columns, and Towers per SSG Document Number 16.023.003.

3.2 TESTING

- A. Refer to Section 16950 for testing details.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

A. This section describes the requirements for approved conduit systems:

1. Rigid Metal Conduit
2. PVC Coated Rigid Metal Conduit
3. Liquidtight Flexible Metal Conduit
4. Electrical Metallic Tubing
5. Rigid Non-Metal Conduit

1.2 CONDUIT SELECTION

A. Utilize the following Conduit Selection Table

| | LOCATION | RIGID METAL CONDUIT | LIQUIDTIGHT FLEXIBLE METAL CONDUIT | ELECTRICAL METALLIC TUBING WITH COMPRESSION FITTINGS | FLEXIBLE METAL CONDUIT | RIGID NONMET ALLIC CONDUIT (NOTE 5) | PLASTIC COATED RIGID METAL CONDUIT (NOTE 3) | FLEXIBLE COUPLINGS |
|----------------------------------|---|---------------------------|---|---|------------------------------|---|--|-----------------------|
| CHEMICAL ATTACK | NON-CORROSIVE | A | A | A | A | A | A | A |
| | CORROSIVE | A | A | | | A | A | A (NOTE 1) |
| SPECIFIC CONDITIONS OF USE | OFFICE, TOILET LOCKER ROOM, HALLWAY, CORRIDOR PLENUM ELECT. COMM ROOMS | A | A | P | A | A (NOTE 4) | NR | A |
| | OUTSIDE IN NON PROCESS AREAS | A | A | A | | A | NR | A |
| | OUTSIDE ENCLOSED STRUCTURE | A | A | | | A | A | A |
| | UNDERGROUND | A | NR | | | P | NR | |
| | CONCEALED INSIDE WALL | A | A | A | A | | | |
| | IN FLOOR SLAB | A | | | | P | NR | |
| | SUBJECT TO PHYSICAL DAMAGE | A | A | A (NOTE 7) | | | A | A |
| | REACTOR ROOMS | A (NOTE6) | A | | | | P | |
| | CLEAN ROOMS | A (NOTE6) | A | A (NOTE6) | | P (NOTE4) | A | |
| | LABORATORY | A | A | A | | A (NOTE4) | A | A |
| CLASSIFIED AREAS | CLASS 1, DIV 1 | P | | | | | A | A (NOTE 2) |
| | CLASS 1, DIV 2 | P | A | | | | A | A (NOTE 2) |

LEGEND: P- Preferred, A-Approved; NR- Approved but Not Recommended, Blank Space- Not Approved

- NOTES
1. Finished installation with 3 layers of half lapped 3M Scotch 33+ vinyl tape.
 2. UL approved for use in classified areas varies with coupling diameter.
 3. Use only in areas where severe corrosion is proven to exist.

4. Not for use in Plenums.
 - a. I.E.: Ceiling space used for HVAC return air system
5. Schedule 80 PVC conduit to be used in lieu of schedule 40 where subject to physical damage. See below for examples of areas subject to damage
 - a. Mobile leaning equipment
 - b. Mobile tables and/or counters
 - c. exposed to shoe traffic.
6. Only allowed in these areas if painted.
7. Not for severe physical damage. See below for examples of areas subject to severe damage
 - a. Exposed to forklift traffic.
 - b. Exposed to pallet jacks.
 - c. Possible contact of vehicles.

1.3 GENERAL REQUIREMENTS

- A. Rigid steel conduit shall be the only raceway system used unless otherwise approved in the table above. Aluminum and associated components are not acceptable.
- B. Liquidtight flexible metal conduit to be used:
 1. At motor connections. (3/4" min.)
 2. At equipment subject to vibration.
 3. Where flexibility is required.
- C. Conduits entering enclosures from the top or sides (outdoors and in indoor wet/ wash-down areas) shall do so with an "O" ringed hub. (Meyers or equal). Note: Avoid top entries when possible.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Rigid Metal Conduit (RMC) and Accessories:
 1. Rigid Metal Conduit.
 - a) Hot dipped galvanized per ANSI Standards
 - b) UL Labeled or Listed per UL
 - c) Minimum size of 3/4 inch.
 2. Factory Elbows, Nipples, and Couplings
 - a) Material to match Rigid Steel Conduit requirements
 3. Fittings for Standard and Class I or Class II, Division 2 Areas
 - a) Crouse-Hinds Form 7 Feraloy
 - b) Appleton FM7 Grayloy
 - c) OZ-Gedney FM-7
 - d) T&B-Form 7 Blue Coat
 4. Fittings for Class I or Class II, Division 1 Areas
 - a) Crouse-Hinds cast Feraloy® including covers.
 - b) Appleton Unilet® malleable iron including covers
 - c) OZ-Gedney
 - d) T&B-Ductile Iron Including covers
 5. Three Piece Conduit Coupling

- a) Use only in standard, indoor areas.
- 6. Unions for Classified or Outdoor Areas
 - a) Crouse-Hinds UNY or UNF series.
 - b) Appleton UNY or UNF series.
 - c) T&B UNY or UNF series
- 7. Drains and Breathers
 - a) For Standard areas:
 - 1) Crouse-Hinds "Universal" ECD-15 drain or breather
 - 2) Appleton ECDB-38 Universal drain/breather
 - 3) T&B ECD15-TB
 - b) For Class I, Division 1&2, Groups C and D areas:
 - 1) Crouse-Hinds "Universal" ECD-15 drain or breather
 - 2) Appleton ECDB-38 Universal drain/breather
 - 3) T&B ECD15-TB
 - c) For Class I, Division 1&2, Groups B, C, and D areas:
 - 1) Crouse-Hinds ECD-16 drain/breather
 - 2) Appleton ECDB-50-B Universal drain/breather
 - 3) T&B ECD15-TB
- 8. Sealing Fittings, Compound, and Fiber
 - a) Sealing fittings
 - 1) Crouse-Hinds Feraloy Type EYD or EYS Series.
 - 2) Appleton Grayloy or Malleable Type EYDM or EYF Series.
 - 3) T&B Grey iron alloy Type EYD or EYS Series

Note: Pay Close attention to Class and Group are when ordering seals
 - b) Sealing compound and fiber
 - 1) Crouse-Hinds Chico "A" Compound with Crouse-Hinds Chico "X" Fiber.
 - 2) Appleton KWIKO Sealing Cement and Fiber Filler.
 - 3) T&B Sealing Cement and Fiber Packing
 - c) All Appleton sealing fittings are UL listed for use with Appleton KWIKO and Crouse-Hinds Chico "A" cement
- 9. Clamps (Type RC, EC, and PC): Galvanized malleable iron
 - a) Acceptable Manufacturers
 - 1) Steel City
 - 2) T&B
 - 3) Appleton
- 10. Pipe Straps
 - a) Galvanized malleable iron
 - b) One hole style for conduit sizes 3 inches and smaller
 - c) Two hole style for conduit sizes 3 1/2 inches and larger
- 11. Conduit to Cable Tray Grounding Clamp
 - a) Acceptable Manufacturers
 - 1) OZ Gedney "Tray-Bond"
 - 2) T&B Swivel Tray Clamp

12. Bushings as defined by NEC
 - a) Insulating Type
 - b) Insulating Type with Grounding Lug
13. Hubs: Meyers, Appleton, or T&B
14. Flexible Couplings for Class I and Class II, Division 1 Areas
 - a) Crouse-Hinds EC series
 - b) Verify compliance for Group A or B classified areas
15. Cable and Tubing Fittings:
 - a) Crouse-Hinds type CGB with Neoprene bushings.
16. Expansion Fittings:
 - a) Crouse-Hinds expansion union.
 - b) Use only in indoor areas.
17. Burial Warning Tape:
 - a) Brady, Detectable Identoline
18. Masonry Wall Anchors:
 - a) Steel or Lead expansion machine bolt type.
- B. PVC Coated Rigid Metal Conduit (P-RMC) and Accessories
 1. PVC Coated Conduit
 - a) Robroy
 - b) Ocal
 - c) Cal Bond
 - d) Minimum size of 3/4 inch.
 2. Factory Elbows, Nipples, and Couplings
 - a) Robroy
 - b) Ocal
 - c) Cal Bond
 3. Fittings for Standard and Class I or Class II, Division 2 Areas
 - a) Robroy
 - b) Ocal
 - c) Cal Bond
 4. Unions for Classified or Outdoor Areas
 - a) Robroy UNF or UNY
 - b) Ocal UNF or UNY
 - c) Cal Bond UNF or UNY
 5. Sealing Fittings, Compound, and Fiber
 - a) Sealing fittings
 - 1) Robroy
 - 2) Ocal
 - 3) Cal bond

- b) Sealing compound and fiber
 - 1) Crouse-Hinds Chico "A" Compound with Crouse-Hinds Chico "X" Fiber.
 - 2) Appleton KWIKO Sealing Cement and Fiber Filler.
- 6. Clamps (type RC, EC and PC (PVC Coated))
 - a) Robroy
 - b) Ocal
 - c) Cal Bond
- 7. Pipe Straps (PVC Coated)
 - a) Robroy
 - b) Ocal
 - c) Cal Bond
- 8. Touchup Compounds
 - a) Robroy
 - b) Ocal
 - c) Cal Bond
 - d) Or Equal
- C. Liquidtight Flexible Metal Conduit (LTMC) and Accessories
 - 1. Flexible metal conduit with PVC jacket
 - a) For use in Standard or Class I or Class II, Division 2 Areas
 - b) Minimum size of 3/4 inch, except 1/2 inch allowed for instrument connections which must be supported within 3 feet.
 - c) Acceptable manufacturers:
 - 1) Anaconda Type UA
 - 2) Electri Flex Type LA
 - 3) Liquid-Tuff Type LFMC
 - 2. Connectors
 - a) Straight, 90 degree or 45 degree at equipment end of flexible conduit, Malleable Iron type.
 - b) Acceptable manufacturers:
 - 1) Appleton Series ST
 - 2) OZ Gedney Series 4Q
 - 3) Crouse Hinds Series LT
- D. Electrical Metallic Tubing (EMT) and Accessories:
 - 1. Steel only (others not acceptable)
 - 2. EMT not to be used where exposed to severe physical damage
 - 3. Minimum size of 3/4"
 - 4. Hot dipped galvanized
 - 5. Fittings and conduit bodies:
 - a) Steel compression type connectors and couplings only (set screw type not acceptable)
 - b) Sheet metal boxes for flush mounted installations
 - c) FS type boxes for surface mount installations

6. Wall anchors:
 - a) Steel or Lead expansion machine bolt type
 - b) Plastic screw anchor:
 - 1) Rawl
 - 2) Blackburn
 - c) Rawl Tapper® screw anchors – up to 1-1/4"
 - d) Rawl plug anchors
 - e) Rawl (Hex Head) LOK/BOLT®
- E. Rigid Non-Metallic Conduit (RNC) and Accessories:
 1. Electrical Grade PVC
 2. Schedule 40 minimum
 3. Minimum size 3/4"
 4. Fittings and conduit bodies:
 5. To be rigid PVC type

PART 3 EXECUTION

3.1 PREPARATION

- A. Plan precise routing. Drawings show conceptualized routing only.
- B. Frame and/or seal wall and floor penetrations per Section 16000, Part 3.01 C.

3.2 INSTALLATION

- A. General Conduit Installation for Rigid Steel Conduit, Electrical Metallic Tubing, and Rigid Nonmetallic Conduit
 1. Installation shall comply with the NEC and manufacturer's specifications
 2. Routing
 - a) Run exposed, except as specifically directed
 - b) Parallel or perpendicular to building lines
 - c) Group conduit in parallel runs where practical.
 3. Conduit Supports
 - a) Fabricate from steel bar, angle, or channel of adequate size.
 - b) Supports shall not create closed pockets which could trap liquids.
 - c) Plated Unistrut may be used in standard, indoor, non-process areas only.
 - d) C-Clamps used for conduit support hangers shall be Appleton Type BH or OZ/Gedney Type IS, malleable iron.
 - e) Threaded rod shall be 1/2" minimum for all trapeze supports.
 4. Clearances:
 - a) Hot pipes and surfaces - 6 inches minimum
 - b) Aisle ways and passageways:
 - 1) 8 feet minimum vertically above floor
 - c) Do not block maintenance access to equipment

5. Fittings and Pull Boxes:
 - a) Do not mix manufacturers of cover, gasket, and body.
 - b) Size and locate in the field as required by the NEC Article 314.16 even though not specified on drawings.
 - c) Covers
 - 1) Orient for ease of accessibility and maintenance.
 - 2) Identify circuit number and voltage on covers with a vinyl label or Permanent marker.
6. Electrical Continuity: System to maintain electrical continuity.
7. Conduit System Integrity
 - a) Reasonable measures shall be taken during construction to prevent moisture and foreign matter from entering the conduit system.
 - b) At no time shall conduits be installed with the opening facing up, including sealtight fittings and CGB fittings, without the approval of the Owner. (Exception: stubs on the top of MCC's, etc.)
- B. Rigid Metal Conduit Installation Additional Information
 1. Threading:
 - a) Coat exposed threads with acid resistant cold galvanizing treatment to prevent corrosion.
 2. Screw Threads on Fittings, Plugs, and Box Covers:
 - a) Coat with an anti-seize compound (e.g., Molykote®, NeverSeize grease) or conduit system manufacturer's recommended lubricant.
 3. Conduit Seals:
 - a) Provide at each location required by the NEC and appropriate Area Classification Map even though it may not be specified on drawings.
 - b) Seals shall not be poured except with approval of Owner after equipment has been tested for functionality. Contractor, if requested, shall remove plugs or covers on packed fittings for inspection prior to pouring.
 - c) Apply yellow paint on plug and cover after sealing fitting is poured to indicate seal has been completed.
 - d) For conduit seals evaluated by engineering and determined not required, do not pour seal and apply green paint on seal plug to indicate poured seal was not necessary.
 4. Conduit Drains
 - a) Install at low points of conduit system.
 - b) Cable tray
 - 1) All conduits attached to cable tray in outdoor locations, or areas protected with sprinklers, shall be kicked down 15 degrees wherever possible.
 - 2) For cases where conduit cannot be kicked down 15 degrees, use straight conduit and apply duct seal to end of conduit.
- Note: Sealing not required in electrical and communications rooms.
- C. Liquidtight Flexible Metal Conduit Installation for Flexibility
 1. Installation shall comply with NEC.

2. Length
 - a) Minimum: 18 inches long
 - b) Maximum: 6 feet long, 3 feet long for motors.
 3. Bonding Jumper
 - a) If the flexible conduit does not contain an equipment grounding conductor, an external bonding jumper shall be installed.
 - b) If the flexible conduit contains an internal grounding conductor, a label shall be installed to indicate an internal ground conductor is present.
 - c) Green insulated stranded copper conductor sized per NEC, minimum size is #12 AWG.
- D. Underground Conduit Installations
1. Installations Shall Comply with the NEC.
 2. Installations to be Rigid Conduit unless otherwise noted.
 - a) Galvanized Rigid Metal Conduit (RMC) Long radius elbows required
 - b) Where a RMC penetrates or is in direct contact of concrete, conduit shall be rigid PVC coated conduit or galvanized rigid conduit coated with 3M Scotchrap pipe primer and 3M Scotchrap 50 corrosion protection tape.
 3. Installations can be Rigid Non-Metal Conduit (RNC / Sch 40-PVC) with owners approval or as shown on the drawings.
 - a) RNC installations require Galvanized RMC long radius elbows.
 - b) RNC installations required to be converted to Galvanized RMC where exposed above grade.
 4. Installations shall be installed with a warning ribbon buried 12" below grade directly above conduits.
 - a) RNC installation require a warning ribbon with a Tracer Wire (Detectable warning tape).
 5. Pull Boxes, Hand Holes, or Man Holes shall be installed at a maximum of 400' spacing.
 - a) Tracer wires from warning ribbons must be exposed in the boxes, Man/Hand Holes.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section describes the requirements for the most commonly used cable tray system - hot dipped galvanized steel ladder.

1.2 REFERENCES

- A. SSG Document Numbers
 - 1. 16.112.007: Firestopping Cable Tray Openings
 - 2. 16.112.008: Cable Tray Installation Details
 - 3. 16.112.009: Cable Tray Floor Penetrations (Non-Fire Rated)
- B. Publications
 - 1. NEMA Standards Publication No. VE 1, Metallic Cable Tray Systems
 - 2. NEMA Standards Publication No. VE 2, Cable Tray Installation Guidelines

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Cable Tray and Fittings (unless otherwise specified)
 - 1. Hot dipped galvanized after fabrication (HDGAF) steel ladder per ASTM Standard A123. (Mill galvanized cable tray is not acceptable.)
 - 2. Rung spacing shall be 9 inch.
 - 3. Tray shall be Class 20C with 6 inch high side channels with flange turned out. (4" can be used with prior Engineering approval)
 - 4. Acceptable manufacturer:
 - a) P-W Industries, System Number 09-1F54 with series 2 type fittings
- B. Sealing of cable trays openings using 3M fire barrier 2001 Silicone RTV Foam
- C. Sealing of cable trays openings using Hilti-fire stopping & weather sealing system
 - 1. Hilti, Inc., Tulsa, Oklahoma 800-879-8000/www.us.hilti.com
 - a) SPECIFIC MATERIALS
 - 1) Hilti CFS-BL Fire Block
 - 2) Hilti CFS-S-SIL-GG Silicone Joint & Penetration Firestop Sealant
 - 3) Hilti Filler: Mineral Wool
 - 4) Hilti CP 637 Firestop Mortar
 - 5) Hilti CP 675T Firestop Board

PART 3 EXECUTION**3.1 INSTALLATION**

- A. Cable tray routing shall be as shown on the drawings.
- B. Cable Tray Supports
 - 1. Install and support cable tray system per SSG Document Number 16.112.008 and NEMA VE 2.
 - 2. Provide as specified on drawings, within 5 feet of a splice, 2 feet of a fitting and as necessary to adequately support tray. NOTE: No more than one splice between supports on runs of tray.

3. Supports not detailed on drawings shall be fabricated from steel bar, angle, or channel of suitable size.
 - a) Areas with High EMF (Reactor Cables) shall be constructed out of non-magnetic material such as stainless steel.
4. Supports shall not form closed pockets which could trap liquids.
5. Plated Unistrut may be used in standard, indoor, non-process areas only.
6. C-Clamps used for cable tray support hangers shall be Appleton Type BH or OZ/Gedney Type IS, malleable iron.
7. Threaded rod shall be 1/2" minimum for all trapeze supports.
 - a) Areas with High EMF (reactor cables) shall be constructed out of non-magnetic material such as stainless steel.
- C. Design basis for cable tray support structures shall be based on ultimate loading of cable trays or at a minimum the following weight per foot for each tray width.
 1. 12" Tray - 50Lb/ft
 2. 24" Tray - 100Lb/ft
 3. 30" Tray - 125Lb/ft
 4. 36" Tray - 150Lb/ft
 5. 6" Channel - 25Lb/ft
- D. Cable tray system shall be securely fastened to supports except at designated expansion fittings.
- E. Burrs and galvanizing slag shall be removed from tray and fittings during installation, and cold zinc rich galvanizing shall be applied to bare steel. (Anytime the factory galvanizing has been damaged cold zinc rich galvanizing must be applied).
- F. Sealing floor and wall penetrations using 3M fire barrier 2001 Silicone RTV Foam.
 1. Minimum depth of Fire Barrier Foam shall be 8 inches
 2. Initial foaming of cable tray opening shall be done by a specialty contractor that is well versed in using 3M® Fire Barrier 2001 Silicone RTV Foam. Any miscellaneous patching around cables, if required, can be done by the electrical contractor installing the cables.
 3. All openings through walls (concrete block or poured block) shall have a metal framework or smooth finished masonry opening built in such a way that it can be easily dammed up and foamed in without incurring any leaks either inside or outside the wall. Prefabricated metal walls shall have metal frame extending inside the building in order to obtain the necessary depth for foaming.
 4. See SSG Document Number 16.112.007 for installation details when fire stopping cable tray openings.
- G. Sealing floor and wall penetrations using Hilti-fire stop and weather sealing products.
 1. PREPARATION
 - a) Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 2. INSTALLATION
 - a) Manufacturer's Instructions: Comply with manufacturer's instructions for installation.
 - 1) Manufacturer offers and recommends onsite installation training. 800-879-8000/www.us.hilti.com

- 2) Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
 - 3) Consult with Owners Representative prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
3. FIELD QUALITY CONTROL
 - a) Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
 - b) Keep areas of work accessible until inspection by Owner's Representative.
 - c) Prior to project close out, the firestop/weather seal installation will need to be inspected and approved by the Owner's Representative.
 4. ADJUSTING AND CLEANING
 - a) Remove equipment, materials and debris, leaving area in undamaged, clean condition.
 5. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.
 6. SPECIFIC APPLICATION
 - a) Fire Block is preferred method where practical.
 - b) Provide flush and finished surface on both sides of wall and floors.
 - c) Exposed face of all Fire Block to be coated with CFS-S-SIL-GG silicone sealer (indoor and outdoor).
 - d) Filler material may be mineral wool or pieces of Fire Block.
 - e) CP 637 Firestop Mortar to be used for pipe or conduit openings greater than 1".
 - f) CP-675T Firestop Board to be used for large openings
 - g) Fire proofing to be installed to meet a one hour fire rating unless otherwise noted.
 7. See SSG Document Number 16.112.007 for installation details when fire stopping cable tray openings.
- H. Cable tray entering a building shall be sloped upward approximately 1 inch in last 10 to 15 feet.
- I. Cable tray grounding.
1. NEC 392 requires cable trays to be electrically continuous and effectively bonded, weather the tray is used as an equipment grounding conductor or not.
 - a) Where cable tray is used as the equipment grounding conductor it shall comply with NEC article 392
 - b) Where a separate equipment grounding conductor is required and installed it must comply with NEC article 250.
 - c) As required See SSG Document 16.112.008.003 for typical installation details.
 - 1) Install 2/0 AWG bond jumpers around expansion and hinge (adjustable) joints.
 - 2) Install 2/0 AWG continuous bare ground wire, bonded to tray at 50' intervals and bonded to building steel at each end. Note: Verify building steel is bonded to building grounding system.
- J. Cable tray system shall be completely installed and inspected by Owner before cable is installed in the tray.
- K. When trays are divided, at building entrances the communication section should be located on the north or east side of the tray, the 24V Inst. section should be in the middle of the tray and the 120V section should be on the south or west side of the tray.
1. See SSG 16.112.002.004, 16.112.008.001 and 16.112.008.002.

L. Cable Tray Dividers

1. Install as indicated on drawings.
2. Install dividers per manufacturer's instructions, Note: P&W recommends using retaining clips on outdoor installations and self-drilling screws on indoor installations. See SSG Document Number 16.112.008.003 Detail "23" for installation details
3. Install stainless steel clips when joining dividers

M. Cable Tray Covers

1. Install as indicated on drawings.
2. Install cable tray covers on vertical cable trays from floor level to height of 6 feet AFF even if not specified on drawings.
3. Covers shall be provided for cable tray located within four (4) feet horizontal distance of platform handrails.

Note: Consult Owner prior to installing cable tray covers, to verify cable de-rating has been addressed.

3.2 Cable Tray Tagging Requirements

1. Tag all Cable Tray at the following locations:
 - a) Minimum every fifty (50) feet on straight runs.
 - b) At dead ends.
 - c) At every change in direction; vertical and horizontal.
 - d) Both sides of a wall penetration.
 - e) Inside dividers and tray.
2. Tags shall be laminated plastic.
3. Affix tags to outside of cable tray, both walls and on dividers of tray, using Dow Corning 790 or 732 clear sealant.
4. See SSG Document Number 16.195.006.001 for tagging examples.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

A. This section covers requirements for the following:

1. Building Wire
2. Power and Control Tray Cable
3. Wire and Cable Accessories
4. Instrument wiring

1.2 REFERENCES

A. Codes

1. Wiring method and materials shall comply with The National Electrical Code (NEC)

B. SSG Document Numbers

1. 16.120.010: 600 Volt, 500 Kcmil Cable Splicing

PART 2 PRODUCTS**2.1 MATERIALS**

A. Building Wire

1. NEC Type, All wiring shall be UL listed or labeled.
2. This document is intended as a guide for new installations to promote standardization for selecting types of building wire for these new installations.

3. Building wire selection chart

| <u>WIRE SIZE</u> | <u>NEC TYPE</u> | <u>TEMP. RATING</u> | <u>LOCATION</u> |
|----------------------------------|-----------------|---------------------|-----------------------------|
| | (See 2.7) | | |
| #14 through #8 AWG | THW | 75°C | Acceptable in all locations |
| | XHHW | 75°C | Acceptable in all locations |
| | TW | 60°C | See 6 |
| | THHN/THWN | 75°C | See 4 |
| #6 through #4/0 AWG | THW | 75°C | Acceptable in all locations |
| | XHHW | 75°C | Acceptable in all locations |
| | THHN/THWN | 75°C | See 4 |
| #250 kcmil through #500 kcmil | XHHW | 75°C | Acceptable in all locations |
| | THW | 75°C | Acceptable in all locations |
| | THHN/THWN | 75°C | See 4 |

4. Usage of THHN/THWN wiring is limited to the following:

- a) Office areas
- b) Toilet and locker rooms
- c) Hallways and corridors
- d) Plenums
- e) Switch Rooms, Nest Rooms and Comm rooms
- f) Laboratories and Cleanrooms
- g) Control rooms
- h) Non-Chlorosilane atmospheres in some plant locations
- i) Other areas with engineering approval

5. The engineer issuing a work request for construction shall specify the type of wire allowed based on the list above.
6. TW Wire acceptable in all locations.
NOTE: The availability of TW wire is becoming scarce and will eventually be unavailable.
7. Even though XHHW and THHN wires have 90°C temperature ratings in dry and damp locations, they are to be treated as having 75°C temperature ratings because terminals are not rated over 75°C at this time.
8. Wiring for certain equipment, such as circulation heaters, may require higher temperature-rated insulation, such as type FEPB (rated for 200°C in dry locations).
9. Any wire factory marked with the required insulation type is permitted (e.g., MTW/THW is permitted to be used for THW applications).

B. Color coding and tagging

1. 480 Volt 3 phase motor power conductors and 480 Volt 3 phase power conductors (e.g., circulation heaters, transformers, and feeders)
 - a) Building wire and Multiconductor cable - conductors to be all black or black, red, and blue.

2. Motor control conductors

- a) Building wire per the following:

- 1) Wire 1 - red
- 2) Wire 2 - white
- 3) Wire 3 - yellow
- 4) Wire 4 - blue
- 5) Wire 5 - orange
- 6) Wire 6 – brown

NOTES:

1. Wire 5 shall be orange for Building wire only.
2. Some complicated control schematics require different color coding schemes. In that case, specific changes in wire color coding scheme shall be documented on the drawings. Wire #2 shall remain white for all cases.

- b) Multiconductor cable is to be color coded per ICEA Method 1, Take K-2 as follows:

| ICEA METHOD 1, TABLE K-2 | | | |
|---------------------------------|--------------|---------------------------------|-----------------------------|
| WIRE NUMBER | COLOR | RENUMBER IN FIELD AS | TAPE IN FIELD AS |
| 1 | BLACK | 5 | |
| 2 | RED | 1 | |
| 3 | BLUE | 4 | |
| 4 | ORANGE | 2 | WHITE |
| 5 | YELLOW | 3 | |
| 6 | BROWN | 6 | |
| 7 | RED/BLACK | 7 | |
| 8 | BLUE/BLACK | 8 | |
| 9 | ORANGE/BLACK | 9 | |
| 10 | YELLOW/BLACK | 10 | |
| 11 | BROWN/BLACK | 11 | |
| 12 | BLACK/RED | 12 | |

3. 120/240 Volt – 1 phase, 3 wire for lighting, power, and motor circuits
 - a) White or gray - "neutral" conductor

- b) Black and red - phase conductors
- 4. 208Y120 Volt - 3 phase, 4 wire for lighting, power, and motor circuits
 - a) White or Gray - "neutral" conductor
 - b) Black, Red, and Blue - phase conductor
- 5. 480Y277 Volt - 3 phase, 4 wire (grounded wye) for lighting
 - a) White or Gray - "neutral" conductor
 - b) Black, Red, and Blue - phase conductors
- 6. Color coding of phase, neutral, and grounding conductors
 - a) Phase (1), (A), or (X) - Black
 - b) Phase (2), (B), or (Y) - Red
 - c) Phase (3), (C), or (Z) - Blue
 - d) Neutral or grounded - White or Gray
 - e) Grounding - green or bare (used solely for equipment and enclosure grounding purposes, unless specifically indicated otherwise)
- 7. Power DC wiring
 - a) Red - positive conductor
 - b) Black - negative conductor
- 8. Instrumentation DC wiring
 - a) Black – positive conductor
 - b) White – negative conductor
- C. Wire and cable tags
 - 1. Electrical / Instrument
 - a) Brady self-adhesive, preprinted markers
 - b) Ziptape "Rite and Wrap" markers
 - c) Brady sleeve with typed characters
- D. Wire Identification Tags
 - 1. All lighting, power, and control wiring shall have, in addition to the above color coding, numbered wire markers or preprinted slip-on wire markers affixed to each conductor with lighting circuit or wire number in accordance with the drawings.
 - a) These numbers shall appear at each termination and splice point.
 - b) All motor control wires routed between the motor starter and instrument I/O cabinets shall be labeled with the instrument loop numbers and the wire number as shown on the electrical schematic at each termination point.
 - c) Equipment such as disconnect, transfer switches, UPS etc. with multiple conductors must include source or feeder equipment and terminal number.

E. Cable Identification Tags

1. All lighting, power, and control multiconductor cables shall have preprinted slip-on cable markers affixed to each end of the cable with the number in accordance with the cable schedule and/or drawings.
 - a) All motor control cables routed between the motor starter and instrument I/O cabinets shall be labeled at each termination point with the motor starter number.

F. Portable Cords

1. Materials for portable cords:
 - a) Do not use less than #14 AWG conductors, with ground wire.
 - b) Do not use flat cords due to twisting and kinking.
 - c) Use Type SO for extra hard usage in applications of 600 Volts or less.
 - d) Use Type SJO for hard usage in applications of 300 Volts or less.
2. Materials for power supply cords and cord sets.
 - a) Use no less than #18 AWG conductors, with ground wire.
3. Areas of use for cords:
 - a) On cord connected equipment, do not connect cords to devices and fittings such that tension will be transmitted to joints or terminals. These connections may require additional mechanical support.
 - b) Do not use where exposed to rough treatment, like vehicular traffic, foot traffic, exposure to chemicals, or other severe physical abuses. Do not use as a substitute for fixed wiring or conceal behind wall coverings.
 - c) Use of these cords on equipment requiring frequent movement or relocation is permitted.
 - d) With the use of the appropriate plugs and receptacle sets, only type SO should be used in Hazardous Areas. (Refer to NEC-501-140 and SSG Document Number series HSG-GDL-16140 - Plugs and Receptacles)

G. Tray Cable, Power and Control**1. 600 Volt, Multiconductor, Power Tray Cable**

- a) Standards and codes compliance
 - 1) Cable shall comply with applicable ASTM, IEEE, ANSI, NEC, UL, and ICEA codes/standards.
 - 2) Cable shall meet requirements of 70,000 Btu/hour "Cable Tray Preparation Test" per IEEE 383, plus same test conducted at 210,000 Btu/hour.
2. Construction
 - a) Cable shall be 600 Volt, NEC Type TC, multi-conductor, non-armored, power cable, suitable for cable tray, conduit, or direct burial installations.
 - b) Insulated conductors shall be Class B; stranded copper conductor with cross-linked polyethylene insulation, 75°C wet and 90°C dry location rated, NEC Type XHHW or THHN/THWN where allowed.
 - c) Insulated conductors shall be identified as follows:

- 1) Cables containing conductors #8 AWG and larger shall be colored black and numbered per ICEA Method 4. Cables containing conductors #10 AWG and smaller shall be numbered and color coded per ICEA Method 3, Table K-2 as follows

| Wire Number | Color |
|-------------|--------|
| 1 | Black |
| 2 | Red |
| 3 | Blue |
| 4 | Orange |

NOTE: Where the fourth (orange) wire is used as "neutral" for 3-phase, 4-wire systems, it will need to be taped white during construction.

- d) Bare, stranded ground wire(s) shall be included and sized per UL Standard 1277.
- e) Overall jacket shall be sunlight resistant with a gas/vapor tight continuous sheath, polyvinyl chloride with surface markings in compliance with NEC Article 310-11.
3. Warranty
- a) Cable shall be free from defects in materials and workmanship and shall conform to specifications included herein.
- b) Warranty period shall be one year after installation, not to exceed eighteen months after receipt of cable.
4. 600 Volt, Multiconductor, Control Tray Cable
- a) Standards and codes compliance
- 1) Cable shall comply with applicable ASTM, IEEE, ANSI, NEC, UL, and ICEA codes/standards.
- 2) Cable shall meet requirements of 70,000 Btu/hour "Cable Tray Preparation Test" per IEEE 383, plus same test conducted at 210,000 Btu/hour.
5. Construction
- a) Cable shall be 600 Volt, NEC Type TC, multi-conductor, non-armored, control cable, suitable for cable tray, conduit, or direct burial installations.
- b) Individual conductors shall be Class B; stranded copper conductor with cross-linked polyethylene insulation, 75°C wet and 90°C dry location rated, NEC Type XHHW or THHN/THWN where allowed.
- c) Conductors shall be color coded per ICEA Method 1, Table K-2 as follows:

| Wire Number | Color |
|-------------------------|--------------|
| 1 | Black |
| 2 | Red |
| 3 | Blue |
| 4 | Orange |
| 5 | Yellow |
| 6 | Brown |
| 7 | Red/Black* |
| 8 | Blue/Black |
| 9 | Orange/Black |
| 10 | Yellow/Black |
| 11 | Brown/Black |
| 12 | Black/Red |
| * Red with black tracer | |

Overall jacket shall be sunlight resistant with a gas/vapor tight continuous sheath, polyvinyl chloride with surface markings in compliance with NEC Article 310-11.

6. Warranty

- a) Cable shall be free from defects in materials and workmanship and shall conform to specifications included herein.
- b) Warranty period shall be one year after installation, not to exceed eighteen months after receipt of cable.

H. Minimum Conductor Sizes

1. Power Circuits - #12 AWG
2. Lighting and Receptacle Circuits - #12 AWG
3. Motor Control Circuits - #14 AWG (600 volt rated)
4. Non-Motor Controls Circuits - #16 AWG 90°C wire (300 Volt or 600 Volt Rated)

I. Wire, Cable, and Accessories

1. This document is intended as a guide for new installations to promote the use of the appropriate wires, cables and electrical materials, and installation techniques.
2. Building wire shall be per section A above and shall be color-coded per section B above.
3. Tray cable shall be per SSG Document Numbers per section G above.
4. Flexible cord shall be "S0" type. See section F above for additional information.
5. Fixture wire shall be Number 14 AWG, with 2/64 inch (30 mil) silicone rubber insulation and glass braid, NEC-Type SF-2 with 200°C rating.
6. Wire connectors shall be UL listed.
7. Solder-less Pressure Connectors shall be used for taps and splices such as T&B one-piece non-insulated PT connector.
8. Termination Lugs shall be seamless wrought type lugs, such as T&B 54000 series or Burndy YA. For Motor Control Center (MCC) feeders, use two hole lugs.
9. Wire nuts shall not be used except for ballast/driver connections within fluorescent/LED fixtures.
10. Splices made with non-insulated connectors in all wiring 600 Volt and lower shall be taped.
11. Terminals shall not have more than three (3) wires installed under one terminal connection.
12. Tape used for splicing and terminating wires (600 Volt and less) shall be 3M SCOTCH® 33+.
13. 600 Volt and lower motor lead splices shall be either taped or be made up with pre-molded, insulated sleeve kits. Use UL listed sleeve kits.
14. Cable ties shall be sunlight resistant, black polypropylene. (Nylon cable ties are not acceptable.)

J. Variable Frequency Drive and SCR controlled Devices

1. Cables up to #2 AWG shall comply with SSG #16.120 Tray Cable Section; having sunlight resistant PVC jacket, braided shield with minimum 75% coverage, 100% coverage foil drain, minimum #6 AWG phase conductors with type XLPE insulation, NEC Type XHHW. Cables size #1 and larger AWG may have 2 spiral copper tape shields with 100% coverage.
2. Use Belden #295xx, Service Wire Co. type "ServiceDrive ASD" or Owner-approved equal
 - a) Equivalent cables must be submitted to the owners lead electrical engineer via the owner electrical engineering representative in writing a minimum of 10 days prior to the bid due date.
 - b) Submittal does not guarantee approval.

- c) All equivalent materials must be approved in writing before they can be used in the plant.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Wire and cable shall be installed in cable tray, conduit, or other raceway system unless otherwise specified.
- B. Cable terminations for Dry Type Transformers, Motor Control Centers, Motors, etc shall be bolted crimp type Terminal Lugs per section H above
- C. All 480 volt circuits to be installed in separate rigid conduits unless Owner approved.
- D. Cable installed in cable tray shall be neatly arranged and lashed to rungs every 18 inches (maximum) in vertical runs and every 5 feet (maximum) in horizontal runs using black polypropylene cable ties.
 - 1. Excess cable ties shall be cut off as close as possible with the locking end of the tie located on the back (outside) of the cable tray. Note: This is to prevent cutting and scarring of future cables and personal injuries.
- E. Adequate slack shall be provided in wire and cable:
 - 1. Inside boxes and enclosures to ensure that there is no binding at entrance bushing.
 - 2. Inside MCC wireways to ensure that there is enough slack to reach the bottom or top starter/disconnect.
 - 3. On motor leads within starter enclosure to permit use of a "clamp-on" ammeter in any phase conductor.
- F. Continuous wire lengths (without splices from terminal to terminal) shall be installed.
 - 1. Lighting and receptacle branch circuit, single conductor wires may be tapped and spliced as required at conduit fittings.
- G. Wiring taps and splices shall be properly insulated
 - 1. For 600 Volt wire, use T&B Sta-Kon Crimp-on insulated wire joint or PT and tape with a minimum of four half-lapped layers. (Wire nuts shall not be used for this purpose.) Exception: Wirenuts can be used in lighting ballasts enclosures.
 - 2. Underground taps or splices in handholes or manholes are to be approved for the purpose and installed per manufacture instructions.
- H. Terminals shall not have more than three (3) wires installed under one terminal connection.
- I. No sharing of neutral conductors.
- J. 480 Volt VFD Driven motors and SCR Controlled Devices
 - 1. Shielded power cables will be used for all 480 Volt VFD Drive and SCR Controlled Devices.
 - 2. Shields shall be terminated in as noted in SSG 16.020.007
- K. 500 Kcmil Splicing for MCC's
 - 1. Each MCC with 500 Kcmil feeders ran in cable tray over 100 feet in length may use the free air rating allowed by the NEC. To meet the NEC three conductors in conduit rating the cable will need to be spliced in accordance with SSG 16.020.010.
 - 2. Each MCC with feeders ran in conduit or cable tray less than or equal to 100 feet in length will use the NEC three conductor in conduit ratings.

3.2 Cable Designation and Wire Tagging

- A. Cables shall be labeled on each end with the cable number shown on drawings and/or cable schedules.
 - 1. Minimum Text size shall be 16pt
- B. Wires and individual cable conductors shall be labeled on each end with wire numbers shown on drawings.
- C. Spare wires shall be marked "SP" on each end.
- D. Cable conductors originating in lighting or instrument (circuit breaker) panelboards shall have the following tagging on the destination (load) end, in addition to the above:
 - 1. Phase and grounded (neutral) conductors shall be tagged with the panelboard designation and circuit number (e.g. "B-6").

3.3 TESTING

- A. Refer to Section 16950 for testing details.

END OF SECTION

PART 1 GENERAL

1.1 SCOPE

- A. This section covers requirements for the following wiring devices and associated mounting boxes:
 - 1. Control (pushbutton) Stations
 - 2. Receptacles
 - 3. Toggle Switches
 - 4. Wall mounted occupancy sensors
 - 5. Wiring Device Mounting Boxes
 - 6. Local Disconnect Switches (External to MCC)

1.2 REFERENCES

- A. SSG Document Numbers
 - 1. 16.140.001 HSC Typical Allen-Bradley Pushbutton Stations
 - 2. 16.481.001 Electrical Conduit Installation for Motors

PART 2 PRODUCTS

2.1 MATERIALS

- A. Control (pushbutton) stations for standard and Class I, Division 2, Groups A, B, C, and D areas per SSG Document Number 16.140.001.
 - 1. Allen-Bradley Bulletin 800R hermetically sealed contact units in NEMA 4X enclosures unless otherwise specified.
 - 2. Stations shall be furnished with silicone rubber protective boots (standard Hypalon® boots are not acceptable).
 - 3. Stop buttons shall be equipped with a Padlocking Attachment Unit.
 - 4. Pushbuttons and selector switches shall be provided with legend plate markings per the drawings.
- B. Receptacles
 - 1. 125/250/277 Volt General use receptacles for standard areas should be specification grade with straight blade 3-wire grounding type with brown phenolic body, having screw terminals for side wiring ("Quick-connect", back-wired terminations are unacceptable) the following meet this criteria:
 - Note: Standard area receptacle catalog numbers do **not** include mounting box.
 - a) 15A, 125V Single Outlet (NEMA 5-15R): Hubbell No. HBL 5261
 - b) 15A, 125V Duplex Outlet (NEMA 5-15R): Hubbell No. HBL 5262
 - c) 15A, 250V Duplex Outlet (NEMA 6-15R): Hubbell No. HBL 5662
 - d) 20A, 125V Single Outlet (NEMA 5-20R): Hubbell No. HBL 5361
 - e) 20A, 125V Duplex Outlet (NEMA 5-20R): Hubbell No. HBL 5362
 - f) 20A, 250V Duplex Outlet (NEMA 6-20R): Hubbell No. HBL 5462
 - g) 20A, 250V Single Outlet (NEMA 6-20R): Hubbell No. HBL 5461
 - h) 30A, 250V Single Outlet (NEMA 6-30R): Hubbell No. HBL 9330
 - i) 15A, 277V Duplex Outlet (NEMA 7-15R): Hubbell No. HBL 5302
 - Acceptable substitutes: Leviton and Pass & Seymour (P&S).

2. 120V General use GFCI receptacles for standard areas shall be straight blade heavy duty industrial specification grade type, 2-pole, 3-wire grounding, and brown thermoplastic body, the following meet this criteria:

NOTE: Standard Area GFCI receptacle catalog numbers do not include mounting box.

- a) 15A, 125V duplex GFCI receptacle (NEMA 5-15R): Hubbell cat. # GF5262
- b) 20A, 125V duplex GFCI receptacle (NEMA 5-20R): Hubbell cat. # GF5362

Acceptable substitutes: Leviton and Pass & Seymour (P&S).

3. Isolated ground general use receptacles for standard areas should be specification grade with straight blade 3-wire grounding type with orange nylon face and brown thermoplastic body, having side screw terminals for side wiring ("Quick-connect", back-wired terminations are unacceptable), the following meet this criteria:

NOTE: Standard Area isolated ground receptacle catalog numbers do not include mounting box.

- a) 15A, 125V duplex isolated ground receptacle (NEMA 5-15R): Hubbell cat. # IG5262
- b) 20A, 125V duplex isolated ground receptacle (NEMA 5-20R): Hubbell cat. # IG5362

Acceptable substitutes: Leviton and Pass & Seymour (P&S).

4. 120 Volt Receptacles for Classified Areas General use receptacles (120VAC) for classified areas should be Appleton U-line, factory sealed, M-series malleable iron, 125VAC, 20 amp, 2-wire, 3-pole, 3/4 inch hub, with a top hinged cover; the following meet this criteria:

- a) 20 amp, 125VAC, single outlet, feed-through: Appleton EFSCB175-2023M (includes mounting box)
- b) Plug for U-line receptacles shall be Appleton-type plugs, 125VAC, 15 amp, 2-wire, 3-pole, catalog number ECP-1523.
- c) Plug for U-line receptacles shall be Appleton-type plugs, 125VAC, 20 amp, 2-wire, 3-pole, catalog number ECP-2023.
- d) These watertight plugs also fit NEMA 5-15R, 5-20R, or 6-20R receptacles in non-classified areas, but ordinary plugs will not activate the U-line receptacle.
- e) The above receptacles and plugs are approved for the following hazardous locations:
 - 1) Class I, Division 1 and 2, Groups B, C, and D
 - 2) Class II, Division 1 and 2, Groups F and G
 - 3) Class III

5. 480 Volt Switch/Receptacles for Standard and Classified Areas

- a) Indoor, Dry and Non-Classified Location:
 - 1) Square D Interlocked Non-Fusible Receptacle Switch, Cat. No. HU362AWC, 60 amp, 600 Volt, 3-pole, NEMA 12 switch with Crouse-Hinds 60 amp, 3-pole, 4-wire, ARKTITE receptacle (for use with Crouse-Hinds No. APJ6485 plug).
- b) Outdoor and Class I, Group B, C and D, and Class II, Group G Locations:
 - 1) Appleton No. EBR6034EH50-GB, 480 V, 3-pole, 4-wire, 60 amp rated receptacle with 50 amp circuit breaker. Device to be U.L. listed for Class I, Group B, C, and D, and Class II, Group G. (For use with Appleton No. ACP6034BC plug).
- c) Plugs:
 - 1) Appleton No. ACP6034BC plug and Crouse-Hinds No. APJ6485 plug are equivalent and interchangeable.

C. Toggle Switches

1. 120-277 Volt Toggle Switches for Standard and Classified areas.

Note: (switches being used for an maintenance disconnecting means shall be equipped with a locking device)

- a) A general use toggle switch for standard areas is constructed so that it can be used in flush device boxes, through an outlet box cover, or otherwise used in conjunction with wiring systems. The following are Federal Specification Grade switches, rated 20A, 120-277V, AC ONLY, with brown handle.

NOTE: Standard area toggle switch catalog numbers do not include enclosure.

1) 1-pole:

- (i) Hubbell No. HBL-1221
- (ii) Arrow-Hart No. 1991
- (iii) Pass & Seymour (P&S) No. 20AC1
- (iv) Leviton No. 1221-2

2) 2-pole:

- (i) Hubbell No. HBL-1222
- (ii) Arrow-Hart No. 1992
- (iii) Pass & Seymour (P&S) No. 20AC2
- (iv) Leviton No. 1222-2

3) 3-way:

- (i) Hubbell No. HBL-1223
- (ii) Arrow-Hart No. 1993
- (iii) Pass & Seymour (P&S) No. 20AC3
- (iv) Leviton No. 1223-2

4) 4-way:

- (i) Hubbell No. HBL-1224
- (ii) Arrow-Hart No. 1994
- (iii) Pass & Seymour (P&S) No. 20AC4
- (iv) Leviton No. 1224-2

- b) Toggle switches for classified areas, **except Group B**, shall be Crouse-Hinds EDS, factory sealed switches as listed below:

| Hub Size | Style | <u>Amperes</u> | | <u>Single Gang</u> | | <u>Two Gang</u> | |
|----------|--------|----------------|--------|--------------------|-------------------|-----------------|---------------------|
| | | 120VAC | 277VAC | Dead End Cat. # | Through Feed Cat# | Dead End Cat# | Through Feed Cat. # |
| 3/4 | 1-pole | 20 | 20 | ESD2129 | ESD2129 | ESD2229 | ESD2229 |
| 3/4 | 2-pole | 20 | 20 | EDS218 | EDSC218 | | EDSC228 |
| 3/4 | 4-way | 20 | 20 | EDS2130 | EDSC2130 | EDS2230 | EDSC2230 |
| 3/4 | 4-way | 20 | 20 | EDS2140 | EDSC2140 | | EDSC2240 |
| 1 | 1-pole | 20 | 20 | EDS3129 | EDSC3129 | EDS3229 | EDSC3229 |
| 1 | 2-pole | 20 | 20 | EDS318 | EDSC318 | EDS328 | EDSC328 |
| 1 | 3-way | 20 | 20 | EDS3130 | EDSC3130 | EDS3230 | EDSC3230 |
| 1 | 4-way | 20 | 20 | EDS3140 | EDSC3140 | EDS3240 | EDSC3240 |

- 1) The above switches are approved for the following hazardous locations:

- (i) Class I, Groups C and D
- (ii) Class II, Groups E, F, and G
- (iii) Class III

- c) Toggle switches **for Group B** classified areas shall be Appleton EDS factory sealed switches listed below:

| Hub Size | Style | | | <u>Single Gang</u> | |
|----------|--------|--------------------------|--------|--------------------|------------------------|
| | | <u>Amperes</u> 120VAC | 277VAC | Dead End Cat. # | Through Feed Cat. # |
| 3/4 | 1-pole | 20 | 20 | EDS175-F1 | EDSC175-F1 |
| 3/4 | 2-pole | 20 | 20 | EDS175-F2 | EDSC175-F2 |
| 3/4 | 3-way | 20 | 20 | EDS175-F3W | EDSC175-F3W |
| 3/4 | 4-way | 20 | 20 | EDS175-F4W | EDSC175-F4W |

Note: Group B switches are not available for two gang enclosures or with hubs greater than 3/4 inch.

- 1) The above toggle switches are approved for the following hazardous locations:
- (i) Class I, Groups B, C and D
 - (ii) Class II, Groups E, F, and G
 - (iii) Class III

D. Wall mounted occupancy sensors

1. Leviton ODS10 series passive infrared
2. Sensor switch series WSD passive infrared

E. Wiring Device Mounting Boxes and Covers

1. General use mounting boxes for standard areas shall be Crouse-Hinds or Appleton standard (FS) or deep (FD) mounting boxes with 3/4" or 1" threaded hub or drill and tap, dead end or feed through as needed.

2. Example Boxes:

| <u>Description</u> | <u>Appleton</u> | <u>Crouse Hinds</u> |
|---|-----------------|---------------------|
| Single gang shallow, 3/4" hub | FS-1-75 | FS2 |
| Single gang deep, 3/4" hub | FD-1-75 | FD2 |
| Two gang shallow, 3/4" hub, feed through | FSC-2-75 | FSC222 |
| Three gang deep, Drill and tap, multiple covers | FDB-3L | FD039 |

3. Use the following Crouse Hinds box covers in standard areas.
4. Use the following Appleton box covers in standard areas.

5. Example covers:

| <u>Description</u> | <u>Appleton</u> | <u>Crouse Hinds</u> |
|---|--------------------|---------------------|
| Receptacle Dry | FSK-1R-T | DS21 |
| Receptacle Dry 2 gang | FSK-2R-Q | S212 |
| Duplex Receptacle Dry | FSK-1DR | DS23 |
| Duplex Receptacle Dry 2 gang | FSK-2DR | S232 |
| Receptacle Wet Location | FSK-1VR | WLRS-1 |
| Duplex Receptacle Wet Location | FSK-1VDR | WLRD |
| Toggle Switch cover Dry locations | FSK-1TS | DS32 |
| Toggle Switch cover Dry Locations, 2 gang | FSK-2TS | S322 |
| Toggle Switch Wet Locations (lockable) | FSK-1VS or FSK-WT2 | DS-199 |

6. Covers for FS type boxes to be stamped steel with stainless steel screws, less gasket.
7. Covers for flush mounted boxes to be Stainless Steel unless specified otherwise.
8. When lockable switch covers in dry locations are required use Allen-Bradley #600-N1 or Square-D #251-FL1 with toggle switch covers listed above.

- F. Local Disconnect Switches (External to the MCC)
 - 1. Provide and install Non-Fusible type switches (unless otherwise specified).
 - a) Install Fusible type switches if there is no upstream circuit fusing.
 - 2. Standard Areas (indoor and outdoor)
 - a) Square "D" Class 3110 Heavy Duty Visible Blade Safety Switches.
 - 3. Class I, Groups B, C & D and Class II, Groups E, F & G Areas
 - a) Appleton type EDS Heavy Duty Explosion Proof Disconnect Switches.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mounting Heights (unless otherwise specified)
 - 1. Control Stations - 4 feet, 6 inches to top of unit.
 - 2. 120/277 Volt Toggle and Local Disconnect Switches - 4 feet to center of device.
 - 3. 120 Volt Receptacles in Office Areas - 15 inches to center of device.
 - 4. 120 Volt Receptacles in Process Areas - 3 feet above floor to bottom of receptacle.
 - 5. 480 Volt Receptacles - 3 feet to bottom of unit.
 - 6. 480 Volt Disconnect Switches – 5 feet, 6 inches to top of unit.
- B. Control Stations
 - 1. Provide and install control station stand per SSG Graphic Document Number 16.481.001.003
 - a) Consult with Owner to determine best location.
 - b) Location shall avoid blockage of operating and maintenance access to process equipment.
 - 2. Conduit entry into control stations shall be from the bottom of the station per SSG Graphic Document Numbers 16.481.001.001 and 16.481.001.003.
 - 3. Tagging of control station to be per Section 16195.
- C. 125/250/277 Volt Receptacles
 - 1. Mount receptacles in vertical format with ground pole down.
- D. 480 Volt Switch/Receptacles
 - 1. Consult with owner to determine the best location of the 480 Volt Switch/Receptacles per SSG Document Number 16.146.404.
 - 2. Equipment Wiring
 - a) Provide and install a Separate Equipment Grounding Conductor from the MCC Starter/Disconnect Switch to each Switch/Receptacle.
 - 3. Equipment Fusing
 - a) Install LPS type Fuses. Install 30 Amp Fuses for 30 Amp Receptacles and 60 Amp Fuses for 60 Amp Receptacles. Local Disconnect Switches (if needed) shall be the fusible type.
 - 4. SMP Overload Relay Settings if applicable
 - a) 60 Amp Switch/Receptacles: Set the Allen Bradley SMP2 Electronic Overload Relay Full Load Current Setting to 60 Amps, Ground Fault to "ON", Reset Type to "Manual", Trip Class to "10" and Jam/Stall to "ON".

5. Warning labels

- a) Install a Warning Sign at each 480V Receptacle/Switch per SSG Graphic Document Number 16.195.004.006

6. Phase connections

- a) Match existing plant phase sequence.

- 1) 30A, 600V units: 1-2-3, 2-3-1, 3-1-2, A-B-C, B-C-A, or C-A-B.
- 2) 60A, 600V units: 2-1-3, 1-3-2, 3-2-1, B-A-C, A-C-B, or B-C-A.

Note: Use phase meter to match existing sequence.

7. Extension Cord Connections

- a) When extending a cord, the plug connections shall be installed using a Female and Male Plug (Appleton ACP6034BC AND ARC6034BC or CH equal). The Female Plug contains an internal bonding lug which provides a solid ground to the housing and the connected load.

E. All terminations to be torqued to manufacturer's specifications and identified by a red paint pen across the fastener and the back plane.

1. Acceptable manufacturers

- a) Sanford
- b) Uni Paint
- c) Alternates can be submitted for owners approval

3.2 TESTING

A. Receptacles

- 1. Verify polarity connections.
- 2. Verify proper ground.
- 3. Verify Ground Fault Circuit Interruptible outlets trip at 5 milli-amps

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers requirements for tagging and identification of electrical system equipment and wiring.
- B. If desired for a particular installation the engineer shall issue to the electrical contractor with instructions to install this tagging in lieu of that identified in this specification.

1.2 REFERENCES

- A. SSG Document Numbers
 - 1. 16.195.004: Tagging and Identification Construction Requirements
 - 2. 16.195.006: Cable Tray Tagging

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Wire and Cable Tags per Section 16120.
- B. Equipment Tags per SSG Document Number 16.195.004.
- C. Cable Tray Tags per SSG Document Number 16.195.006.
- D. Communication per Section 27150
- E. Fire Alarm per Section 28320 and 28321
- F. Electronic Security System (Access Control) per Section 28140

PART 3 EXECUTION**3.1 DISCUSSION**

- A. Philosophy of tagging
 - 1. Electrical equipment must be clearly and accurately tagged and identified for:
 - a) Safety reasons
 - b) Maintenance operations
 - c) Future changes and/or additions to equipment
 - 2. When tagging is properly installed, it provides a trail which will lead to the data required to complete the task at hand. The more information there is on the tags, the better the chances of finding the necessary data.
 - 3. Not all equipment will require the same information, nor will all tags be identical in size or format. Further definition may be found in other sections of this SSG.

3.2 INSTALLATION

- A. Warning signs shall be installed immediately Preceding Energization of equipment indicating that the equipment is energized (In Service or "Hot"). Temporary Signs shall remain in place for duration of construction.
- B. Temporary Tagging
 - 1. Temporary tags shall be installed immediately after equipment is installed unless permanent engraved plastic tags are available.
 - 2. Temporary tagging and identification shall be used during construction to prevent incorrect permanent tagging, aid construction and ensure personnel protection
 - a) Temporary tagging shall be replaced Prior to Equipment Energization with permanent tags.

- b) Once permanent tags are in place remove temporary tags and any remaining tape or glue residue

C. Permanent Tagging

1. Permanent tagging shall be completed and in place Prior to Energizing Equipment and before final payment is made to the electrical contractor.
 - a) The equipment installer shall provide and install tagging unless specifically identified otherwise in a tagging SSG or formal contract document.
 - b) All tags shall be permanently engraved on laminated plastic tags as described by the applicable SSG unless otherwise indicated in a tagging SSG or formal contract document.
2. Electrical Distribution Equipment Tagging:
 - a) Electrical distribution equipment identification shall include relevant the circuit number(s), equipment or item number, a brief description of equipment, location of service or equipment serviced and wiring diagram as appropriate.
 - b) See the Attachments below for typical tagging locations on field equipment.
3. Arc-Flash Tagging
 - a) Arc-Flash Tagging will be provided by and installed as directed by HSC Power Distribution Engineering.
 - 1) Leave a 3" Height by 5" Wide space on the breaker, disconnect or bucket for the Arc-Flash Tag installation.
 - b) All Medium Voltage Disconnects/Breakers, Main Substation Switchgear (MS), Unit Substation Switchgear (USM) and Medium Voltage Motor Control Centers (MVC) will be tagged with the Appropriate Arc-Flash Sticker.
 - 1) Including but not limited to MS/USM/MVC Main, Tie and Branch Breaker/Disconnects
 - c) All 480 Volt Unit Substations switchgear (USL), standalone Main Disconnects and Motor Control Centers (MCC) will be tagged with the Appropriate Arc-Flash Sticker.
 - 1) Including but not limited to USL/MCC Main, Tie and Branch
4. Field Equipment Tagging:
 - a) Field equipment tagging identification shall include relevant the circuit number(s), equipment or item number, a brief description of equipment, location of service or equipment serviced and wiring diagram as appropriate.
 - 1) Refer to the "Typical Tagging Locations on Field Equipment" SSG documents 16.195.004.001, through 16.195.004.007 for general field equipment tags.
 - 2) Refer to SSGs 16.195.004.009 for graphic representations of SMP-453 DCS/SIS Warning Tags
 - 3) Refer to SSGs 16.195.004.010 through 16.195.004.029 of graphic representations of electrical distribution equipment tagging
 - 4) Refer to SSGs 16.195.004.033 of graphic representations of electrical enclosures with multiple sources
 - 5) Not all equipment may be detailed in the listed SSGs. However, the SSGs do provide guidance for developing the required tags.
 - 6) In the event that the Field Equipment Tagging SSGs conflict with the Electrical Distribution Equipment Tagging SSGs, the Electrical Distribution Equipment Tagging SSGs shall have precedence.

5. Warning/Caution signs listed below shall be furnished and installed where specified below.

- a) Electrical equipment rooms (above 600V). Sign to read:

**DANGER
HIGH VOLTAGE
(Brady Cat. #: 80269)**

- b) Outside Warning Tagging. (16195004024)

- c) Electrically heated vessel and pipelines:

ELECTRIC TRACED

- d) 480 Volt Switch/Receptacles(16.195.004.006)

- e) SMP-453 DCS/SIS Warning Tags (16.195.004.009)

- f) Equipment fed from more than one power source:
as shown in 16.195.004.010 through 16.195.004.029.

6. Typical sizes, colors and heights

- a) Refer to the attached SSG documents for typical sizes, colors and heights.
b) Tags shall be affixed using DOW CORNING® 790 or 732 clear sealant.
c) Tag edges to be beveled (to avoid sharp edges).

D. Conduit system labeling

1. Individual conduits shall be labeled with the circuit number.

- a) Label conduits at the exit point from motor control centers and at both sides of wall penetrations. Example:

MC-1011

E. Wire and cables shall be labeled per requirements in Section 16120.

F. Lighting and distribution panels shall contain a CADD or PDF generated circuit schedule inside the door.

1. Prior to panelboard energization place a temporary hard copy of each panelboard schedule on the inside door of each respective panelboard. The panelboard schedule shall be printed from the latest drawing of record.
2. At completion of construction, the Electrical contractor shall complete an "As Built" of each panelboard schedule and return to Engineering to compare to schedules on file and update as needed.
3. Final Panelboard schedules will be provided by Engineering and installed in the respective panelboards by Engineering or the Construction Representative.

G. Critical Control Systems (UPS Type I)

1. Tags to be installed after the Process UPS start-up and before energizing the panelboard for new units.
2. UPS panelboards should have a separate tag identifying the panel is fed from the Process UPS and to contact the appropriate personnel prior to working on the panel or its loads per SSG 16195004025: "AC Panel Tagging".
3. All cable trays containing UPS circuits should be tagged:

CAUTION – UPS CIRCUITS

4. Tagging (White Lettering on Orange Background):

- a) MCC primary supply disconnect switch should have a separate tag stating:

WARNING

PRIMARY SUPPLY TO UPS
CONTACT ELECTRICAL SHOP OR
PLANT ENGINEERING
BEFORE OPENING THIS SWITCH

- b) MCC bypass supply disconnect switch should have a separate tag stating:

WARNING

PRIMARY SUPPLY TO UPS
CONTACT ELECTRICAL SHOP OR
PLANT ENGINEERING
BEFORE OPENING THIS SWITCH

- c) Disconnect switch(es) located at the UPS should have a separate tag stating:

WARNING

PRIMARY SUPPLY TO UPS
CONTACT ELECTRICAL SHOP OR
PLANT ENGINEERING
BEFORE OPENING THIS SWITCH

- d) All UPS circuit wires should be tagged as follows:

CIRCUIT #

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers requirements for general purpose, dry-type transformers for supplying circuit breaker panelboards.

1.2 REFERENCES

- A. SSG Document Numbers
 - 1. 16.461.003: Installation Test and Inspection Record for Dry-Type Transformers
 - 2. 16.020.004: Grounding of Dry Type Transformers, Panelboards and Associated Circuitry

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Single-phase and 3-phase transformers.
 - 1. For single-phase transformers, use this format, selecting one item from within the parenthesis:
(15, 25, 37.5, 50) KVA TRANSFORMER, single-phase, (Square D, Acme, Sola/Hevi-Duty), 480 Volts primary, 120/240 Volts secondary, 60 hertz, 220°C insulation system, 80°C rise by resistance, copper or aluminum windings, (indoor, outdoor) enclosure, (floor, wall) mounting; Six 2-1/2 percent taps, 2 above and 4 below normal primary voltage, UL listed.
 - 2. For three-phase 480Δ-208Y120 VAC transformers, use this format, selecting one item from within the parenthesis:
(15, 30, 45, 75, 112.5) KVA TRANSFORMER, three-phase, (Square D, Acme, Sola/Hevi-Duty), 480 Volts delta primary, 208Y120 Volts secondary, 60 hertz, 220°C insulation system, 80°C rise by resistance, copper or aluminum windings, (indoor, outdoor) enclosure, (floor, wall) mounting; Six 2-1/2 percent taps, 2 above and 4 below normal primary voltage; UL listed.
 - 3. For three-phase 480Δ-480Y277 VAC transformers, use this format, selecting one item from within the parenthesis:
(45, 75, 112.5) KVA TRANSFORMER, three-phase, (Square D, Acme, Sola/Hevi-Duty), 480 Volts delta primary, 480Y/277 Volts secondary, 60 hertz, 220°C insulation system, 150°C rise by resistance, , copper or aluminum windings, (indoor, outdoor) enclosure, (floor, wall) mounting; Six 2-1/2 percent taps, 2 above and 4 below normal primary voltage; UL listed.
- B. All general purpose transformers shall be NEMA TP1 with maximum efficiency at 35%

PART 3 EXECUTION**3.1 INSTALLATION**

- A. Transformer placement shall not interfere with personnel access or wiring access to any panelboard.
- B. All terminations to be torqued to manufacturer's specifications and identified by a red paint pen across the fastener and the back plane.
 - 1. Acceptable manufacturers
 - a) Sanford
 - b) Uni Paint
 - c) Alternates can be submitted for owners approval

3.2 GROUNDING

- A. Provide transformer grounding per SSG Document Number 16.020.004.

3.3 TESTING

- A. Refer to Section 16950 for testing details.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers requirements for circuit breaker panelboards.

1.2 REFERENCES

- A. SSG Document Numbers

- 1. 16.020.004: Grounding of Dry Type Transformers, Panelboards and Associated Circuitry

1.3 DEFINITIONS

- A. RMC: Galvanized Rigid Metal Conduit per NEC Article 344

PART 2 PRODUCTS**2.1 MATERIALS**

- A. For single-phase 120/240 VAC panelboards, use this format, selecting one item from within the parenthesis:
120/240 VAC PANELBOARD, single phase, Square "D" NQ, unassembled, three-wire, (100, 225, 400) Amp main bus rating with standard (60, 80, 150, 200, 300) Amp 2-pole main breaker type (KA, LA, QOB), (top, bottom) feed, copper bussing, NEMA 1 enclosure, 42 circuit capacity, 20 inch wide box with interior mounting brackets), mono-flat (surface, flush) mounting front, equipment ground bar, (ground bar insulator kit), branch circuit breaker type QO/QOB.
- B. For three-phase 208Y120 VAC panelboards, use this format, selecting one item from within the parenthesis:
208Y120 VAC PANELBOARD, three phase, Square "D" NQ, unassembled, four-wire, (100, 225, 400) Amp main bus rating with standard (50, 100, 150, 250, 350) Amp 3-pole main breaker type (KA, LA, QOB), (top, bottom) feed, copper bussing, NEMA 1 enclosure, 42 circuit capacity, 20 inch wide box with interior mounting brackets), mono-flat (surface, flush) mounting front, equipment ground bar, (ground bar insulator kit), branch circuit breaker type QO/QOB.
- C. For three-phase 480Y277 VAC panelboards, use this format, selecting one item from within the parenthesis:
480Y277 VAC PANELBOARD, three phase, Square "D" NF, unassembled, four-wire, (100, 250) Amp main bus rating with standard (70, 110, 175) Amp 3-pole main breaker type (KA, KC, EDB, EJB), (top, bottom) feed, copper bussing, NEMA 1 enclosure, (30, 42) circuit capacity, 20 inch wide box with interior mounting brackets, mono-flat (surface, flush) mounting front, equipment ground bar, branch circuit breaker type EDB, EJB.
- D. 120/240 Volt single-phase and 208Y120 Volt 3-phase circuit breaker panelboards to be Square D NQ with plug & bolt-on branch breakers.
 - 1. Except for 20 amp/single pole and 20 amp/2 pole breakers which may be plug-on type.
- E. 480Y277 Volt 3-phase circuit breaker panelboards to be Square D "NF" with bolt-on branch circuit breakers.
- F. Integrated Power Centers:
 - 1. 208Y120 Volt 3-phase circuit breaker panelboards to be Square D NQ
 - 2. 480Y277 Volt 3-phase circuit breaker panelboards to be Square D "NF"
 - 3. General purpose transformers be NEMA TP1 with maximum efficiency at 35% current energy efficiency ratings:

PART 3 EXECUTION**3.1 INSTALLATION**

- A. Mounting height above finished floor to top of panelboard shall be:
 - 1. 6 feet for panelboards less than 4 feet in height
 - 2. 6 feet - 6 inches for panelboards 4 feet in height or greater
- B. Install (2) 3" RMC conduit from panelboard to the Cable Tray (if cable tray is used)
 - 1. Minimum 1 3" RMC Conduit to remain empty at the end of construction for new panelboard installations.
 - 2. Above the bottom cord of the Roof/Ceiling Truss (if cable tray is not available)
 - 3. Above the Lay-In Acoustical Tile Ceiling (if cable tray is not available)

Note: The above requirement is a minimum, conductor fill and de rating per NEC still applies
- C. Circuiting will be as specified on drawings.
- D. Tagging of Panelboards per Section 16195 shall be completed prior to Energizing the Panelboard.
- E. All terminations to be torqued to manufacturer's specifications and identified by a red paint pen across the fastener and the back plane.
 - 1. Acceptable manufacturers
 - a) Sanford
 - b) Uni Paint
 - c) Alternates can be submitted for owners approval

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

A. This section covers requirements for the following commonly used motor controllers:

1. 480 Volt Combination Starters
2. 480 Volt Motor Control Centers (MCCs)
3. 480 Volt Variable Frequency Drives (VFDs)
4. Manual Motor Starters
5. Manual Motor Switches

1.2 REFERENCES

A. SSG Document Numbers –

1. 16.140: 120-277 Volt Toggle Switches For Standard and Classified Areas
2. 16.030.001: Installation Test and Inspection Record for Motors and Motor Wiring (Motors Less Than 150HP)

PART 2 PRODUCTS**2.1 EQUIPMENT**

A. 480 Volt MCCs will be Allen-Bradley Centerline 2100 Standard or IntelliCENTER units as indicated on the plans.

1. IntelliCENTER Devicenet Electronic Overloads E3 Plus
2. Standard MCC Non-Devicenet Electronic Overloads E1 Plus

B. 480 Volt Combination VFDs / Fused Disconnect will be Allen-Bradley Power-Flex.

C. 480 Volt Non-Reversing Combination Starters NEMA size 1 through 7 to be Allen Bradley Bulletin 512 unless otherwise specified.

D. Manual Motor Starters (with overload protection) for Fractional HP Motors

1. For 480 Volt, Three-Phase Motors
 - a) Square D Class 2510, Type M with enclosure suitable for application.
2. For 115 Volt, Single-Phase Motors
 - a) Allen-Bradley Number 600-TOX4 with enclosure suitable for application.

E. Manual Motor Switches (without overload protection) for Fractional HP Motors

1. For 480 Volt, Three Phase Motors
 - a) Square D Class 2510, Type K with enclosure suitable for application.

F. All Manual motor switches are to be installed with a locking type of coverage or device.

1. See Section 16.140 for acceptable covers or locking devices.

2.2 MATERIALS

A. Fuses

1. For Combination Starters and MCCs, size per drawings.
 - a) Use Bussmann Low Peak LPS fuses, or owner approved equal.
2. For VFDs, fuses will be provided with unit unless otherwise specified.

B. Starter Overload Elements

1. Modifications to existing motor starters
 - a) Size based on actual motor nameplate information and appropriate selection tables.
 - b) Heater elements shall be suitable for manual reset, eutectic alloy, thermal overload relay.
 - c) For general applications, overload elements shall be Class 20, Type W units.
 - d) For canned pumps, overload elements shall be Class 10, Type J units.
2. New motor starters will be provided with Allen Bradley type E1+ or E3+ electronic overload relays.

PART 3 EXECUTION**3.1 INSTALLATION**

- A. Install equipment per the drawings and manufacturer's installation instructions.
- B. Bolted connections shall be properly tightened and torqued to manufacturer's recommendations prior to energization.
- C. All terminations to be torqued to manufacturers specifications and identified by a red paint pen across the fastener and the back plane
 1. Acceptable manufacturers
 - a) Sanford
 - b) Uni Paint
 - c) Alternates can be submitted for owners approval
- D. Equipment Setup
 1. Set-up procedures for Allen Bradley E1 Plus and E3 Plus Relays per SSG Document Number 16.030.001.001.
- E. Tagging
 1. Tagging of controllers shall be completed per Section 16195 prior to Equipment Energization.

3.2 TESTING

- A. Refer to Section 16950 for testing details.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

A. This section covers requirements for the following commonly used lighting systems:

1. LED
2. Fluorescent Lighting
3. High Intensity Discharge (HID) Lighting
4. Emergency Lighting

1.2 REFERENCES

A. SSG Document Numbers

1. 16.510.001 Installation Details for Interior Chain Suspended Fluorescent Lighting Fixtures
2. 16.520.000 Details for Pendant (and Stanchion) Mounted Lighting Fixtures
3. 16.535.003 6 & 12 volt wall mounted emergency lighting units

PART 2 PRODUCTS**2.1 Manufacturers**

A. Manufacturers are listed on the drawings in the Lighting Fixture Schedule.

1. See Section 16000 "General Electrical Conditions (1.4 "Equal/Equivalent Manufacturers and/or Materials"

2.2 MATERIALS

A. Lighting Fixtures:

1. Lighting fixture type and manufacturer will be as specified on the drawings in the Light Fixture Schedule.
2. Do not substitute Manufacturers, Fixture Type, Fixture Series, etc without written authorization from the Lead Electrical Engineer or designated representative.
3. Provide the light fixtures specified using the manufacturer's part number, fixture description and fixture remarks to ensure a complete installation meeting the Owner's requirements.

B. Lamps;

1. Lamp type and manufacturer will be as specified on the drawings.
 - a) Metal Halide: Pulse Start
 - b) High Pressure Sodium:
 - c) LED
 - 1) Light Fixtures: Minimum 100,000 hr life, 4000°K interior fixtures and 5000°K exterior fixtures.
 - 2) HID, Fluorescent & Compact Fluorescent Instant Fit or Retrofit Lamps: Minimum 50,000 hr life, 4000°K interior fixtures and 5000°K exterior fixtures
 - (i) Unless specified otherwise
 - 3) A15/A19 Replacement Lamps: Minimum 25,000 hr life, 4000°K interior fixtures and 5000°K exterior fixtures
 - d) T5 lamps: 36,000 Hrs (3 Hr starts with Program Start Ballast)
 - e) T8 lamps: 85% CRI, 4100°K color, and 60,000 Hrs Extra Long Life (3 Hr starts with Instant Start Ballast).
 - f) Compact Fluorescent Lamps 85% CRI, 4100°K color and 16,000 to 20,000 Hrs (3 Hr starts with Program Start Ballast).

C. Ballast:

1. T8 Lamp Fluorescent Ballast to be High Frequency Instant Start with a high power factor and standard ballast factor.
2. T5 Lamp Fluorescent Ballast to be High Frequency Program Rapid Start with a high power factor and standard ballast factor.
3. Compact Fluorescent Lamp Ballast to be High Frequency Program Rapid Start with a high power factor and standard ballast factor.
4. Ballast must be capable operating instant/direct fit LED lamps from GE, Philips or Sylvania.

D. Lighting fixtures should have the following

1. Factory or field installed fusing.
2. Ballast Quick Disconnects to line power.

PART 3 EXECUTION**3.1 INSTALLATION**

A. Lighting Fixture Mounting

1. Fabricate and install supports as necessary to provide adequate, secure mounting of lighting fixtures.
2. Pendant and stanchion mounted fixtures to be installed per details on SSG Document Number 16.520.000.
3. Properly align lighting fixtures with directional lenses or refractors.
4. Interior chain suspended fluorescent lighting fixtures to be installed per details on SSG Document Number 16.510.001.
5. Ceiling grid fixtures shall be fastened to the grid supports to comply with the current NEC requirements.

B. Lighting Fixture Wiring

1. Use the appropriate wire for the purpose (Some fixtures require a 90°C high temperature wire within the HID ballast housing).
2. Connect to circuits as shown on drawings.
3. If not provided with the light fixture provide plug-in type quick disconnects between the ballast/driver and the line circuit.
4. Connect lighting contactors and photocells as specified on drawings.

C. Final Inspection

1. Relamp any lighting fixtures with failed lamps at completion of construction.
2. Clean dirt and paint splatters from lenses, globes, refractors, and reflectors of lighting fixtures.
3. Inspect all exterior lighting fixtures for signs of moisture inside of the lenses, globes, refractors, and reflectors
 - a) Repair or replace as necessary.

3.2 TAGGING

- A. Tagging of all fixtures shall be completed per Section 16195 prior to Energization.
- B. Identification of Emergency fixtures
 - 1. Ballast housings for exterior or interior HID pendant, Wall and Stanchion mounted lighting fixtures that are used for emergency lighting in classified and /or industrial areas:
 - a) Finish color shall be OSHA Red (international interfine 629).
 - b) Must be visible from floor elevation.
 - 2. Trim rings, ballast housing, or lighting fixture end caps for interior fluorescent lighting fixtures that are used for emergency lighting in non-finished or industrial areas:
 - a) Finish color shall be OSHA Red (international interfine 629, Pantron 485 C, RAL 3028, RGB 218 41 28, HEX/HTML DA291C, etc).
 - b) Must be visible from floor elevation.
 - 3. Interior fluorescent lighting fixtures that are used for emergency lighting in finished areas (I.E.; Offices, Lobbies, etc)
 - a) Identify each fixture with a Red Dot in the south/west corner of the lighting fixtures housing trim ring. Use 3/4" L075-RD stickers available from LabelLab.com or equal.

3.3 TESTING

- A. Refer to Section 16950 for testing details.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers the construction requirements for the installation of an Uninterruptible Power Supply (UPS) System, and the installation of circuits powered from a UPS system.

1.2 REFERENCES

- A. SSG Document Numbers
 - 1. 16.601.001 Uninterruptible Power Supply (UPS) System Construction Requirements

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Uninterruptible Power Supply (UPS) Unit will be supplied by the Owner.

PART 3 EXECUTION**3.1 INSTALLATION**

- A. All Type I UPS branch circuits shall be in separate raceways from Type II and Type III branch circuits
 - 1. UPS circuits shall be ran in Galvanized Rigid Metal Conduit (RMC) when not ran in cable trays
 - a) Exception: EMT conduit can be used in approved interior spaces per section 16111
 - 2. UPS circuits shall be in a separate cable tray or a separate section of a divided cable tray.
 - a) Exception: Armored cable can be installed with non-UPS cables in a cable tray.
 - 3. Dual feeds to the UPS unit shall be installed in separate raceways.
- B. The installation of UPS circuits to remote buildings should be addressed on a case by case basis in the issued construction work package,
- C. Install separate neutral wires for each branch circuit. Do not share neutral wires.
- D. For panelboards not dedicated for Type I UPS circuits, all Type I UPS circuits should have circuit breaker locks installed. This is an added measure of protection for circuits requiring UPS power versus circuits that don't specifically require UPS power but are fed from the same panelboard (mainly applies to existing Plant 1 and 2 installations).
- E. All UPS receptacles should be installed with an orange isolated ground faceplate and clear labeling for its intended purpose.
- F. Construction site adjacent to UPS to be kept as clean as possible at all times.
 - 1. The UPS should be covered at all times during construction when not energized or in manual bypass.
 - 2. Provide filters over the intake and outlet air louvers (holes) whenever the UPS is energized.
 - 3. Tagging (White Lettering on Orange Background):
- G. Tagging to be completed per SSG Document Number 16.195.004.
 - 1. All UPS circuits to be tagged with orange tags.
- H. All terminations to torque to manufacturers specifications and identified by a red paint pen across the fastener and the back plane.
 - 1. Acceptable manufacturers
 - a) Sanford
 - b) Uni Paint
 - c) Alternates can be submitted for owners approval

3.2 TESTING

- A. Refer to Section 16950 for testing details.

END OF SECTION

PART 1 GENERAL

1.1 SCOPE

- A. This section covers requirements for commonly used electric heat tracing for moderate temperature maintenance.

1.2 REFERENCES

- A. SSG Document Numbers
 - 1. 16.855.001 Installation Test and Inspection Record for Electrical Heat Tracing.
- B. Installation instruction guide supplied by heat tracing manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Heating cable and accessories – manufacturers and type shall be as specified on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Heating cable shall be installed in strict accordance with manufacturer's instructions and installation details.
- B. Wrapping of cable at valves, instruments, etc., to be accomplished as shown in details on drawings to allow for easy maintenance of system.
- C. Cable attachment to pipe to be made per the following:
 - 1. Space at 1 foot minimum increments on straight lengths.
 - 2. Space as needed on elbows, tees, etc., to hold cable in proximity to pipe.
 - 3. Cable attachment to equipment where cable ties or tape cannot be used shall be accomplished using stainless steel banding.
- D. Insulation shall not be applied until heating cable installation is inspected and approved by Owner, and "Test and Inspection Record" 16.855.001 is completed and submitted to Owner.
- E. Electric traced labels shall be installed on the insulation with a maximum spacing of 10 feet.
- F. Tagging of heating cables shall be completed per Section 16195.
- G. Installations shall be protected from physical damage during and after installation is complete and until the insulation has been installed.

3.2 TESTING

- A. Refer to Section 16950 for testing details.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. Grounding Systems
- B. Wire and Cable
- C. Dry-Type Transformers
- D. Motor Control Centers
- E. Motors and Motor Wiring
- F. Lighting Systems
- G. UPS System Circuits
- H. Heating Cable

1.2 REFERENCES

- A. 16.020.021 Ground Resistance Test and Results Submittal Form
- B. 16.022.020 Equipment Static Grounding Test Method
- C. 16.030.001 Installation Test and Inspection Record for Motors and Motor Wiring
- D. 16.370.004 Medium Voltage Cable Change or Installation Form
- E. 16.410.010 Installation Test and Inspection Record 480V Non-motor Circuits
- F. 16.461.003 Installation Test and Inspection Record for Dry-Type Transformers
- G. 16.481.002 Installation Test and Inspection Record for Motor Control Centers
- H. 16.601.001.001 Installation Test and Inspection Record Uninterruptible Power Supply (UPS) System Circuit
- I. 16.855.001 Installation Test and Inspection Record for Electrical Heat Tracing

1.3 SUBMITTALS

- A. Test Reports
 - 1. All test reports required by this specification shall be submitted to the Owner Representative within five (5) days of test completion.
 - 2. The Owners Electrical Engineering Representative will review the test results to ensure all required information is filled out properly, and meets the specified testing requirements.
 - 3. Test forms will be scanned into PDF format and forwarded to the projects Lead Electrical Engineer.
- B. Failure to provide the required Testing Submittals (complete with satisfactory results) within the required time frame will result in the testing being performed by other qualified individuals hired to complete documents at the contractor's expense.
 - 1. Any repairs or adjustments to obtain a satisfactory result, (within the scope of the contract); will also be completed at the expense of the contractor.

1.4 QUALIFICATIONS

- A. Test equipment shall be properly calibrated.
 - 1. Capable of passing a UL listing test.
- B. Operators of test equipment shall be experienced in accepted procedures.
 - 1. Provide certification to the Owner with the test results.

1.5 UNACCEPTABLE TEST RESULTS

- A. Condition shall be corrected without cost to Owner when due to defective equipment, materials, or work furnished by Contractor.
- B. Where condition is a result of design, equipment, materials, or work furnished by others, notify Owner to obtain instructions for corrective action.

PART 2 PRODUCTS**2.1 NONE****PART 3 EXECUTION****3.1 TEST PROCEDURES**

- A. Ground Resistance Test
 - 1. "Three Point" Method per SSG Document Number 16.020.021.
 - 2. Results submittal form is SSG Document Number 16.020.021.001.
 - 3. Maximum acceptable test value is 5 ohms.
 - 4. Test Building Grounding System
- B. Equipment Static Ground Test
 - 1. Per SSG Document Number 16.022.020.
 - 2. Submit list of equipment checked, resistance, and date test performed.
 - 3. Maximum acceptable test value is 100,000 ohms (typical values should be less than 10 ohms).
 - 4. Test equipment requiring static grounding per Section 16020.
- C. 500 Volt Megger Test
 - 1. Use battery powered, motor driven insulation tester with minimum range of 0 to 500 Megohm at 500 Volts DC.
 - 2. Minimum acceptable test value is 2 Megohm.
 - 3. Equipment and circuits to be Megger tested:
 - a) 480 Volt Motor Control Centers and associated service
 - 1) Test phase-to-phase and phase-to-ground.
 - 2) Submittal form per SSG Document Number 16.481.002.
 - b) 460 Volt Motors and associated wiring
 - 1) Test motor windings-to-ground
 - 2) Test motor wiring phase-to-phase and phase-to-ground
Note: Do not Megger test E1Plus and E3Plus electronic overload relays and VFD wiring with conductors connected to line or load side.
 - 3) Submittal form per SSG Document Number 16.030.001
 - c) 480 Volt Primary Dry-Type Transformers and associated wiring
 - 1) Test transformer primary-to-ground, secondary-to-ground, and primary-to-secondary.
 - 2) Test transformer primary service and secondary feeder phase-to-phase and phase-to-ground.
 - 3) Submittal form per SSG Document Number 16.461.003
 - d) 460 Volt Heaters and associated wiring
 - 1) Test heater elements-to-ground
 - 2) Test heater wiring phase-to-phase and phase-to-ground.
 - 3) Use Motor submittal form, SSG Document Number 16.030.001

- e) 480 Volt Non-motor circuits
 - 1) Test non-motor circuits (welding receptacles, non-motor heater, etc).
Note: Do not Megger test SCR Controller wiring with conductors connected to line or load side.
 - 2) Submittal form per SSG Document Number 16.410.001.
- f) Electrical Heat Tracing and Associated Wiring
 - 1) Test supply wiring to ground.
 - 2) Test heating cable "bus" or resistance wire to ground.
 - 3) For cables with ground braid, isolate braid and test to ground.
 - 4) Complete submittal form, SSG Document Number 16.855.001.
- D. 2500 Volt Megger Test
 - 1. Minimum acceptable test value is 20 Megohm
 - 2. Test 4160 Volt Motor Control Centers
 - 3. Test each phase bus to ground with all supply and load cabling disconnected.
 - 4. Test self-regulating heat tracing
 - a) Test the "bus" wires to the ground braid.
 - b) Isolate the ground braid and test the ground braid and ground.
 - c) Record readings on submittal form SSG Document Number 16.855.001.
- E. 2500 Volt Megger and High Potential Test
 - 1. Test cables supplying 4160 Volt MCCs and 4000 Volt Motors.
 - 2. Pre-test conditions
 - a) Notification and approval to proceed from Owner.
 - b) Cable terminations completed.
 - c) Cables disconnected on source and load end.
 - 3. 2500 Volt Megger Test
 - a) Perform on each cable prior to high potential test.
 - b) Continue test until level-off reading (3 consecutive readings, 10 seconds apart) is obtained.
 - c) Minimum acceptable test value is 20 Megohm
 - 4. DC High Potential Test
 - a) Perform test subsequent to above 2500 Volt Megger Test
 - b) Apply test between each conductor and ground with all other circuit conductors, conductor shields, and metallic armor (where used) grounded to the same ground.
 - c) Increase test voltage in 5 kV increments with one minute duration between steps to allow time for absorption currents to stabilize.
 - d) Record steady state leakage current at each voltage level.
 - e) Maximum applied DC test voltage shall be 25 kV.
 - f) Maintain maximum test voltage for five minutes and record leakage currents at one minute intervals.
 - g) Maximum acceptable leakage currents should be less than 5 microamps.
 - 5. Submit test results to Owner for analysis and acceptance per SSG Document Number 16.370.004

- F. 2500 Volt Megger Test and Polarization Index Computation
1. Perform on 4000 Volt Induction Motors
 2. Pre-Test Conditions
 - a) Notification and approval to proceed from Owner.
 - b) Supply cables disconnected.
 - c) Surge protection disconnected. (Reconnect immediately after test is completed.)
 3. 2500 Volt Megger Test
 - a) Test each stator winding to ground (motor frame).
 - b) Connect stator windings at their neutrals so that all three phases are included in each test.
 - c) Record Megger readings at one minute intervals over a period of ten minutes.
 4. Polarization Index Computation
 - a) Calculate ratio of ten minute 2500 Volt Megger reading to one minute value.
 - b) Minimum acceptable ratio is 2.5.
 5. Submit test results to Owner for analysis and acceptance.
- G. Phase Rotation Test
1. Verify correct phase rotation for the following:
 - a) 4160 Volt Motor Control Centers.
 - b) 480 Volt Motor Control Centers.
 - c) 480 Volt Receptacles.
 - d) Three phase circuit breaker panelboards.
 - e) Three phase uninterruptible power supply (UPS) system.
- H. Motor Rotation Test
1. Verify correct motor rotation for all three phase motors.
 2. Pre-Test Conditions
 - a) Notification and approval to proceed from Owner.
 - b) Couplings to driven equipment disconnected.
- I. Functional Test
1. Perform on all equipment, devices, lighting fixtures, and heating cable installed.
 - a) All final test must be complete under normal building load conditions
 2. Pre-Test Conditions
 - a) Notification and approval to proceed from Owner for operational tests of process equipment.

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. Section Includes: Communications building pathways.

1.2 REFERENCES

- A. Comply with the References requirements of Section 27100
- B. In addition to those codes, standards, etc., list in Section 27100 comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
1. 27.052.002.001 – Communications Box Details (Sheet 1 of 3)
 2. 27.052.002.002 – Communications Box Details (Sheet 2 of 3)
 3. 27.052.002.003 – Communications Box Details (Sheet 3 of 3)
 4. 27.110.002.001 - Communication Equipment Cabinet Detail Arrangement
 5. 27.110.002.002 - Communication Server Cabinet Detail Arrangement
 6. 27.110.002.003 – Communications Rack Layout Arrangement
 7. 27.130.002.050 – Inside Plant (ISP) Fiber Optic & Copper Backbone Cable Labels
 8. 27.800.002.002 – Communications Grounding and Torque Details
 9. ASTM A 510 Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
 10. ASTM B 633 Specifications for Electrodepositing Coatings of Zinc on Iron and Steel, Sections SC2 and SC3.
 11. ASTM A 653 Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process
 12. ASTM A 591 Specifications for Electrodepositing Coatings of Zinc on steel wire or sheets.
 13. ASTM A 123 Specifications for Zinc (Hot Galvanized) Coatings on Iron and Steel.
- C. National Electrical Manufacturers Association:
1. NEMA VE 1 - Metal Cable Tray Systems.
 2. NEMA VE 2 - Cable Tray Installation Guidelines.

1.3 DEFINITIONS

- A. Definitions as described in Section 27100 Part 2 shall apply to this section.
- B. “J-hook” Hangers: A metal, most often steel, cable support device shaped (section view) similar to the letter J; alternately, a fabric strap or non-metallic. The device is available in different sizes supporting different quantities of cables, and is also available with different attachment hardware to be supported by different methods (e.g., wire support, beam flange clip, etc.).
- C. “D-rings” Hangers: A metal, most often steel, cable support device shaped (section view) similar to the letter D. The device is available in different sizes supporting different quantities of cables. Product is intended for Vertical attachment only in MC and TR locations (e.g., wall field build out).

1.4 SYSTEM DESCRIPTION

- A. Base Bid Work
1. Refer to specification section 27001 “Intra-Building Communications Scope of Work” for a detailed description of work.
 2. The work under this section shall include the planning and coordination with General Contractor, Construction Rep. (and other trades) of communications system pathways, the furnishing of necessary materials, and the labor & associated services required to install pathways as called out in the plans and in these specifications.

- B. The Communications Building Pathways may consist of the following subsystems:
 - 1. ISP innerduct, from MC to TR's, as shown on Drawings
 - 2. Primary Pathways: Wire Basket, Cable Tray, including supports and Conduit not supplied by other trades.
 - 3. Secondary Pathways: Wire Basket, Cable Tray, J-hook Hangers, including supports and Conduit
 - 4. Conduit, pull boxes and device boxes identified as to be provided by this contractor.
- C. Work Covered Under a separate contract unless noted otherwise on the Construction Drawings.
 - 1. Conduit, pull boxes, device boxes.

1.5 SUBMITTALS

- A. Comply with the Submittals article of Section 27100 for procedural, quantity, and format requirements.
- B. Preconstruction Submittal Requirements:
 - 1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications and specifications.
 - 2. Shop Drawings Submittal, consisting of proposed changes to cable routing.
- C. Project Completion Manual Requirements:
 - 1. As-Built Drawings.
 - a) Final Cable routing.

1.6 QUALITY ASSURANCE

- A. Comply with the Quality Assurance requirements of Section 27100.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Comply with the Delivery, Storage and Handling requirements of Section 27100.

1.8 WARRANTY

- A. The interior communications pathway system, as specified in this section, shall receive a 1-year product, craftsmanship and intended application warranty.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

- A. Comply with the Substitutions requirements of Section 27100.

2.2 INSIDE PLANT INNERDUCT RISER RATED

- A. Application: Suitable for an indoor installation, typically within a riser system or backbone conduit, for the support of communications fiber optic cables. (Note: Does not eliminate the need for plenum or riser rated fiber)
- B. Description: Designed and manufactured as a continuously extruded corrugated pipe.
- C. Material: Fabricated from Capron resin, or equivalent.
- D. Minimum Size: 1.25 in (32mm)
- E. Color: Orange
- F. Manufacturers, or equal:
 - 1. Carlon/Thomas and Betts "Riser Guard" series innerduct
 - 2. Endot "Endocor/RI" series innerduct
 - 3. Pyramid "Fire Flex Riser Duct" series innerduct

2.3 INSIDE PLANT INNERDUCT, PLENUM RATED

- A. Application: Suitable for an indoor installation, typically within a riser system or backbone conduit, and within plenum spaces, such as above ceiling or within an access floor, for the support of communications fiber optic cables. (Note: Does not eliminate the need for plenum rated fiber)
- B. Description: Designed and manufactured as a continuously extruded corrugated pipe.
- C. Minimum Size: 1.25 in (32mm)
- D. Color: White
- E. Material: Fabricated from PVDF resin, or equivalent.
- F. Manufacturers, or equal:
 - 1. Carlon/Thomas and Betts "Plenum Guard" series innerduct
 - 2. Endot "Endocor/PL" series innerduct
 - 3. Pyramid "Fire Flex Plenum Duct" series innerduct

2.4 CONDUIT AND BACK BOXES

- A. Refer to specification section 16.111.001 for detailed information regarding conduit and back boxes.

2.5 KNOCK-ON BUSHINGS

- A. Application: The bushing shall prevent chafing of cable at the entry or exit of each conduit or sleeve.
- B. NEC/UL Rating: bushing shall be compliant with NEC 300-15 for cable protection and listed for use in environmental air spaces (NEC 300-22/plenum rated).
- C. Knock-on bushings are provided for under a separate contract, however this contractor shall coordinate or provide for should none be installed. At no time should cables be installed in raceways with-out a bushing being installed.
- D. Communications contractor shall supply and install bushings if conduit is installed under their contract.
- E. Manufacturer: Arlington or equal

| Manufacturer | Part Number | Size/Application |
|--------------|-------------|---|
| Arlington | EMT100 | 1in (25mm) bushing for EMT conduit |
| Arlington | EMT125 | 1-1/4in (32mm) bushing for EMT conduit |
| Arlington | EMT150 | 1-1/2in (38mm) bushing for EMT conduit |
| Arlington | EMT200 | 2in (51mm) bushing for EMT conduit |
| Arlington | EMT250 | 2-1/2in (64mm) bushing for rigid or EMT conduit |
| Arlington | EMT300 | 3in (77mm) bushing for rigid or EMT conduit |
| Arlington | EMT350 | 3-1/2in (90mm) bushing for rigid or EMT conduit |
| Arlington | EMT400 | 4in (101.6mm) bushing for rigid or EMT conduit |
| Arlington | RGD100 | 1in (25mm) bushing for rigid conduit |
| Arlington | RGD125 | 1-1/4in (32mm) bushing for rigid conduit |
| Arlington | RGD150 | 1-1/2in (38mm) bushing for rigid conduit |
| Arlington | RGD200 | 2in (51mm) bushing for rigid conduit |

2.6 PULL ROPE/TAPE

- A. Pull rope shall be ¼ in (6.3mm) PVC or equivalent with a minimum pull strength of 1250 pounds. Rope shall be installed in the innerduct prior to delivery to the construction site. Pull rope shall extend 6 ft (1.83m) beyond the termination at each end.

- B. For plenum applications the pull tape shall be plenum rated with minimum pull strength of 1250 pounds. Pull tape shall be installed in the innerduct prior to delivery to the construction site. Pull tape shall extend 6 ft (1.83m) beyond the termination at each end.

2.7 INNERDUCT COUPLINGS/FITTINGS

- A. All installed innerduct shall have innerduct terminating connectors installed at the Fiber Optic Light Shelf at each end.
- B. All installed innerduct shall have innerduct terminating connectors installed at pull boxes if present.
- C. All installed innerduct shall have innerduct coupling connectors installed at any innerduct splice point.
- D. Construction: Materials may be either metallic or non-metallic.
- E. Manufacturers, or equal:
 - 1. Carlon/Thomas and Betts
 - 2. Endot
 - 3. Pyramid

2.8 CABLE BASKET

- A. Application: Suitable for indoor installation to support, store, and manage communication cables, either overhead or mounted vertically on a wall.
- B. Description: Cable basket shall be made of high strength steel wires and formed into a mesh pattern with intersecting wires welded together. Wire ends along sides (flanges) shall be rounded during manufacturing for safety of cables and installers. Straight section longitudinal wires shall be straight with no bends.
- C. Materials and Finishes: Material and finish specifications for each wire basket type pathway are as follows:
 - 1. Yellow Zinc Dichromate: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated yellow zinc dichromate in accordance with ASTM B633 SC2.
 - 2. Black Powder Coat: Straight sections shall be powder coated black with an average paint thickness of 1.2mils (30microns) to 3.0mils (75microns).
 - 3. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 Stainless Steel.
- D. Refer to Drawings for sizes.
- E. Manufacturers, or equal:
 - 1. B-Line WB series
 - 2. Cablofil EZ-Tray series
 - 3. GS Metals Flextray series
 - 4. Chalfant Wire Mesh series

2.9 LADDER RACK/TUBULAR RUNWAY

- A. Application: Suitable for indoor installation to support, store, and manage communications cables, either overhead, mounted vertically on a wall or mounted vertically perpendicular to racks.
- B. The sections shall be available in straight, inside radius 90°, outside radius 90° and flat turns 90°.
- C. The manufacture shall also offer a complete series of splices, wall/ceiling mount kits, standoff feet and other related accessories.

D. Materials and Finishes:

1. Tubular Steel
2. Black Powder Coat

E. Rungs shall be welded between the stringers (telco style)

F. Refer to drawings for sizes

G. Manufacturers, or equal:

1. Chatsworth: 10250-7XX series
2. Hubbell: HLS series
3. Ortronics: OR-TRT series

2.10 CABLE STORAGE RINGS

A. Application: Suitable for proper storage of cable service loops on communication backboards and select pull boxes

B. Description: The storage ring shall consist of 16 gauge sheet metal circular plate 12 in (305mm) or 24 in (610mm) diameter and hook/loop style loops to contain and secure the cable.

C. Manufacturers, or equal:

1. Leviton 48900-IFR 12 in (305mm) ring for indoor cable
2. Leviton 48900-OFR 24 in (610mm) ring for OSP cable or larger diameter cable

2.11 CABLE HANGERS (J-HOOKS)

A. Application: Suitable for indoor installation within ceiling space for the support of communications cables.

B. Listings: UL 2043, for use in air handling spaces

C. Finish: All metal cable hangers installed in process areas shall be painted prior to installation.

1. Very color and painting process with owner.
2. Non-Metallic cable hangers shall NOT be used in process areas.

D. Manufacturers (or variation per installation method), or equal (Quantities are based on typical 4pr. UTP @ .25 in (6.3mm) O.D.):

| Manufacturer | Part Number | Size | # of .25 in (6.3mm) O.D. cables (Typ Cat 6) |
|--------------|-------------|--------------------|---|
| B-Line | BCH12 | 3/4 in (19mm) | 10 |
| B-Line | BCH21 | 1-5/16 in (33.3mm) | 32 |
| B-Line | BCH32 | 2 in (51mm) | 50 |
| B-Line | BCH64 | 4 in (101.6mm) | Max 50 |
| Erico/Caddy | CAT12 | 3/4 in (19mm) | 10 |
| Erico/Caddy | CAT21 | 1-5/16 in (33.3mm) | 32 |
| Erico/Caddy | CAT32 | 2 in (51mm) | 50 |
| Erico/Caddy | CAT64 | 4 in (101.6mm) | Max 50 |
| Panduit | JP75W-L20 | 3/4 in (19mm) | 10 |
| Panduit | JP131W-L20 | 1-5/16 in (33.3mm) | 32 |
| Panduit | JP2W-L20 | 2 in (51mm) | 50 |
| Panduit | JP4W-L20 | 4 in (101.6mm) | Max 50 |

2.12 DISTRIBUTION RINGS (D-RINGS)

A. Application: Intended for the routing and protection of cabling and cross-connects on the communications backboard.

- B. Material: Aluminum alloy
- C. Manufacturer: Allen-Tel, Arlington or equal

| Manufacturer | Part Number | Size | Size Metric |
|--------------|-------------|------------------|--------------|
| Allen-Tel | GB-13A | 1-7/8 x 2-3/4 in | 48mm x 70mm |
| Allen-Tel | GB-13B | 3-1/8 x 3-3/4 in | 80mm x 95mm |
| Allen-Tel | GB-13C | 5-1/8 x 3-3/4 in | 130mm x 95mm |

PART 3 EXECUTION

3.1 GENERAL

- A. Comply with the Execution requirements of Section 27100 Part #3.

3.2 EXAMINATION

- A. Examine areas to receive overhead hanger/support system prior to the start of work within this section. Notify the Owner of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Installer is responsible for the integrity of the structures to which the system is attached, including their capability of safely accepting the loads imposed as evaluated by the Owner.

3.3 MINIMUM REQUIREMENTS

- A. New facilities or major renovations must meet the following requirements.
- B. Conduit
 - 1. Refer to specification section 16.100.001 and 16.111.001 for detailed information regarding conduit and back box requirements.
 - 2. Conduits shall be routed in a home run fashion from the outlet box to the tray, accessible ceiling or MC/TR per the drawings. Daisy chaining of outlets is not permitted.
 - a) See drawings for floor box installations which MAY allow daisy chaining.
 - 3. Flexible conduit shall not be used.
 - 4. Conduit shall be bonded to ground on one or both ends in accordance with national and/or local codes requirements.
 - 5. Withstand the environment to which they will be exposed.
 - 6. Achieve the best direct route (e.g. parallel to building lines) with no route exceeding 180 degrees between pull points.
 - 7. The conduit size for cabling must accommodate:
 - a) Multiple building occupants
 - b) Cables placed at different times.
 - c) No more than 40% fill.
 - 8. Terminate conduits that protrude through floors a minimum of 3 in (77mm) above finished floor.
 - 9. All conduits shall terminate in accessible ceiling space or cable-tray.
 - 10. No more than the equivalent of Two (2) 90 degree sweeps is allowed in a run, including offsets. Absolutely no "LB" (elbows) allowed in any conduit route inside and outside plant.
 - 11. A third bend may be acceptable in a pull section without de-rating the conduits capacity if one of the statements below are true;
 - a) Total run does not exceed 33ft (10m).
 - b) The conduit size is increased to the next trade size.

- c) At least one (1) of the bends is within 12 in (305mm) of the cable feed end (This exception only applies to placing operations where cable is pushed around the first bend).
- 12. Use of conduit bodies intended for the routing of communication cables:
 - a) The conduit body shall match the conduit type (No plastic fittings allowed).
 - b) The "LU" style conduit body may be used for directional changes.
 - c) The "C" style conduit body may be used as a supplemental pull point.
 - d) The use of other conduit bodies such as the "LB" style is not permitted.
- 13. After installation conduits shall be left;
 - a) Clean, dry, and unobstructed.
 - b) Capped for protection.
 - c) Labeled for identification.
 - d) Reamed and fitted with bushings.
 - e) With a pull cord.
- C. Conduit Sleeves
 - 1. Refer to specification section 16.100.001 and 16.111.001 for detailed information regarding conduit requirements.
 - 2. All communication cable penetrations through walls, floor or ceilings shall be installed in sleeves. There are no exceptions to this campus wide policy.
 - 3. Ensure proper capacity for cabling,
 - 4. Flexible conduit shall not be used.
 - 5. Conduit Sleeves shall be bonded to ground on one or both ends in accordance with national and/or local codes requirements.
 - 6. Withstand the environment to which they will be exposed.
 - 7. Achieve the best direct route (e.g. parallel to building lines).
 - 8. The conduit sleeve size for cabling must accommodate;
 - a) Multiple building occupants
 - b) Cables placed at different times.
 - c) No more than 40% fill.
 - 9. Terminate conduit sleeves that protrude through floors or wall a minimum of 3 in above finished floor.
 - 10. All conduits shall terminate in accessible ceiling space or cable-tray.
 - 11. After installation conduits sleeves shall be left;
 - a) Clean, dry, and unobstructed.
 - b) Capped for protection.
 - c) Labeled for identification.
 - d) Reamed and fitted with bushings.
 - 12. All sleeves penetrating fire rated walls/floors shall fire caulked to meet wall/floor rating. MSDS sheets for all fire caulk shall be provided to the owner.
- D. Pull boxes
 - 1. All pull boxes shall be installed in accessible areas.

2. A pull box should not be installed in lieu of a bend.
3. Conduits that enter the same pull box from opposite ends of each other shall be aligned. No directional changes.
4. Size pull box in accordance with EIA/TIA-569-B standards.
5. Pull boxes should be placed in sections of conduit that;
 - a) Exceed 100ft (30.5m) in length.
 - b) Contain more than two 90 degree bends.
 - c) Contain a reverse bend.

3.4 INSTALLATION

A. Conduit

1. Minimum Separation

- a) For safety purposes, power cables should be kept physically separated from communication cables (refer to table below). For branch circuits of 5kVA or less, no additional separation is necessary.
- b) Minimum separation distance for possible sources of Electromagnetic interference exceeding 5 kVA.

| Condition | Minimum Separation Distance |
|---|-----------------------------|
| Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways | 24 in (610mm) |
| Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathways | 12 in (305mm) |
| Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal pathway | 6 in (152mm) |
| Electrical motors and Transformers | 47 in (1194mm) |

2. Bend Radius

- a) Conduit bends should be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
- b) Choose a bend radius for conduit according to the guidelines below:

| If conduit has an internal Diameter of.... | Minimum Bend Radius |
|--|---|
| 2in (51mm) or less diameter | 6 times the internal conduit dimension |
| More than 2in (51mm) in diameter | 10 times the internal conduit dimension |

B. Innerduct

1. Provide innerduct for routing of fiber optic cables. The innerduct shall be continuous from originating room to destination. Truncate the innerduct in either room prior to slack storage.
2. When routing through corridors, place innerduct in the cable tray / primary pathway / dedicated supports. When routing vertically through communications rooms, support innerduct on vertical cable support (such as runway) and fasten using cable ties. When routing horizontally through communications rooms, support innerduct on overhead cable support and fasten using cable ties. Install cable ties at 24 in (610mm) intervals.
3. Label innerducts at both ends and at all transition points. The label shall be visible to a technician standing at-ease.

C. Cable Basket/Ladder Rack/Tubular Runway

1. Install pathway system in accordance with manufacturer's instructions and recognized industry practices, and ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
2. Install system at locations indicated on the drawings. Routes are diagrammatic in nature. Field verify route prior to installation.
3. Provide trapeze hangers, or wall brackets to support/hang the pathway. If not shown in the Drawings, provide 3/8-in (9.5mm) diameter threaded rods for the trapeze hangers. For wall brackets, use approved fasteners depending on the mounting substrate. Support separation shall conform to applicable codes.
4. Splice straight sections using hardware specifically designed for the purpose with serrated flange locknuts or factory splice hardware.
5. Bond pathway system per section 27800 and manufactures requirements in accordance with national and local codes.

D. Cable Hangers (J-Hooks)

1. Install hangers in accordance with recognized industry practices, to ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
2. Provide dedicated supports at 60 in (1525mm) separation, maximum, per a given route. Supports shall consist of #12 wire or ¼ in threaded rod. Suspend wire or rod using components appropriate for the structure – e.g., powder-actuated clip fastener for wire, beam flange clip or angled flange clip for either wire or rod, or an embedded anchor for the threaded rod. Do not share support (wire/rod) with other trades. Do not support the hanger on ceiling grid support wires. Do not support the hanger from ductwork, piping, or other equipment hangers.
3. Install hangers 6 in (152mm), minimum, from light fixtures or other EMI source. Install hangers between 6 in (152mm) and 12 in (305mm) above ceiling grid.
4. J-Hooks may be used for various types of cabling but shall not contain more than 50 (fifty) Category 6 cables regardless of capacity. Always follow the manufacturer guidelines when sizing and installing cable hangers.

E. Cable Hangers (D Rings)

1. D rings are only approved for use on the communication wall field, any deviation from this must be approved by the Owner in advance before installation.
2. Install D rings in accordance with recognized industry practices, to ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
3. Provide dedicated supports at 24 in (610mm) separation, maximum, per a given vertical route. Securely fasten each ring with a minimum of two (2) anchors.
4. Install rings 6 in (305mm), minimum, from other EMI source.

F. Cable Storage Rings

1. Storage rings are to be provided and installed where backbone service loops are present on the communications backboard and select pull boxes or other locations as detailed by the drawings.
2. The ring is to be secured to the building structure in such a manner as not to damage the fiber optic cable jacket.
3. Utilize supplied hook/loop style fasteners to secure the fiber service loop conforming to manufactures bend radius requirements.

4. Do not stack or exceed the capacity of the cable storage ring.
 - a) Each ring may contain multiple service loops of similar cable (all fiber or all copper) provided each service loop is bundled separately with hook and loop fasteners and labeled per the EMTN (entering and exiting storage ring).
 - b) ISP and OSP shall be in dedicated cable storage rings. Do not place ISP and OSP in the same storage ring.

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. Section includes: communications Inter-building pathways.

1.2 REFERENCES

- A. Comply with the References requirements of Section 27100 Part #2.
- B. In addition to those codes, standards, etc., list in Section 27100, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 1. 27.130.002.001 – Entrance Facility – Wall field Detail Standard
 2. 27.130.002.002 – Entrance Facility – Wall field Detail Building Distributor
 3. 27.130.002.003 – MAN Backbone FDC Strand Assignment Detail
 4. 27.130.002.004 – Fiber Distribution Center Strand Termination Diagram
 5. 27.130.002.005 – Outside Plant (OSP) Communication Aerial Cable Guying and Messenger Detail
 6. 27.130.002.006 – Outside Plant (OSP) Communication Aerial Cable Slack Storage Details
 7. 27.130.002.007 – Outside Plant (OSP) Communication Aerial Cable Slack Storage at Copper Splice Details
 8. 27.130.002.008 – Outside Plant (OSP) Communication Aerial Cable Lashing Details
 9. 27.130.002.009 – Outside Plant (OSP) Communication Duct Bank Details
 10. 27.130.002.010 – Outside Plant (OSP) Communication Conduit Under Railroad Tracks Details
 11. 27.130.002.011 – Outside Plant (OSP) Communication Handhole Details
 12. 27.130.002.012 – Outside Plant (OSP) Communication Handhole Detail
 13. 27.130.002.013 – Outside Plant (OSP) Communication Duct Bank To Highline Bent Riser Detail
 14. 27.130.002.014 – Outside Plant (OSP) Communication Pole Riser Detail
 15. 27.130.002.015 – Outside Plant (OSP) Communication Maintenance Hole Detail
 16. 27.130.002.050 – Inside Plant (ISP) Fiber Optic & Copper Backbone Cable Labels
 17. 27.130.002.051 – Outside Plant (OSP) Fiber Optic Patch Cable Labels
 18. 27.130.002.052 – Outside Plant (OSP) Fiber Optic & Copper Backbone Cable Labels
 19. 27.130.002.053 -Building Entrance Protector (BEP) Labeling Detail
 20. 27.800.002.002 – Communications Grounding and Torque Details
- C. ASTM International (ASTM)
 1. ASTM B 1 Standard Specification for Hard-Drawn Copper Wire
 2. ASTM B 8 Standard specifications for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 3. ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2700 kN-m/m³)
 4. ASTM D 709 Laminated Thermosetting Materials
 5. ASTM A 510 Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
 6. ASTM B 633 Specifications for Electrodepositing Coatings of Zinc on Iron and Steel, Sections SC2 and SC3.

7. ASTM A 653 Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process
8. ASTM A 591 Specifications for Electrodepositing Coatings of Zinc on steel wire or sheets.
9. ASTM A 123 Specifications for Zinc (Hot Galvanized) Coatings on Iron and Steel.
- D. Institute of Electrical and Electronics Engineers (IEEE)
 1. IEEE C2 National Electrical Safety Code
 2. IEEE Std 100 The Authoritative Dictionary of IEEE Standards Terms
- E. Insulated Cable Engineers Association (ICEA)
 1. ICEA S-87-640 Fiber Optic Outside Plant Communications Cable
 2. ICEA S-98-688 Broadband Twisted Pair, Communications Cable Aircore, Polyolefin Insulated Copper conductors
 3. ICE S-99-689 Broadband Twisted Pair Communications Cable Filled, Polyolefin Insulated Copper Conductors
- F. National Electrical Manufacturers Association (NEMA)
 1. NEMA C62.61 Gas Tube Surge Arresters on Wire Line telephone Circuits
- G. National Fire Protection Association (NFPA)
 1. NFPA 70 National Electrical Code
- H. Telecommunications Industry Association (TIA)
 1. TIA J-Std-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 2. TIA-590-A Standard for Physical Location and Protection of Below Ground Fiber Optic Cable plant
 3. TIA-758-A Customer-Owned Outside Plant Telecommunications Cabling Standard
 4. TIA/EIA-455-B Standard test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components
 5. TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements
 6. TIA/EIA-568-C.2 Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 7. TIA/EIA-568C.3 Optical Fiber Cabling Components Standard
 8. TIA-EIA-569-B Commercial Building Standards for Telecommunications Pathways and Spaces, and all addenda
 9. TIA/EIA-598-B Optical Fiber Cable Color Coding
 10. TIA-EIA-606-A Administration Standard for the Telecommunications Infrastructure
- I. The Society for Protective Coatings (SSPC)
 1. SSPC SP 6 Commercial Blast Cleaning
- J. U. S. Department of Agriculture (USDA)
 1. RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction
 2. RUS Bull 1751F-630 Underground Plant Design
 3. RUS Bull 1751F-640 Design of Buried Plant, Physical Considerations
 4. RUS Bull 1751F-643 Design of Aerial Plant
 5. RUS Bull 1751F-815 Electrical Protection of Outside Plant

6. RUS Bull 1753F-201 Acceptance Tests of Telecommunications Plant (PC-4)
7. RUS Bull 1753F-401 Splicing Copper and Fiber Optic Cables (PC-2)
8. RUS Bull 345-50 Trunk Carrier Systems (PE-60)
9. RUS Bull 345-65 Shield Bonding Connectors (PE-65)
10. RUS Bull 345-72 Filled Splice Closures (PE-74)
11. RUS Bull 345-83 Gas Tube Surge Arrestors (PE-80)

K. Underwriters Laboratories

1. UL 497 Protectors for Paired Conductor Communication Circuits
2. UL 510 Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
3. UL 83 Standard for Thermoplastic-Insulated Wires and Cables

1.3 DEFINITIONS

- A. Definitions as described in Section 27100 shall apply to this section.
- B. Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA/EIA-568-C.1, TIA/EIA-568-C.2, TIA/EIA-568-C.3, TIA/EIA-569-B, TIA/EIA-606-A, and IEEE Std 100 and herein.
 1. Campus Distributor (CD)
 - a) A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect – (MC).
 2. Entrance Facility (EF)
 - a) An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.
 3. Entrance Room (ER)
 - a) A centralized space for communications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a communications room because of the nature of its complexity.
 4. Building Distributor (BD)
 - a) A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect – (IC).)
 5. Pathway
 - a) Physical infrastructure utilized for the placement & routing of communications cable.

1.4 SYSTEM DESCRIPTION

A. BASE BID WORK

1. Refer to specification section 27001 "Inter-Building Communications Scope of Work" for a detailed description of work.
2. The work under this section shall include the planning and coordination with owner, and other trades of communications system pathways, the furnishing of necessary materials, and the labor & associated services required to install pathways as called out in the plans and in these specifications.

B. The Communications Inter-building Pathways may consist of the following subsystems:

1. OSP innerduct, from Building serving MC to Building serving MC as shown on Drawings

2. Primary Pathways: High-Line Cable Tray, Underground duct banks, including supports and Conduit not supplied by other trades.
 3. Secondary Pathways: Utility Poles, Maintenance and Hand Holes Wire Basket, Cable Tray, J-hook Hangers, including supports and Conduit
 4. Conduit, pull boxes and device boxes identified as to be provided by this contractor.
 5. Aerial Distribution, Bldg serving MC to Bldg serving MC.
- C. Work Covered Under a separate contract unless noted otherwise on the Construction Drawings.
1. High-Line cable tray, utility poles, underground duct banks, maintenance and hand holes, building entrance conduit and pull boxes.

1.5 SUBMITTALS

- A. Comply with the Submittals article of Section 27100 for procedural, quantity, and format requirements.
- B. Preconstruction Submittal Requirements:
 1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications and specifications.
 2. Shop Drawings Submittal, consisting of proposed changes to cable routing.
- C. Project Completion Manual Requirements:
 1. As-Built Drawings.
 - a) Final Cable routing.

1.6 QUALITY ASSURANCE

- A. Comply with the Quality Assurance requirements of Section 27100

1.7 DELIVERY, STORAGE AND HANDLING

- A. Comply with the Delivery, Storage and Handling requirements of Section 27100

1.8 WARRANTY

- A. The interior communications pathway system, as specified in this section, shall receive a 1-year product, craftsmanship and intended application warranty.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

- A. Comply with the Substitutions requirements of Section 27100

2.2 OUTSIDE PLANT INNERDUCT

- A. Highline Applications:
 1. Suitable for an Outdoor installation, typically within a riser system or backbone conduit, for the support of Communications fiber optic cables.
 - a) NOT for use in a riser or plenum environment without being enclosed on conduit.
 2. Description: Designed and manufactured as a continuously extruded corrugated pipe.
 3. Material: Fabricated from UV stabilized HDPE, or equivalent.
 4. Minimum Size: 1.25in (32mm)
 5. Color: Orange
 6. Pull Rope: Minimum of 1-1/4 in (32mm) PVC or equivalent with a minimum pull strength 1250 pounds. Rope shall be installed at the factory prior to delivery to the construction site. Pull rope shall extend 6 ft (1.83m) beyond the termination at each end.
 7. Manufacturers, or equal:

- a) Carlon/Thomas and Betts "A9D HDPE" series innerduct
- b) Endot "Endocor/ICE" series innerduct

B. Underground and Duct Bank Applications:

- 1. Suitable for an Outdoor installation, typically within a riser system or backbone conduit, for the support of Communications fiber optic cables.
- 2. Description: Designed and manufactured as a continuously extruded smooth wall pipe.
- 3. Material: High Density Polyethylene (HDPE), or equivalent.
- 4. Minimum Size: 1.25 in (32mm)
- 5. Color: Green, Red and Blue
- 6. Wall: SDR 11 and 13.5
- 7. Pull Rope: Minimum of ¼" (6.3mm) PVC or equivalent with a minimum pull strength 1250 pounds. Rope shall be field installed by the installer. Pull rope shall extend 6 ft (1.83m) beyond the termination at each end and secured to a building or vault structural member.
- 8. Manufacturers, or equal:
 - a) Carlon/Thomas and Betts
 - b) Endot
 - c) Pyramid

2.3 INSIDE PLANT INNERDUCT

- A. Refer to specification section 27052 for detailed information regarding inside plant innerduct.

2.4 CONDUIT AND BACK BOXES

- A. Refer to specification section 16.100.001 and 16.111.001 for detailed information regarding conduit and back box requirements.

2.5 KNOCK-ON BUSHINGS

- A. Knock-on bushings are provided for under a separate contract, however this contractor shall coordinate or provide for should none be installed. At no time should cables be installed in raceways with-out bushing being installed.
- B. Communications contractor shall supply and install bushings if conduit is installed under his or her contract.

2.6 PULL ROPE

- A. Pull rope shall be ¼ in (6.3mm) PVC or equivalent with a minimum pull strength of 1250 pounds. Rope shall be installed in the innerduct prior to delivery to the construction site. Pole rope shall extend 6 ft (1.83m) beyond the termination at each end.

2.7 INNERDUCT COUPLINGS/FITTINGS

- A. Refer to specification section 27052 for detailed information regarding innerduct couplings and fittings.
- B. Select material and finish based on outdoor or underground environment.

2.8 HANDHOLES

- A. Refer to civil package specifications for detailed information regarding handhole requirements.
- B. 24X36in (610 x 914mm) Handhole Box:
- 1. Construction: polymer concrete
 - 2. Load requirements: designed for 22,500 and load tested for 33,750 pounds
 - 3. Box shall be UL listed

4. Manufacturer: Hubbell Quazite or equal
 - a) Quazite # PG2436BA42 – 24X36 in (610 x 914mm) heavy duty box 42 in (1067mm) deep
5. 24X36 in (610 x 914mm) Handhole Cover:
6. Designed for 15,000 with a load test of 22,500 pounds.
7. Cover shall be engraved COMMUNICATIONS.
8. Cover shall be UL listed.
9. Manufacturer: Hubbell Quazite or equal
 - a) Quazite # PG2436HA00 – 24X36 in (610 x 914mm) heavy duty cover with 2 bolts
- C. 30X60 in (610 x 1525mm) Handhole Box:
 1. Construction: polymer concrete
 2. Load requirements: designed for 22,500 and load tested for 33,750 pounds
 3. Box shall be UL listed
 4. Manufacturer: Hubbell Quazite or equal
 - a) Quazite # PG3060BA21 – 24X60 in (610 x 914mm) heavy duty box 21 in (533mm) deep
 - b) Quazite # PG3060BA30 – 24X60 in (610 x 914mm) heavy duty box 30 in (762mm) deep
- D. 30X60 in (610 x 914mm) Handhole Cover:
 1. Designed for 15,000 with a load test of 22,500 pounds.
 2. Cover shall be engraved COMMUNICATIONS.
 3. Cover shall be UL listed.
 4. Manufacturer: Hubbell Quazite or equal
 - a) Quazite # PG3060HA00 – 24X60 in (610 x 914mm) heavy duty cover with 2 bolts

2.9 UNDERGROUND WARNING TAPE

- A. Application: For underground use to help identify and locate buried communications cabling.
- B. Construction: Orange PE Detectable marker tape 6 in (152mm) width
- C. Legend: The marker tape shall be printed with "CAUTION COMMUNICATIONS CABLE BURIED BELOW"
- D. Manufacturer: TeraTape by Reef Industries or equal
 1. TeraTape # 42-0042 Orange 6 in (152mm) X 1000 ft (305m) COMMUNICATIONS CABLE
 2. TeraTape #60-0085 Terra Clip to maintain tape continuity between sections of tape

2.10 CABLE TRAY

- A. Refer to specification section 16.100.001 and 16.112.001 for detailed information regarding Cable tray requirements.
- B. Application: Suitable for Outdoor installation to support, store, and manage communications cables, either overhead or mounted vertically on a wall.

2.11 CABLE HANGERS

- A. Refer to specification section 27052 for detailed information regarding Cable Hangers requirements.

2.12 AERIAL DISTRIBUTION

- A. Refer to Engineering Specification Section 16.370.001 "PURCHASE SPECIFICATION FOR POLE LINE MATERIALS" and Communication section 27130 for detailed information regarding Aerial attachment Hardware requirements.
- B. Application: Aerial distribution of Communications cabling.
- C. Aerial Distribution refers to communication copper cables and fiber optic cables that are attached to utility poles at varying span lengths by lashing cables to separate suspension strands.

2.13 AERIAL PATHWAYS

- A. Aerial facilities consist of poles, support strand, cable and supporting pole hardware. Aerial cable is typically lashed to a cable support strand. Self-supporting or figure 8 cables are NOT permitted.

2.14 AERIAL SUPPORT

- A. Utility Poles
 - 1. Only Class 5 poles shall be utilized
 - 2. Pole lines for aerial plant construction involving the crossing of railroads, limited-access highways, and other special situations should be designed for Grade B construction which is defined in Section 24 of the latest edition of the NESC.
 - 3. Poles are also subjected to a transverse load. The transverse load is the load applied when the wind pressure occurs at a right angle to the direction of the pole line. Transverse loading on poles should be calculated using the storm loading assumptions for the three loading districts established in Section 25, Loading for Grades B, C, and D, of the latest edition of the NESC.
- B. Messenger and Guying Strand
 - 1. Provide "6M" or "10M" steel messenger strand specific to the application. Messenger strand shall to be manufactured to ASTM A475 specifications and be accepted by RUS standards.
 - 2. Suspension strands are available in utilities and extra high strength grades. Both the utilities and extra high strength grades come in;
 - a) 6M
 - b) 10M
 - c) 16M
 - 3. The suspension strand size for cable in the systems usually will be either 6M or 10M strand.
 - 4. The rated breaking strength (minimum breaking strength) of the 6M and 10M strands are;
 - a) 6M - 6,000 pounds-force (26,689 newtons)
 - b) 10M - 11,500 pounds-force (51,154 newtons),
 - 5. Aerial cable plant design is based on not exceeding 60 percent of the rated breaking strength of the suspension strand when the cable and strand are loaded as calculated according to assumptions of wind, ice, and temperature specified in accordance with the storm loading districts specified in Section 25 of the latest edition of the NESC.
 - 6. The 16M strand will permit longer spans than the 10M strand.
 - 7. Both the utilities and extra high strength grade suspension strands are available in three zinc coating weights referred to as Class A, Class B, and Class C coatings.
 - a) The Class A coated strand has lowest zinc coating weight
 - b) Class C coated strand has the highest zinc coating weight.
 - 8. The Class A coated strand is the preferred suspension strand installed in the communications systems.

9. The Class C coated suspension strand should be used in aerial plant construction where the Class A coated strand is subjected to excessive corrosion.
10. RUS Bulletin 1751F-670, Outside Plant Corrosion Consideration, should be referenced to determine if the corrosion could be a problem in the construction area.

C. Strand Connectors

1. Strand connectors, suspension/cable clamps, grounding tap clamps, hangers, 1-bolt and 3-bolt clamps shall be rated to adequately support the strand.
2. Strand runs in excess of 15 ft (4.6m) between structural columns, additional ½ in (12.7mm) rod supports and appropriate strand clamps (such as 3-hole clamp) shall be provided and installed on minimum 25 ft (7.6m) centers.

D. Galvanized Steel Attachment Hardware

1. S type guy bolts, wall straps and brackets shall be used to adequately support the cable.
2. S type guy bolts (or commonly called anchor rods or thimble-eye bolts) shall be a minimum of 5/8 in (16mm) diameter with a straight shank and be designed for attaching messenger strand dead ends. The bolt length shall be at least 4 in (101.6mm) longer than the width of the structural steel flange it will be attached to.
3. B type beam clamps, or approved equivalent, shall be specified for use when dead-ending strand on the flange of structural steel members (columns and beams).

E. Lashing Wire

1. Lashing wire shall be stainless steel type 430 with .045 in (1.1mm) minimum diameter.

F. Grounding Apparatus

1. All installations shall be grounded according to RUS and ANSI/TIA/EIA 758-A requirements.

G. Guying Apparatus and Anchors

1. Guying Strand
 - a) Guying strand shall be “6M” or “10M” galvanized steel.
 - b) Guying strand shall be manufactured to ASTM A475 specifications and be accepted by RUS standards.
 - c) A minimum 8 ft (2.4m) safety yellow polyethylene guy strand cover is required.
2. Guying Anchor
 - a) Shall be an eight way anchor designed for installation in an 8 in hole with 135 sq. in. area and shall include a ¾ in (19mm) thimble eye bolt.
 - b) Shall have a one piece top plate that expands upon impact into undisturbed earth to form a cone shaped square which distributes the anchors holding power over a wide area.
 - c) Anchor shall be covered with asphalt paint to protect against corrosive soil conditions.
 - d) Rod shall be hot dipped galvanized.

2.15 CABLE STORAGE RINGS

- A. Refer to specification section 27052 for detailed information regarding cable storage rings.

2.16 SNO-SHOE

- A. Refer to specification section 27131 for detailed information regarding sno-shoes.

2.17 SIMPLEX CONDUIT SEALS

- A. Refer to specification section 27131 for detailed information regarding simplex conduit seals.

2.18 DUCT/CONDUIT PLUS

- A. Refer to specification section 27131 for detailed information regarding duct/conduit plugs.

2.19 INNERDUCT ORGANIZER PLUG

- A. Refer to specification section 27131 for detailed information regarding innerduct organizer plugs.

PART 3 EXECUTION**3.1 GENERAL**

- A. Comply with the Execution requirements of Section 27100 Part #3.

3.2 EXAMINATION

- A. Examine areas to receive overhead hanger/support system prior to the start of work within this section. Notify the General Contractor of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Installer is responsible for the integrity of the structures to which the system is attached, including their capability of safely accepting the loads imposed as evaluated by the Owner

3.3 INSTALLATION**A. Innerduct**

1. Provide innerduct for routing of fiber optic cables. The innerduct shall be continuous from originating Building to destination. Truncate the innerduct in either room prior to slack storage.
2. When routing through High-lines, place innerduct in the cable tray / primary pathway / dedicated supports. When routing vertically support innerduct on vertical cable support (such as runway) and fasten using UV rated cable ties. When routing horizontally support innerduct on overhead cable support and fasten using cable ties. Install cable ties at 24 in (610mm) intervals.
3. Fiber that is placed in a 4 in (101.6mm) conduit will require (3 different colored) 1-1/4 (32mm) in smooth wall innerducts.
 - a) Install conduit/innerduct rings at bell-ends for a water tight fit.
 - b) Install innerduct plugs in all un-used innerducts.
4. Label innerducts at both ends and at all transition points. The label shall be visible to a technician standing at-ease. The label on the innerduct shall reflect the cable identifiers of the installed cables with each innerduct. Utilize the OSP cable labels (metal embossed tags) as identified in Part 2 of 27131. See section 27131 part 3 for information on cable label identifiers.

B. Direct Burial System

1. Installation shall be in accordance with RUS Bull 171F-640. Under paved areas, and roadways install cable in conduit encased in concrete (when possible). Slope ducts to drain.
2. Excavate trenches by hand or mechanical trenching equipment.
3. Provide a minimum cable cover of 36 in (914mm) below finished grade.
4. Trenches shall be not less than 6 in (152mm) wide and in straight lines between cable markers.
5. Do not use cable plows.
6. Bends in trenches shall have a radius of not less than 36 in (914mm).
7. Where two or more cables are laid parallel in the same trench, space laterally at least 3 in apart.

8. When rock is encountered, remove it to a depth of at least 3 in (77mm) below the cable and fill the space with sand or clean earth free from particles larger than ¼ in (6.3mm).
9. Do not unreel and pull cables into the trench from one end. Cable may be unreeled on grade and lifted into position.
10. Provide color, type and depth of warning tape as specified in this section.
11. Cable Placement
 - a) Separate cables crossing other cables or metal piping from the other cables or pipe by not less than 3 in (77mm) of well tamped earth.
 - b) Cables shall be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is finished.
 - c) Avoid bends in cables of small radii and twists that might cause damage.
 - d) Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.
 - e) Leave a horizontal service loop of approximately 10-30 ft (3-9 m) in an approved Maintenance/Hand hole on each end of cable runs, within a connection box, and at points where connections are brought above ground.
 - f) Where cable is brought above ground, leave additional slack to make necessary connections.
12. Identify each cable with corrosion-resistant embossed metal tags at all transition points.
13. Identification Slabs [Markers]
 - a) Provide a marker at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways and over each splice. Identification markers shall be of concrete, approximately 20 in square by 6 in (152mm) thick.
 - b) All markers shall be labeled with the type of cable installed beneath as well as the cable ID.
14. Backfill for Rocky Soil
 - a) When placing cable in a trench in rocky soil, the cable shall be cushioned by a fill of sand or selected soil at least 2 in thick on the floor of the trench before placing the cable or wire. The backfill for at least 4 in above the wire or cable shall be free from stones, rocks, or other hard or sharp materials which might damage the cable or wire. If the buried cable is placed less than 24 in depth, a protective cover of concrete shall be used.

C. Conduit

1. Direct buried applications;
 - a) Top of conduit must be buried at least 36in below finished grade.
 - b) Place Detectible plastic warning tape a minimum of 12in (305mm) below finished grade.
 - c) Refer to the drawings for the encasing conduit in concrete.
2. Conduits shall not exceed 400 ft (122m) between pull points.
3. Flexible conduit shall not be used.
4. Metallic conduit shall be bonded to ground on one or both ends in accordance with national and/or local codes requirements.
5. Withstand the environment to which they will be exposed.

6. Achieve the best direct route (e.g. parallel to building lines) with no route exceeding 180 degrees between pull points.
 7. The conduit size for OSP cable must accommodate;
 - a) Multiple building feeds
 - b) Cables placed at different times.
 8. Terminate conduit that protrude through floors a minimum of 3 in (77mm) above finished floor
 9. No more than the equivalent of Two (2) 90 degree sweeps is allowed in a run, including offsets. Absolutely no "LB" (elbows) allowed in any conduit route.
 10. A third bend may be acceptable in a pull section without de-rating the conduits capacity if one of the statements below are true;
 - a) Total run does not exceed 33ft (10m).
 - b) The conduit size is increased to the next trade size.
 - c) At least one (1) of the bends is within 12in (305mm) of the cable feed end (This exception only applies to placing operations where cable is pushed around the first bend).
 11. After installation conduits shall be left;
 - a) Clean, dry, and unobstructed.
 - b) Capped for protection.
 - c) Labeled for identification.
 - d) Reamed and fitted with bushings.
 - e) With a pull cord.
- D. Pull boxes
1. Pull boxes shall be rated for the area they are being installed.
 2. All pull boxes shall be installed in accessible areas.
 3. A pull box should not be installed in lieu of a bend.
 4. Conduits that enter the same pull box from opposite ends of each other shall be aligned.
 - a) No cable directional changes are allowed.
 5. Pull boxes should be placed in sections of conduit that;
 - a) Exceed 400ft (122m) in length.
 - b) Contain more than two 90 degree bends.
 - c) Contain a reverse bend.
- E. Maintenance/Hand Holes
1. All MH shall be installed in accessible areas.
 2. A MH should not be installed in lieu of a bend.
 3. Conduits that enter the same MH from opposite ends of each other shall be aligned.
 4. Man/Hand holes should be placed in sections of conduit that;
 - a) Exceed 400ft (122m) in length.
 - b) Contain more than two 90 degree bends.
 - c) Contain a reverse bend.

F. Minimum Separation

1. For safety purposes, power cables should be kept physically separated from communication cables (refer to table below). For branch circuits of 5kVA or less, no additional separation is necessary.
2. Minimum separation distance for possible sources of Electromagnetic interference exceeding 5 kVA.

| Condition | Minimum Separation distance |
|--------------------------------|--|
| Power or other foreign conduit | 3 in (77mm) of concrete or 4 in (101.6mm) of masonry or 12 in (305mm) of well – tamped earth |
| Pipes (gas, oil and water) | 6 in (152mm) when crossing. 12 in (310mm) when parallel |

G. Bend Radius

1. Conduit bends should be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
2. Bend radius for all conduits designer for outside plant cabling shall be a minimum of 10 (ten) times the internal conduit dimension.

H. Underground Vaults

1. Underground conduit Vaults
2. Cable duct assignments should be the same in each UCV, whenever possible. However, each duct should be chosen section-by-section, since the same relative position in each UCV may not always provide the best cable arrangement.
 - a) Cables shall not be placed in ducts other than those indicated on drawings.
3. Where cables are pulled through Underground Conduit Vaults' without splicing, duct selections shall be the same at both ends of UCVs unless specifically noted on the Drawings.
4. Changes in duct selections, especially in elevations, shall be avoided to ensure that no damage occurs to the cable sheaths and that pulling tensions are kept as low as possible.
5. A sufficient length of cable shall be left in each UCV to properly rack and splice the cable. A minimum of one revolution (without innerduct) around the diameter of the UCV is required which is about 10-30 ft (3-9 m).
6. Cables in UCVs shall be racked and spliced as soon as practicable and in no case shall racking and splicing occur greater than one week after cable installation.
7. Cables in UCVs shall be routed to avoid blocking duct access.
8. Cables shall be pulled simultaneously when more than one cable is being installed in the same raceway.
9. Cables shall be fed into ducts from the end of the duct which creates the least sidewall pressure on a bend during installation (i.e. cable should be fed from the end closest to the bend).
10. Use pulling compound or lubricant where necessary.
 - a) Lubricants shall be compatible with the cable jacket material and shall be used in accordance with manufacturer's recommendations.
 - b) Soap-based lubricants shall not be used.
 - c) Where cable is pulled through a UCV, the cable shall be re-lubricated prior to feeding into the next duct.

- d) Immediately after cables have been installed, exposed cables in UCVs and at termination points shall be cleaned of lubricants using dry rags.
- 11. In order to prevent moisture entry into the core of filled cables and in order to prevent damage during installation, cable ends shall be sealed and protected with end caps immediately after installation and until terminated in a termination enclosure.
- 12. Vacant ducts should be selected that would allow new cables to be installed without crossing over existing cables or blocking other vacant ducts
- 13. Loop copper/ fiber once around the maintenance hole or hand-hole in addition to a coil if one is required. Maintain manufactures minimum bend radius at all times.
- I. Penetrations
 - 1. Caulk and seal cable access penetrations in walls, ceilings and other parts of the building. Seal openings around electrical penetrations trough fire resistance-rated wall, partitions, floors, or ceilings in accordance with EMTN 3226 section 16112 Cable Tray.
- J. Cable Pulling
 - 1. Place the leader guard (shoe) in the duct before placing the cable to prevent damaging the cable sheath on the sharp edges of the duct.
 - 2. Test duct lines with a mandrel and swab out to remove foreign material before the pulling of cables or innerducts.
 - 3. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware.
 - 4. Outside plant cables minimum bend radius is 20 times the cable diameter under max rated pulling tension and 10 times unloaded.
 - 5. Do not step on cables when entering or leaving the maintenance/hand hole.
 - 6. Do not place cables in ducts other than those shown without prior written approval of the Owner.
 - 7. Roll cable reels in the direction indicated by the arrows painted on the reel flanges.
 - 8. Set up cable reels on the same side of the maintenance/hand hole as the conduit section in which the cable is to be placed.
 - 9. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting.
 - 10. Under no circumstances shall the cable be paid off from the bottom of a reel.
 - 11. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started.
 - 12. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects.
 - 13. When defects are noticed, stop pulling operations and notify the Owner to determine required corrective action.
 - 14. Cable pulling shall also be stopped when reel binds or does not pay off freely.
 - 15. Rectify cause of binding before resuming pulling operations.
 - 16. Provide cable lubricants recommended by cable manufacturer.
 - 17. Avoid bends in cables of small radii and twists that might cause damage.
 - 18. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

K. Cable Tensions

1. Obtain from the cable manufacturer and provide to the Owner, the maximum allowable pulling tension. This tension shall not be exceeded.

L. Pulling Eyes

1. Equip cables 1.25 in (32mm) diameter and larger with cable manufacturer's factory installed pulling-in eyes.
2. Provide cables with diameter smaller than 1.25 in (32mm) with heat shrinkable type end caps or seals on cable ends when using cable pulling grips.
3. Pulling rings to prevent grip from slipping shall not damage cable sheath.
4. Use a 3/4 in (19mm) swivel link between pulling-in eyes or grips and pulling strand.

M. Installation of Cables in Maintenance holes, Handholes, and Vaults

1. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.
2. Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths.
3. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets and cable insulators at a maximum of 4 ft (1.2m) intervals.
4. In existing manholes, hand-holes, and vaults where new ducts are to be terminated, or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for new cables.
5. Identify each cable with corrosion-resistant embossed metal tags at all transition points.

N. Aerial Support

1. Refer to specification section 16.370.003 "MANDATORY CLEARANCES FOR OVERHEAD ELECTRICAL CABLES" for detailed information regarding Aerial clearance requirements.
2. Utility Poles
 - a) Label as per RUS requirements and ANSI/TIA/EIA 606A.
3. Messenger and Guying Strand
 - a) Install all messenger strands to meet RUS requirements.
 - b) Verify messenger wire assignments with the owner's representative. Because fiber optic cable is light in weight and its sag in aerial span small, it should occupy the uppermost available communication space on the pole. Make sure sufficient space is available to provide the required vertical clearance when installing aerial fiber on joint-use poles.
 - c) Contractor to ensure proper clearances from electric power lines and other cables that may sag near the fiber optic cable. Determine the clearances between the proposed cable plant and existing facilities on a case-by-case basis by referring to the National Electrical Safety Code (NESC) and appropriate safety codes.
 - d) As with copper cables, fiber optic cables should be routed on the inside of messenger intersections at dead-end and aerial crossovers. This practice, along with drip loops, will minimize the chance of damage should a pole in the cable route be damaged.
 - e) Strand tension should not exceed 70% of breaking strength with cable in place and a 300 lb load concentrated at mid-span. Sag should not exceed 10 ft (3m) at a 60 Degree F (16 Degree C) temperature, without any wind loading.

4. Strand Connectors
 - a) Strand connectors, suspension/cable clamps, grounding tap clamps, hangers, 1-bolt and 3-bolt clamps shall only be utilized with prior approval from the Owner.
5. Galvanized Steel Attachment Hardware
 - a) Appropriate guy bolts, wall straps, brackets, etc., shall be installed to adequately support the strand
 - b) Guy bolts (or commonly called anchor rods or thimble-eye bolts) shall be a minimum of 5/8 in (16mm) diameter and be designed for attaching messenger strand dead-ends.
 - c) The bolt length shall be at least 4 in (101.6mm) longer than the width of the pole to which it will be attached.
6. Maintenance Loop and Drip Loops
 - a) When running aerial fiber, a maintenance loop must be placed every ten spans (Minimum of 20-50 ft (6.1-15.2 m) every 1,000 ft (305 m) for emergency restoration. Each maintenance loop shall be lashed to the support strand.
 - 1) Utilize a manufactured "sno-shoe" style support for all maintenance loops.
 - b) When fiber drip loops are used, they must be a "smooth-curve" type (min of 12 in (305mm) radius) – under no circumstances should any other shape be used.
 - c) Corning Cable Systems does not recommend the use of drip loops in applications where fiber optic cable is over-lashed to existing coaxial cable.
7. Lashing Wire
 - a) Cable straps / plastic cable ties shall NOT be used.
 - b) Connect lashing wire to messenger strand using approved strand clamps.
 - c) All cables must be double lashed using a .045in (1.1mm) super high strength lashing wire when over-lashing over existing cable, or placing cable over roadways.
 - d) No self-supporting or figure eight style cables.
 - e) When lashing fiber optic cable to the support strand, there must be at least one wrap of lashing wire per linear foot (305mm). Care should be taken when lashing larger bundles of cables as not to damage the cables outer jacket.
 - f) Cable shall be lashed up span-by-span; the lashing wire shall be terminated at each pole with a lashing wire clamp. This practice will ensure that only one span of cable will be unsupported if a lashing wire is cut.
 - g) When over lashing all old lashing shall be removed.
8. Guying Apparatus and Anchors
 - a) Guying Strand
 - 1) Install guying apparatus per RUS.
 - 2) Install protective guard on all down guys. Guards shall be Yellow in color.
 - b) Anchor
 - 1) Install eight-way anchors designed for installation which includes a minimum $\frac{3}{4}$ in thimble eye bolt.
 - 2) Install one piece top plate that expands upon impact into undisturbed earth to form a cone shaped square distributing the anchors holding power over a wide area.
9. Identify each cable with corrosion-resistant embossed metal tags at each pole and at all transition points.

O. Grounding Apparatus

1. Ground and bond all poles, messenger strand and any other metallic parts in accordance with RUS, the NESC, ANSI/TIA/EIA 758-A and Specification section 27800.
2. Provide grounding and bonding in accordance with RUS 1755.200, TIA J-STD-607-A, IEEE C2, and NFPA 70. Ground exposed non-current carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals.
 - a) Telecommunications Master Ground Bar (TMGB)
 - 1) The TMGB is the hub of the basic communications grounding system providing a common point of connection for ground from outside cable, CD, and equipment.
 - 2) Establish a TMGB for connection point for cable stub shields to connector blocks and BEP protector assemblies as specified in Section 27800 Grounding and Bonding for Communications Systems.
 - b) Incoming Cable Shields
 - 1) Shields shall not be bonded across the splice to the cable stubs.
 - 2) Ground shields of incoming cables in the EF to the TMGB.
 - c) Campus Distributor Grounding
 - 1) Protection assemblies: Mount BEP protector assemblies directly on the communications backboard.
 - 2) Bond each BEP individually to the TMGB. Do not daisy chain the protectors together.
 - 3) Connect assemblies mounted on each vertical frame with No. 6 AWG copper conductor to provide a low resistance path to the TMGB.
 - 4) TMGB connection: Connect TMGB to TGB with copper conductor with a total resistance of less than 0.02 ohms.

P. Detectable Tape

1. Install detectable directly above communications pathway/cable at a depth of 12 in (305mm) below grade.
2. Maintain tape continuity at all times using an approved "clip" or other device between sections.

Q. Cable Storage Rings

1. Refer to specification section 27052 for detailed information on cable storage rings.

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. This Section includes general administrative and procedural requirements for Sections under Division 27, and is intended to supplement, not supersede, Division 1 requirements.
- B. The requirements described herein include the following:
 - 1. References
 - 2. Definitions
 - 3. Submittals
 - 4. Quality Assurance
 - 5. Delivery, Storage And Handling
 - 6. Scheduling
 - 7. Warranty
 - 8. Project Management and Coordination Services.
 - 9. Field quality control.
 - 10. Project Closeout and Record Documents
- C. Related Sections
 - 1. Consult other Sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation.
 - 2. General, Supplementary Conditions and general provisions of this contract apply to 27000 series Sections.
 - 3. Section 27052 - Interior Communications Building Pathways
 - 4. Section 27054 - Exterior Communications Building Pathways
 - 5. Section 27100 - Low Voltage Communications Installation Practices
 - 6. Section 27110 - Communications Equipment Rooms
 - 7. Section 27130 - Communications Backbone Cabling
 - 8. Section 27150 - Communications Horizontal Cabling
 - 9. Section 27800 - Grounding and Bonding Of Communications Systems
 - 10. Section 27900 - Communications System Testing

1.2 REFERENCES

- A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.
- B. Codes: Perform Work executed under this Section in accordance with applicable requirements of the latest edition of governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:
 - 1. United States Department Of Labor (DOL) Regulations (Standards - 29 CFR)
 - a) Part 1910, "Occupational Safety and Health Standards"
 - 2. National Fire Protection Agency (NFPA)
 - a) NFPA 70, "National Electrical Code" (NEC).
 - b) NFPA 75, "Protection Of Information Technology Equipment"

3. Uniform Building Code (UBC).
 4. Uniform Fire Code (UFC).
 5. Uniform Mechanical Code (UMC).
 6. National, State, Local and any other binding building and fire codes.
 7. FCC Regulations:
 - a) Part 15 – Radio Frequency Devices & Radiation Limits
 - b) Part 68 – Connection of Terminal Equipment to the Telephone Network
- C. Standards: Equipment and materials furnished under this Section shall conform to the following standards where applicable:
1. Underwriters Laboratories (UL): Applicable listing and ratings, including but not limited to the following standards:
 - a) UL 444: Communications Cables
 - b) UL 497: Protectors for Paired-Conductor Communication Circuits.
 - c) UL 1651: Optical Fiber Cable
 - d) UL 1690: Data-Processing Cable
 - e) UL 1863: Communications-Circuit Accessories
 - f) UL 2024A: Optical Fiber Cable Routing Assemblies.
 2. TIA-568-C Cabling Standards Family including all addenda
 - a) TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
 - b) TIA-568-C.1 Commercial Building Telecommunications Cabling Standard.
 - c) TIA-568-C.2 Balanced Twisted Pair Telecommunications Cabling and Components Standard
 - d) TIA-568-C.3 Optical Fiber Cabling Components Standard
 3. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces, including all addenda
 4. ANSI/TIA/EIA-598-B Optical Fiber Cable Color Coding.
 5. ANSI/TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
 6. ANSI/J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
 7. ANSI/TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Cabling Standard including all addenda
 8. EIA testing standards.
 9. Insulated Cable Engineers Association (ICEA):
 10. ANSI/ICEA S-80-576-2002 Category 1 & 2 Individually Unshielded Twisted Pair Indoor Cables for Use in Communications Wiring Systems
 - a) ANSI/ICEA S-83-596-1994 Fiber Optic Premises Distribution Cable
 - b) ANSI/ICEA S-87-640-1999 Fiber Optic Outside Plant Communications Cable
 - c) ANSI/ICEA S-90-661-2002 Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cable for Use In General Purpose and LAN Communication Wiring Systems
 - d) ICEA S-104-696-2001 Standard For Indoor-Outdoor Optical Cable

11. BICSI® Publications:

- a) Telecommunications Distribution Methods Manual (TDMM) 13th Edition
 - b) Customer-Owner Outside Plant Design Reference Manual (COSPDM) 5th Edition
 - c) Information Transport Systems Installation Manual (ITSIM) 6th Edition
 - d) Electronic Safety and Security Design Reference Manual, 2nd Edition
- D. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the local Electrical Code and present manufacturing standards.
- E. All materials shall be UL Listed and shall be marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.
- F. The cabling system described in this document is derived from the recommendations made in recognized telecommunications industry standards.
- G. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- H. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.
- I. Reference SSG's:
- 1. 13413 Medium Fiberglass Field Junction Box Assembly
 - 2. 13416 Mounting Stands for Field Junction Boxes and
 - 3. 16000 General Electrical Conditions
 - 4. 16020 Grounding and Lightning Protection
 - 5. 16111 Conduit and Accessories
 - 6. 16112 Cable Tray
 - 7. 16120 Wire, Cable and Accessories
 - 8. 16195 Tagging and Identification
 - 9. 28000 Fire and Life Safety Alarm Systems
 - 10. 29000 Security and Access Control System
 - 11. 27.800.002.001 Communications Grounding System One-Line Diagram
 - 12. 27.110.002.001 Communications Equipment Cabinet Detail Arrangement
 - 13. 27.110.002.002 Communications Server Cabinet Detail Arrangement
 - 14. 27.100.002.002 General Administration and Labeling
 - 15. 27.150.002.001 Typical connection Details Sheet (1 of 7)
 - 16. 27.150.002.002 Typical connection Details Sheet (2 of 7)
 - 17. 27.150.002.003 Typical connection Details Sheet (3 of 7)
 - 18. 27.150.002.004 Typical connection Details Sheet (4 of 7)
 - 19. 27.150.002.005 Typical connection Details Sheet (5 of 7)
 - 20. 27.150.002.006 Typical connection Details Sheet (6 of 7)
 - 21. 27.150.002.007 Typical connection Details Sheet (7 of 7)
 - 22. 27.150.002.050 Copper & Fiber Work Area Outlet (WAO) & Media Interface Cable Labels

23. 27.150.002.051 Copper & Fiber Horizontal Patch Cable Labels

24. 27.150.002.052 Process Communications Cable Labels

1.3 SYSTEM DESCRIPTION

A. In circumstances where the Specifications and Drawings conflict, the most stringent requirement shall apply. Generally, the Drawings shall govern quantity and the Specifications shall govern quality.

1. Base Bid Work

- a) Refer to Project Specification section 27001 "Intra-building Communications Scope of Work" for a detailed description of work.
- b) Provide labor, materials, apparatus, tools, equipment, and transportation required to make a complete working Communications Horizontal Cabling System installation described in these specifications.
- c) Consider horizontal cabling as shown on Drawings to be base bid work, unless otherwise noted.

2. In general, the base bid work may include:

- a) Preconstruction Submittals.
- b) Horizontal cables, terminations, and outlets.
- c) Cable management.
- d) Cable identification tags and system labeling.
- e) Record Documents.
- f) Warranty.

1.4 SUBMITTALS

A. As required by owner: Provide required submittals in accordance with Division #1.

B. Obtain approval in writing by the Project Engineer for the Product Data submittals and for the Shop Drawings (as required) prior to release of order for products and equipment, and prior to installation.

C. Product Data Submittal Requirements

1. Content: Product Data Submittals shall include a manufacturer's data/cutsheet detailing the product number and pertinent physical/electronics information.
2. Quantity: Submit quantity of product data submittals as described in Division #1. In the absence of requirements given, submit (2) product data submittals.
3. Format:
 - a) Product data sheets shall be 8-1/2 x 11 in pages or 11x17 for oversized information.
 - b) Package each submittal with an outer cover. Examples include:
 - 1) 3-ring binder with front cover and spine having clear pockets for insertion of the submittal information.
 - 2) 3-hole report covers with transparent front cover.
4. Clearly label each submittal on the outer cover with the following information:
 - a) Project name and address.
 - b) Submittal Title (e.g., "Product Data Submittal for Telecommunications Equipment Rooms").
 - c) Project submittal number.
 - d) Specification section number/s (e.g., "Section 27.100").

- e) Date and revision; date format: <month> <day>, <year> (e.g., "January 1, 2000")
 - f) General Contractor / Prime Builder.
 - g) Communications Installer.
- 5. Include index dividers for improved navigation through the submittal. Dividers shall match the Table of Contents.
- D. As-Built Drawings Submittal Requirements
 - 1. As required by owner.
 - a) Details may vary for each individual project. Verify requirements for each project with owner's rep. In lieu of absent direction contractor will follow details and requirements for as-built drawing submittal requirements called out above, section 27100, 1.04, D.
 - 2. Quantity: Submit quantity of as-built drawings as described in Division 1. In the absence of requirements given, submit two (2) sets of as-built drawings.
 - 3. Media: Submit drawings on media as described in Section Division 1. In the absence of requirements given, submit drawings full size on bond or eco-bond.
 - 4. Format:
 - a) Prepare as-built drawings by "Marking" Owner provided Engineering Drawings.
 - 1) Drawings and cable schedule as-built information are to be marked up using the following color system:
 - (i) Red pencil: All additions, corrections or modifications
 - (ii) Yellow pencil: work/scope being deleted
 - 2) Drawings and cable without mark ups indicates that no field changes were made shall be noted as "No Changes".
 - b) Use the same sheet size as the Contract Documents, and use the project title block.
 - c) Text: minimum of 3/32 in high and legible penmanship.
 - d) Use symbols identical to the symbols shown on the Drawings.
 - e) Mark-up system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.
 - 1) Cable routes to include all contractor installed pathways, basket tray, conduit, cable hangers (J-hooks), etc.
 - 5. Content:
 - a) As-Built Drawings shall fully represent actual installed conditions and shall incorporate revisions made during the course of construction.
 - b) Floor plans shall show:
 - 1) Locations and identifiers of outlets/devices.
 - 2) Size, quantity, location, and routes of pathways (such as cable basket, cable hangers, and other cable support devices).
 - c) Enlarged room floor plans (if changed or not shown in original documents) scaled at 1/2 in=1ft-0 in showing exact placement of equipment cabinets/frames, rack bays, and other equipment.
 - 1) Applicable rooms: Telecommunications Room
 - d) Enlarged room overhead plans scaled at 1/2 in=1ft-0 in showing exact placement of overhead cable support devices (e.g., cable basket, cable runway, conduit sleeves, etc.).
 - 1) Applicable rooms: Telecommunications Room

- e) Wall elevations (if changed or not shown in original documents) scaled at 1 in =1ft-0 in showing exact placement of termination hardware (e.g., termination/cross-connect blocks).
- f) Installation details.

E. Project Close-out Manual Submittal Requirements

1. As required by owner.
 - a) Details may vary for each individual project. Verify requirements for each project with owner's rep. In lieu of no direction contractor will follow details and requirements for Project Close-out Manual submittal requirements called out section 27100, 1.04, E.
2. Quantity: Submit quantity of Project Close-out Manuals as described in Division #1. In the absence of requirements given, submit one (1) project submittals.
3. Format:
 - a) Package each Manual in a white, 3-ring binder with front cover and spine having clear pockets for insertion of the project information.
 - b) Clearly label the cover of each Manual with the following information:
 - 1) Client name.
 - 2) Project name.
 - 3) Manual title (e.g., "Project Close-out Manual for Communications Cabling System").
 - 4) Date; date format: <month> <day>, <year> (e.g., "January 1, 2000").
 - 5) Communications Installer and General Contractor names.
 - c) Include tabbed separators for improved navigation through the manual.
4. Content:
 - a) Include a Table of Contents at the beginning that lists the contents.
 - b) One (1) CD-ROM containing Testing Documentation.
 - c) Manufacturer's original catalog information sheets for each component provided under applicable Section (One copy of approved Shop Drawings will be adequate to be included in master set of submittals).
 - d) Warranty certificate from the manufacturer and the Contractor for cable and equipment installed.
 - e) Testing Documentation;
 - 1) Example tabbed Sections
 - (i) Communication Horizontal Cabling
 - (ii) Communications ISP Copper backbone cabling
 - (iii) Communications ISP Fiber backbone cabling
 - (iv) Communications OSP Copper backbone cabling
 - (v) Communications OSP Fiber backbone cabling
 - 2) Format of each Tabbed Section;
 - (i) Summary report. (Always required)
 - (ii) Detailed cable test reports.
 - Requirements for detailed cable test reports vary per project. Verify project requirements with Owners rep before submittal.
 - f) Instructions for maintenance and warranty issues.

F. Contractor Qualifications

1. All communications contractors must be pre-approved before bidding.
2. The following information and qualifications must be submitted in order to be considered for pre-approval;
 - a) Provide a copy of Contractors License.
 - b) Provide a copy of Contractors RCDD certificates (minimum of 1 shall be directly employed by the submitting contractor).
 - c) Provide a copy of Contractors proposed on-site personal BICSI ® certificates.
 - 1) ITS Technician (Minimum of 1 (one) on site while work is being performed)
 - 2) ITS Installer 2. Copper
 - 3) ITS Installer 2. Optical Fiber
 - d) Provide a copy of Contractors proposed on-site Technicians and Apprentices qualifications certificates.
 - 1) Manufacturer certifications
 - 2) Manufacturer training
 - 3) Industry training
 - 4) Relevant project experience, etc.
 - (i) Corning Cable Systems Preferred Installer
 - In addition to the Contractor Qualifications requirements of Section 27100, the Communications Installer shall be a LANscape® Network of Preferred Installers (NPI), certified by Corning Cable Systems, and shall be capable of providing the 25-year LANscape Solutions and 10-year Intelligent Traffic System extended warranties.
 - Provide evidence in the bid submission of certification in the NPI program. Evidence shall consist of a "Certification of Participation" issued by Corning Cable Systems listing the Communications Installer's company name.
 - (ii) Hubbell Contractor Qualifications
 - In addition to the Contractor Qualifications requirements of Section 27100, the Communications Installer shall be a Hubbell MISSION CRITICAL™ Certified Installer, certified by Hubbell, and shall be capable of providing an extended warranty in the MISSION CRITICAL™ warranty program.
 - Provide evidence in the bid submission of certification in the MISSION CRITICAL™ program. Evidence shall consist of a "Certification of Participation" issued by Hubbell the Communications Installer's company name.
 - (iii) Ortronics Contractor Qualifications
 - In addition to the Contractor Qualifications requirements of Section 27100, the Communications Installer shall be an Ortronics Certified Installer (OCI), certified by Ortronics Corporation, and shall be capable of providing an extended warranty in the NetClear system warranty program.
 - Provide evidence in the bid submission of certification in the OCI program. Evidence shall consist of a "Certification of Participation" issued by Ortronics Corp listing the Communications Installer's company name.

(iv) Panduit Certified Installer Qualifications

- In addition to the Contractor Qualifications requirements of Section 27.100v, the Communications Installer shall be a Panduit Certified Installer (PCI), certified by The Panduit Corporation, and shall be capable of providing an extended warranty in the PanNet system warranty program.
 - Provide evidence in the bid submission of certification in the PCI program. Evidence shall consist of a "Certification of Participation" issued by Panduit listing the Communications Installer's company name.
- e) Provide proof of a minimum of five, continuous years' experience.
- f) Five, minimum, completed projects similar to scope and cost. Provide a list of projects, including references with contact information, in the submission.
3. Future manufactures may be added at the discretion of the owner.

1.5 MATERIALS

- A. Materials and equipment furnished shall be new, unused and without defects or repairs.
- B. Furnish only specified products and equipment, or products and equipment that have been approved in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. Products shall not be delivered to the site until protected storage space is available.
2. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
3. Deliver materials in manufacturer's original, unopened, undamaged packaging and containers with identification labels (name of the manufacturer, product name and number, type, grade, UL classification, etc.) intact.
4. Replace any and all equipment damaged during shipping at no cost to the Owner.

B. Storage and Protection

1. Store materials in clean, dry, ventilated space free from temperature and humidity conditions (as recommended by manufacturer) and protected from exposure to harmful weather conditions.
2. Comply with manufacturer's requirements for each product. Comply with recommended procedures, precautions or remedies as described in the Material Safety Data Sheets (MSDS) as applicable.
3. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
4. Storage outdoors covered by rainproof material is not acceptable.
5. Provide heat where required to prevent condensation or temperature related damage.

C. Handling

1. Handle in accordance with manufacturer's written instructions.
2. Damaged equipment shall not be installed.
3. Replace damaged equipment at no cost to the Owner.
4. Handle with care to prevent internal component damage, breakage, denting, and scoring.

1.7 SCHEDULING

- A. Unless otherwise specified, the construction schedules of all Sections may be combined.

PART 2 PRODUCTS

2.1 GENERAL

- A. Materials used shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards, other applicable federal, state, and local laws.
- B. Product numbers listed in the following sections are subject to change by the manufacturer without notification. In the event a product number is invalid or conflicts with the written description, notify the Owner in writing prior to ordering the material and performing any installation work. Provision and installation of the approved changed product will be at no additional cost to the Owner.

2.2 SUBSTITUTIONS

- A. Requests for substitutions shall conform to the general requirements and procedure outlined in Division 1.
- B. Where items are noted as "or equal", a product of equivalent function, design, construction, quality and performance will be considered. Include in the substitution request: catalog cuts, product information, and pertinent test data required to substantiate that the product is in fact equivalent to that specified. Only one substitution will be considered for each product specified.
- C. Do not provide substitution material, processes or equipment without written authorization from the Owner.
- D. Substitutions shall be equivalent, in the opinion of the Owner, to the specified product. The burden of proof of such shall rest with the Contractor. When the Owner in writing accepts a substitution, it is with the understanding that the Contractor guaranteed the substituted product, component, article, or material to be equivalent to the one specified and dimensioned to fit within the construction. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the work, or from any provisions of the Specifications.
- E. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility and appearance. Materials, processes or equipment that, in the opinion of the Owner, are equivalent in quality, utility and appearance will be approved as substitutions to that specified when "or equivalent" follows the manufacturers' names and model number(s).
- F. Whenever any material, process or equipment is specified in accordance with a TIA/EIA specification, an ANSI specification, UL rating or other association standard, present an affidavit from the manufacturer certifying that the product complies with the particular standard specification. When requested by the Owner, submit supporting test data to substantiate compliance at no additional cost.
- G. Pay expenses, without additional charge to the Owner, in connection with substitution materials, processes and equipment, including the effect of substitution on self, subcontractor's or other Contractor's work.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Conditions: Verify conditions, provided under other sections, are acceptable for product installation in accordance with manufacturer's instructions.
- B. Pathways: Verify that pathways and supporting devices, provided under other sections, are properly and permanently installed, and that temporary supports, devices, etc., have been removed.
- C. Field Measurements: Verify dimensions of pathways, including length of pathways. For example, "true tape" the conduits to verify cabling distances.

3.2 FIELD QUALITY CONTROL

- A. Staffing: Provide a qualified foreman who is in charge of the Work and who is present at the job site at times Work is being performed. Supervise the work force executing the Work. Perform the installation within the restraints of the construction schedule.
- B. Project Management: Coordinate and attend weekly status meetings to review the overall progress and issues to be resolved throughout the course of construction
- C. Scheduling: Prepare an overall construction schedule based on the results of the planning meetings with the Owner. Issue schedule to Owner for approval. Prepare and issue updated schedules whenever there are modifications.
- D. Inspection: Perform inspection after installation. Keep areas of work accessible and notify Owner, or designated inspectors, of work completion released for inspection. Document completion and inspection as required.
- E. Reference HSC "Communications Infrastructure – Acceptance Checklist" for project quality and close out references. Final copy of document will be filled out and signed by owner's rep.
 - 1. Copy of form can be obtained from owner's representative.

3.3 INSTALLATION

- A. Conform to applicable federal, state and local codes, and telephone/cabling standards.
- B. Coordinate the entire installation with the Owner, and their subcontractors, to meet the construction schedule. Include coordination meetings as required to fulfill this requirement.
- C. Related Products Installation: Refer to other sections listed in Related Sections paragraph herein for related products installation.
- D. Manufacturer's Instructions:
 - 1. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.
 - 2. Maintain jobsite file and comply with Material Safety Data Sheets (MSDS) for each product delivered to jobsite.
- E. Adjusting:
 - 1. Make changes and revisions to the system to optimize operation for final use.
 - 2. Make changes to the system such that any defects in workmanship are corrected and cables and the associated termination hardware pass the minimum test requirements.
- F. Protection:
 - 1. Protect installed products and finish surfaces from damage during delivery and construction.
 - 2. Provide protective coverings on adjacent surfaces for protection from dust.

3.4 INSPECTION AND ADJUSTMENTS

- A. Inspect installed products and completed work in conjunction with the Owner, or Owner's Representative. Develop a punch-list for items needing correction
- B. Provide punch-list to Owner, or Owner's Representative. For review prior to performing punch-list with the Owner.
- C. Repair defects prior to system acceptance.
- D. Inspect installed products and work in conjunction with the Owner, or Owner's Representative for sign off.
- E. Final Inspection
 - 1. Inspect installed products and work in conjunction with the Owner.

2. Develop a punch list for items needing correction.
3. Issue punch list to the Owner for review prior to performing punch list walk.
4. Repair defects prior to system acceptance.
5. Inspect installed products and work in conjunction with the Owner for sign off.
 - a) Owner will fill out "Communications Infrastructure – Acceptance Checklist" form.

3.5 REPAIR/RESTORATION

- A. Replace or repair work completed by others that you deface or destroy. Contractor shall be responsible to pay the full cost of this repair/replacement.
 1. Paint damaged areas to existing painted surfaces caused by this contractors work.
 2. Punch List:
 - a) Inspect installed work in conjunction with the Owner and develop a punch list for items needing correction.
 - b) Provide punch list to Owner for review prior to performing punch walk with Owner.
- B. Re-Installation:
 1. Make changes to adjust the system to optimum operation for final use. Make changes to the system such that any defects in workmanship are correct and cables and the associated termination hardware passes the minimum test requirements.
 2. Repair defects prior to system acceptance.

3.6 CLEANING

- A. Clean daily. Remove temporary coverings and protection of adjacent work areas. Remove unused products, debris, spills, or other excess materials. Remove installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.
- C. Repair or replace damaged installed products.
- D. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Legally dispose of debris.

3.7 DEMONSTRATION

- A. On completion of the acceptance test, schedule a time convenient with the Owner or Owner's Representative for instruction in the configuration, operation, and maintenance of the system.

3.8 WARRANTY

- A. The communication systems, as specified, shall receive a manufacturer's system warranty. This extended warranty shall cover parts and labor for the duration of the extended warranty. This extended warranty shall also cover electrical performance of cabling system to the specific category per ANSI/TIA/EIA-568-C performance criteria for Permanent Link.

3.9 CERTIFICATION

- A. Provide to Owner or Owner's Representative a written form of acceptance for signature. Corrections must be completed before Owner or Owner's Representative and Engineer will give acceptance.

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. Section Includes: Build out of telecommunications rooms and spaces.
- B. Related Sections
 - 1. Comply with the Related Sections of Section 27100.
 - 2. Consult other sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
 - 3. General and Supplementary Conditions.
 - 4. Drawings, general provisions of the Agreement, and Division 1 apply to this Section.
- C. Products Furnished and Installed Under separate contract (unless called for on the Construction Documents):
 - 1. Electrical service (120V and 208V circuits and devices)
 - 2. Conduit, device boxes, and sleeves
- D. Products Furnished and Installed by the Owner:
 - 1. Network switches, UPS systems, and telephone devices unless specified elsewhere.
 - 2. All equipment not specifically called for on the plan and in specifications.

1.2 REFERENCES

- A. Comply with the References requirements of Section 27100.
- B. In addition to those codes, standards, etc., listed in 27100, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. 27.100.002.002 - General Administration and Labeling Detail
 - 2. 27.110.002.001 - Communications Equipment Cabinet Detail Arrangement.
 - 3. 27.110.002.002 - Communications Server Cabinet Detail Arrangement
 - 4. 27.110.002.003 - Communications Rack Layout Arrangement
 - 5. 27.800.002.001 – Communications Ground System One-Line Diagram
 - 6. 27.800.002.002 – Communications Grounding and Torque Details
 - 7. 16000 General Electrical Conditions
 - 8. 16111 Conduit and Accessories
 - 9. 16195 Tagging and Identification
 - 10. 16020 Grounding and Lightning Protection
 - 11. ANSI/EIA-310-D-1992 Racks, Panels And Associated Equipment

1.3 DEFINITIONS

- A. Refer to the Definitions requirements of Section 27100.

1.4 SYSTEM DESCRIPTION

- A. Base Bid Work
 - 1. Refer to specification section 27001 "Intra-Building Communications Scope of Work" for a detailed "Overview" description of work.
- B. Telecommunications Room build out may include the following work:
 - 1. Preconstruction Submittals
 - 2. Plywood backboards

3. Equipment Cabinets (vertical and horizontal management, anchoring, bracing and grounding).
4. Cable, wire and patch cord management.
5. Overhead cable support.
6. Identification tags and labeling.
7. Record Documents.
8. Warranty.

C. Telecommunications Rooms house the following functions:

1. Data backbone cross connect field (fiber terminations)
2. Voice backbone cross connect field (UTP terminations)
3. Data system equipment (distributed active equipment)
4. Horizontal termination field – both voice and data – of cabling served from this room (refer to floor plans for area served)
5. Interconnection between the data system equipment and the horizontal termination field

1.5 SUBMITTALS

- A. Comply with the Submittals article of Section 27100 for procedural, quantity, and format requirements.
- B. Preconstruction Submittal Requirements:
 1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications and specifications.
 2. Shop Drawings Submittal, consisting of proposed changes to equipment room layouts.
- C. Project Completion Manual Requirements:
 1. As-Built Drawings.

1.6 QUALITY ASSURANCE

- A. Comply with the Quality Assurance requirements of Section 27100.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Comply with the Delivery, Storage and Handling requirements of Section 27100.

1.8 WARRANTY

- A. The Communications equipment room system, as specified in this section, shall be covered by a 1-year warranty for both materials and workmanship.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

- A. Comply with the Substitutions requirements of Section 27100.

2.2 EQUIPMENT RACK, FLOOR-STANDING

- A. Application: Suitable for the support of cable termination devices, management devices, common communications equipment, and other similar equipment, installed onto floor.
- B. Refer to SSG 27.110.002.003 Communications Rack Layout Arrangement for additional requirements.
- C. Material: High strength, lightweight 6061-T6 aluminum (black), extrusion construction.
- D. Channel:
 1. Size: The mounting channels shall be 6 in deep by 1.265 in wide with a 0.25 in thick web.

2. Flange: The mounting channels shall have front and back mounting flanges ("double sided"). The flanges shall be 0.25 in thick, and shall have mounting holes front and back.
3. Mounting Holes: The hole pattern shall be industry standard spaced at 5/8 in - 5/8 in - 1/2 in, compatible with ANSI/EIA-310-D (1992) standard. The mounting holes shall be pre-threaded as #12-24 rolled threading.
- E. Assembled Rack: The rack shall come complete with base angles (3.5 in high by 6 in deep by .375 in thick) and top angles (1.5 in high by 1.5 in deep by .375 in thick). The assembled rack shall be 7 ft-0 in high (overall) by 19 in mounting width (20.25 in wide overall), and shall contain 45 EIA mounting spaces.
- F. Include required accessories, such as floor installation kit, seismic mounts, etc. for a complete installation.
- G. Manufacturer, or approved equal:
 1. Chatsworth: 66353-703
 2. Ortronics : OR-MM6706

2.3 VERTICAL DOUBLE SIDED MANAGEMENT SECTION, FOR FLOOR-STANDING RACK

- A. Application: Suitable for cable routing (back) & cord slack storage (front) vertically from the bottom of the rack to the top. The vertical management sections shall be double sided (i.e., the management section shall have covered cable guides on the front and clip-retainers on the rear).
- B. Size & Capacity: 7 ft-0 in high by 6 in wide, with a minimum of 7 in deep cable storage capacity in back and 7 in cord storage capacity in front.
- C. Mounting: The vertical management section shall have matching bolt holes for attachment to the rack.
- D. Color: black (guides and hinged cover).
- E. Manufacturer, or approved equal:
 1. Chatsworth:30095-703
 2. Panduit: WMPVHC45E

2.4 VERTICAL SINGLE SIDED MANAGEMENT SECTION, FOR FLOOR-STANDING RACK

- A. Application: Suitable for patch/equipment cord slack storage (front) vertically from the bottom of the rack to the top. The vertical management sections shall be single sided (i.e., the management section shall have covered cable guides on the front).
- B. Size & Capacity: 7 ft-0 in high by 6 in wide, with 8 in deep cable storage capacity in front.
- C. Mounting: The vertical management section shall have matching bolt holes for attachment to the rack.
- D. Color: black (guides and hinged cover).
- E. Manufacturer, or approved equal:
 1. Chatsworth: 30092-703
 2. Ortronics: OR-MM6VMD706

2.5 EQUIPMENT CABINET, WALL-MOUNTED

- A. Application: Suitable for the support of cable termination devices, management devices, common communications equipment, and other similar equipment, installed onto wall.
- B. Mounting Holes: The hole pattern shall be industry standard spaced at 5/8 in - 5/8 in - 1/2 in, compatible with ANSI/EIA-310-D (1992) standard. The mounting holes shall be pre-threaded as #12-24 rolled threading.
- C. Assembled Cabinet: The Cabinet shall come complete with vented sides, opening front door and minimum 18 in deep center swing out section with front door having a Plexiglas window and

combination lock and front/rear equipment mounting rails. The assembled cabinet shall be a minimum of 25 in deep by 19 in mounting width, and shall contain 25 EIA mounting spaces (RMU).

- D. Cabinets shall be supplied with grounding kits, fan and filter kits, and a horizontal rack mounted power strip.
- E. Refer to SSG 27.110.002.001 Telecommunication Equipment Cabinet Detail Arrangement for additional requirements.
 - 1. Note: Above SSG references a full size floor standing cabinet, but the Build of Material (BOM) will reference the incidentals that are required in a wall mount cabinet. Verify exact requirements and quantities with owners rep. Build out will vary per project
- F. Manufacturer: Chatsworth, Great Lakes or approved equal.
 - 1. Chatsworth: 11996-748; 48 in H x 24 in W x 30 in deep / 26 RMU wall-mounted equipment Cabinet, black.
 - 2. Great Lakes: GL48WM; 48 in H x 24inW x 32.13 in deep / 25 RMU wall-mounted equipment Cabinet, black.
- G. Manufacturer: Great Lakes NEMA 12 areas or approved equal.
 - 1. #GL48N12; 48 in H x 21.25 in x 24.5 in deep / 25 RMU wall-mounted equipment Cabinet, black.

2.6 EQUIPMENT CABINET, FLOOR-STANDING

- A. Application: Suitable for the support of cable termination devices, management devices, common communications equipment, and other similar equipment, installed onto floor.
- B. Mounting Holes: The hole pattern shall be industry standard spaced at 5/8 in - 5/8 in - 1/2 in, compatible with ANSI/EIA-310-D (1992) standard. The mounting holes shall be pre-threaded as #12-24 rolled threading.
- C. Assembled Cabinet: The Cabinet shall come complete with locking sides, opening doors front and rear with front door having a smoked/tinted Plexiglas window, combination lock and equipment mounting rails. The assembled cabinet shall be 42 in depth by 19 in mounting width, and shall contain 42 EIA mounting spaces (RMU).
- D. Cabinets shall be supplied with overhead fans and bottom panel filter or approved equal filtration/cooling system.
- E. Refer to SSG 27.110.002.001 Telecommunication Equipment Cabinet Detail Arrangement for additional requirements.
- F. Manufacturer: Great Lakes or approved equal
 - 1. Great Lakes #Q027464 *; 84 in H x 30 in W x 42 in deep / 42 RMU Floor Standing equipment cabinet, black.
 - 2. Chatsworth # TS1010197*84 in H x 30 in W x 42 in deep / 42 RMU Floor Standing equipment cabinet, black.
 - a) Note:* Part number represents a cabinet package with all additional Cabinet build-out equipment included (Refer to SSG's drawing for additional information).

2.7 SERVER EQUIPMENT CABINET, FLOOR-STANDING

- A. Application: Suitable for the support of cable termination devices, management devices, common communications equipment, and other similar equipment, installed onto floor.
- B. Refer to SSG 27.110.002.002 Telecommunication Server Cabinet Detail Arrangement for additional requirements.
- C. Mounting Holes: The hole pattern shall be industry standard spaced at 5/8 in - 5/8 in - 1/2 in, compatible with ANSI/EIA-310-D (1992) standard and accept 10-32 cage nuts.

D. Assembled Cabinet: The Cabinet shall come complete with vented sides, opening doors front and rear with front door having a vented panels and combination lock and equipment mounting rails. The assembled cabinet shall be a minimum of 40" deep by 19" mounting width, and shall contain 42 EIA mounting spaces (RMU).

E. Manufacturer: HP (or approved equal)

1. #10842G2; 78.7 in H x 31.5 in x 39.7 in deep / 42 RMU equipment cabinet, black.

2.8 HORIZONTAL MANAGEMENT PANEL

A. Application: Suitable for installation into equipment rack for cord routing (front). The horizontal management panel shall match (and fully integrate with) the vertical management sections.

B. Size & Capacity: 1U or 2U high, with hinged/removable cover and pass through capacity. Management panel shall be double sided.

C. Color: black.

D. Manufacturer, or approved equal:

1. Ortronics: OR-MM6HM6D1RU; horizontal cable manager, 1U, double sided.
2. Ortronics: OR-MM6HM6D2RU; horizontal cable manager, 2U, double sided.
3. Panduit: NM1; horizontal cable manager, 1U, double sided.
4. Panduit: NM2; horizontal cable manager, 2U, double sided.

2.9 ACCESSORIES

A. Furnish three (3) bags of fifty (50) Cage nuts (if required) and (3) bags of (50) fifty Phillips Head 12/24 mounting screws per equipment rack or cabinet.

2.10 LABEL PLATES, FOR EQUIPMENT RACKS AND CABINETS

A. Application: Label plate shall be suitable to affix onto top angle of equipment rack (front and rear) and both front and rear doors of all cabinets.

B. Label plate shall be 'engrave-able' stock melamine plastic laminate substrate.

1. Cabinet Label Size (minimum): 2 in high by 11in long by 1/16-in thick.
2. Rack Label Size (minimum): 1-1/4 in high by 6in long by 1/16-in thick.
3. Color: Black.

C. Lettering shall be engraved, shall be 1 in high, and shall be white.

PART 3 EXECUTION

3.1 GENERAL

A. Comply with the General Execution requirements of Section 27100.

3.2 EXAMINATION

A. Equipment Rooms: Prior to installation, verify equipment rooms are complete and ready for, racks, cabinets and cables.

3.3 INSTALLATION

A. Cabinets and Racks

1. Equipment Racks and Cabinets, Floor-Standing

- a) Provide parts and accessories required to complete each cabinet and rack.
- b) Anchor cabinets and racks to the floor using methods (concrete anchors) approved by Owner. Brace cabinets and racks overhead to cable runway where shown on the Drawings.

- c) Bolt all Rack/Cabinets sections to each other at the points designed by the manufacturer and per the manufacturer's installation instructions. Manufacturer baying kit shall be included if required.
 - d) Install support devices (e.g., brackets, threaded rod with strut, etc.) per the manufacturer's instructions and fastened to the wall or ceiling using appropriate fasteners.
 - e) Label all the outlet strips (both vertical and horizontal) and the power cord (at the end) with the intended electrical circuit ID. Label shall be plastic engraved tag on the outlet strip and a wrap label per EMTN requirements at the end of the power cord. Size engraved tag according to outlet strip dimensions.
 - 1) The fan and light shall plug directly into the vertical power strip that connects to UPS power.
 - 2) Devices with dual power supplies shall be plugged into the vertical power strip (one power cord to the UPS outlets strip and the other to the vertical outlet strip with standard building power). Power cords shall not cross at the back of the equipment.
 - 3) Single power supply connections (CATV Amplifiers, DAS repeaters, etc.) shall be plugged into the vertical power strip that connects to UPS power.
 - 4) All power cords shall be managed and separate from the communications cable bundles. Route outlet strip power cords to the appropriate outlet and leave coiled for connection by others.
 - 5) The horizontal power strip shall be plugged directly into the NEMA 5-20R outlet above the cabinet.
2. Wall-Mounted Cabinets
- a) Provide parts and accessories required to complete each cabinet.
 - b) The cabinet shall be secured to the (painted) fire rated backboard using fasteners as approved by the owner and manufacturer's instructions/recommendations.
3. Vertical Management Sections
- a) Provide vertical management sections as shown on Drawings. If not shown, default shall be one vertical management section between each rack/cabinet and at either end of the bay.
 - b) Bolt vertical management sections to the equipment racks at the points designed by the manufacturer and per the manufacturer's installation instructions.
 - c) Install support devices (e.g., brackets, threaded rod with strut, etc.) per the manufacturer's instructions and fastened to the wall or ceiling using appropriate fasteners.
4. Working Clearances:
- a) Server and Equipment Cabinets, Floor-Standing: Field verify dimensions to establish proper clearances as follows:
 - 1) Front: 40 in clearance from channel's front mounting flange.
 - 2) Back: 57 in clearance from channel's back mounting flange.
 - b) Equipment Rack, Floor-Standing: Field verify dimensions to establish proper clearances as follows:
 - 1) Front: 40 in clearance from channel's front mounting flange.
 - 2) Back: 57 in clearance from channel's back mounting flange.
 - c) Wall-Mounted Cabinet: Field verify dimensions to establish proper clearances as follows:
 - 1) Front: 40 in clearance from the cabinet's front door.

- 2) Side: 10 in between cabinet and perpendicular wall.
 - (i) Cabinet shall open fully to allow rear access.
- 3) Bottom: 24 in clearance from floor to bottom of cabinet.
- d) As a minimum the NEC requirement shall be adhered to, a minimum working clearance of
 - 1) 36 in from of the outside surface of any cabinet or panel.
 - 2) 42 in from any 480V power source.
- e) Provide the correct amount of space between each rack for proper installation (according to manufacturer's written instructions) of the vertical management sections.

B. Overhead Cable Support

- 1. Provide overhead cable support as shown on the Drawings for use to support cables and store cable slack within telecommunications rooms.
- 2. Provide parts required to complete the installation (e.g., trapeze, junction nuts, waterfalls, etc.).

C. Vertical Cable Support

- 1. Provide vertical cable support at the locations as shown on the Drawings for use to support cables routing vertically from conduits/sleeves to the overhead cable support.
 - a) Intervals of support shall not exceed 24 in.
- 2. Provide parts required to complete the installation (e.g., vertical mounting brackets, bolts, etc.).
- 3. If cable runway is used, install the runway such that the rungs are facing outward (the greater distance from the rung to the stringer edge is facing inward). If cable basket is used, install the basket with spacers such that the mesh is spaced 1/2 in from the wall.

3.4 LABELING

A. General Requirements: Labeling and identifier assignment shall conform to TIA/EIA-606-A Administration Standard and as approved by Owner before installation.

B. Rack/Cabinet Label Requirements: Provide two (2) main ID label plates per rack/cabinet.

- 1. Permanently affix label plate and position the label plate centered on either the rack top angle brackets and on the doors of cabinets. Labeling required on the front and rear of each rack/cabinet.
 - a) Lamicoid label shall be 11in x 2in with white 1in characters on a black background for the cabinets.
 - b) Lamicoid label shall be 6in x 1-1/4in with white 3/4in characters on a black background for the racks or sized to fit on the top angle brackets.

C. Rack/Cabinet Label Requirements: Provide two (2) main "Alpha" label plates per rack/cabinet.

- 1. Permanently affix "Alpha" label plate and position the label plate centered on either the rack top angle brackets and on the doors of cabinets above the main ID (TBS) label plate. Labeling required on the front and rear of each rack/cabinet.
 - a) Lamicoid label shall be 2in x 2in with white 1.5 in characters on a black background for the cabinets.
 - b) "Alpha" character shall be in descending order associated with the main ID (TBS) number of the cabinet. For example:
 - 1) TBS-xx-N500 cabinet = "A"
 - 2) TBS-xx-N501 cabinet = "B"

- 3) TBS-xx-N502 cabinet = "C"
 - 4) Etc.
- D. All other labeling on cabinet will be covered by others. Unless called out specifically in the Project Scope of Work.
- 1. For example: Power circuit labels, Voltage feed warning labels, HW1-xxxxx drawing labels, Touch Safe and High, Med. And Low risk labels.
- E. Identifier Assignment
- 1. See SSG 27.100.002.050 for labeling information
 - 2. Equipment Racks and Cabinets
 - 3. Main "ID" label plate:
 - a) Prefix: "TBS"
 - b) First field: the Building identifier; for example: "300".
 - c) Second field: the rack type; for example: "N".
 - 1) N= Network
 - 2) I= Instrumentation
 - 3) S= Security
 - d) Third field: the rack number; for example: "501"
 - e) Example; "TBS-300-N501"

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. Section Includes: Backbone ISP (indoor) & OSP (outdoor) twisted pair cabling, coaxial and fiber optic cabling.
 - 1. Building to building.
 - a) EF to MC/TR
 - b) MC to MC/TR
 - c) TR to TR
 - d) TBS cabinet to TBS cabinet
- B. Related Sections
 - 1. Comply with the Related Sections.
 - a) 27100 Telecommunications Basic Requirements.
 - b) 27052 Interior Communications Building Pathways.
 - c) 27054 Exterior Communications Building Pathways..
 - d) 27900 Communications System Testing

1.2 REFERENCES

- A. Comply with Section 27100 and 27054 References requirements.
- B. In addition to those codes, standards, etc., list in Section 27100, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified
 - 1. 27.130.002.001 – Entrance Facility – Wall field Detail Standard
 - 2. 27.130.002.002 – Entrance Facility – Wall field Detail Building Distributor
 - 3. 27.130.002.003 – MAN Backbone FDC Strand Assignment Detail
 - 4. 27.130.002.004 – Fiber Distribution Center Strand Termination Diagram
 - 5. 27.130.002.005 – Outside Plant (OSP) Communication Aerial Cable Guying and Messenger Detail
 - 6. 27.130.002.006 – Outside Plant (OSP) Communication Aerial Cable Slack Storage Details
 - 7. 27.130.002.007– Outside Plant (OSP) Communication Aerial Cable Slack Storage at Copper Splice Details
 - 8. 27.130.002.008 – Outside Plant (OSP) Communication Aerial Cable Lashing Details
 - 9. 27.130.002.009 – Outside Plant (OSP) Communication Duct Bank Details
 - 10. 27.130.002.010 – Outside Plant (OSP) Communication Conduit Under Railroad Tracks Details
 - 11. 27.130.002.011 – Outside Plant (OSP) Communication Handhole Details
 - 12. 27.130.002.012 – Outside Plant (OSP) Communication Handhole Detail
 - 13. 27.130.002.013 – Outside Plant (OSP) Communication Duct Bank To Highline Bent Riser Detail
 - 14. 27.130.002.014– Outside Plant (OSP) Communication Pole Riser Detail
 - 15. 27.130.002.015 – Outside Plant (OSP) Communication Maintenance Hole Detail
 - 16. 27.130.002.050 – Inside Plant (ISP) Fiber Optic & Copper Backbone Cable Labels
 - 17. 27.130.002.051 – Outside Plant (OSP) Fiber Optic Patch Cable Labels
 - 18. 27.130.002.052 – Outside Plant (OSP) Fiber Optic & Copper Backbone Cable Labels

19. 27.130.002.053 -Building Entrance Protector (BEP) Labeling Detail

C. National Fire Protection Association (NFPA)

1. NFPA 70 National Electrical Code

1.3 DEFINITIONS

A. Refer to Section 27100 for Definitions.

B. In addition, the following list of terms as used in this specification shall be defined as follows:

1. "BEP": Building Entrance Protection [systems]
2. "CMP": Communications Multipurpose Plenum [NEC plenum rating]
3. "CMR": Communications Multipurpose Riser [NEC riser/non-plenum rating]
4. "ISP": Inside Plant [cabling]
5. "OSP": Outside Plant [cabling]
6. "SMF": Singlemode fiber type
7. "MMF": Multimode [fiber type]
8. "MPOE" Minimum Point of Entry
9. "OFN": Optical Fiber Non-conductive, general purpose indoor rating
10. "OFNP": Optical Fiber Non-conductive Plenum, plenum rating
11. "OFNR": Optical Fiber Non-conductive Riser, non-plenum riser rating
12. "PE": Polyethylene
13. "LDPE": Light Density Polyethylene
14. "HDPE": High Density Polyethylene
15. "PIC": Plastic Insulated Conductor
16. "PVC": Polyvinyl Chloride
17. "UTP" Unshielded Twisted Pair
18. "UCV" Underground Conduit Vault
19. "EF" Entrance Facility
20. "MC" Main Communications Room
21. "TR" Telecommunications Room

1.4 SYSTEM DESCRIPTION

A. Base Bid Work

1. Refer to Section 27001 "Intra-Building Communications Scope of Work or Inter-Building Communications Scope of Work" for a detailed "Overview" description of the project and work.
2. Provide labor, materials, apparatus, tools, equipment, and transportation required to make a complete working telecommunications backbone twisted pair and fiber optic cabling system installation described in these specifications.
3. Consider backbone cabling shown on the Drawings as base bid work, unless otherwise noted. This includes terminations at both ends, unless otherwise noted.
4. The Drawings are diagrammatic in nature.

B. In general, the base bid work may include:

1. Preconstruction Submittals.
2. Backbone ISP/OSP (riser) twisted pair (copper) cables and terminations.

3. Backbone ISP/OSP fiber optic cables and terminations.
4. Backbone ISP/OSP coaxial cables and terminations.
5. Innerduct within existing pathways
6. Building entrance protection and terminals
7. Splicing apparatus, as specified
8. Cable management.
9. Cable identification tags and system labeling.
10. Record Documents.
11. Warranty.

C. Work Provided Under Other Sections (Unless called for on the plans and specifications)

1. Telecommunications Pathways (Cable Basket, Conduits, Riser Sleeves, etc.). Refer to the Drawings for size/capacity and route information.
2. Build-out of the telecommunications rooms (e.g., backboards, overhead and vertical cable runway, etc.). Refer to the Drawings for build-out information required under this contract.

1.5 SUBMITTALS

A. Comply with Submittal procedural, quantity, and format requirements of Section 27100.

B. Preconstruction Submittal Requirements:

1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications, and specifications.
2. Labeling Submittal, consisting of proposed labeling scheme for backbone cables and backbone terminations.
3. Shop Drawings Submittal, consisting of proposed changes to cable routing, or termination locations/configurations.

C. Submittal Requirements at Closeout:

1. As-Built Drawings.
2. Cross-connection records/cut sheets.
3. Copy of the manufacturer's fiber optic printed reel documentation, including the following.
 - a) Manufacturer's reel number.
 - b) Manufacturer's traceable batch number.
 - c) Length of the fiber cable on the reel.
 - d) Maximum attenuation
 - e) Minimum bandwidth
4. O & M Manuals.
5. Test results of the installed cable – both printed copies and electronic copies.

1.6 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of Section 27100.

B. Contractor Qualifications:

1. In addition to the Contractor Qualifications requirements of Section 27100, the Contractor shall be manufacturer certified to install the proposed and submitted cabling system and to provide an extended warranty. Provide satisfactory evidence of certification in the form of a current letter or certificate from the manufacturer as part of the bid submission.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with Delivery, Storage and Handling requirements of Section 27100.

1.8 WARRANTY

- A. Telecommunications cabling system, as specified in this section, shall carry a 15 year (minimum) extended system warranty (both copper and fiber). This extended warranty shall cover parts and labor for the duration of the extended warranty. This extended warranty shall also cover electrical performance of the twisted pair cabling system to the specific category per TIA/EIA-568-C.2 performance criteria for backbone cabling.

PART 2 PRODUCTS**INTERNAL PLANT:****2.1 SUBSTITUTIONS**

- A. Comply with the Substitutions requirements of Section 27100.

2.2 UNSHIELDED TWISTED PAIR CABLES (MULTI-PAIR)**A. Application:**

1. Cable shall be suitable for indoor installation, between floors in vertical riser system, under access flooring, and through overhead ceiling space (in cable tray, conduit, & hangers).
2. Each and every cable run shall be a continuous single cable, homogenous in nature. Splices are not permitted anywhere.

B. Conductors:

1. Conductors shall be 24 AWG annealed solid copper.
2. Conductors shall be fully insulated. Insulation shall consist of flame-retardant semi-rigid solid PVC.
3. Conductors shall be twisted into pairs. Twisted pairs are stranded into 25-pair bundles and into units (and super units, if required by pair count).
4. Color Coding: Twisted pairs and units (supper units, if necessary) shall be individually color coded to industry standards (ANSI/ICEA Publication S-80-576, and EIA-230).

C. Sheath:

1. Cable shall be NEC rated as CMR for riser applications or CMP for plenum, and UL listed as such. Refer to construction drawing for plenum requirements.

D. Performance:

1. Electrical performance of the twisted pairs and overall cable shall comply with TIA/EIA-568-C.2 requirements for Category 3 UTP cabling.

E. Manufacturers: General Cable, or equal by Berk-Tek, CommScope or Belden.

| Manufacturer | Part Number | UL Listing | Description |
|---------------|-------------|------------|----------------------|
| General Cable | 2131505 | CMP Plenum | Cat 3 25-Pair White |
| General Cable | 2131757 | CMP Plenum | Cat 3 50-Pair White |
| General Cable | 2131758 | CMP Plenum | Cat 3 100-Pair White |
| General Cable | 2133033 | CMR Riser | Cat 3 25-Pair Gray |
| General Cable | 2133161 | CMR Riser | Cat 3 50-Pair Gray |
| General Cable | 2133144 | CMR Riser | Cat 3 100-Pair Gray |

2.3 FIBER OPTIC CABLES

A. Application:

1. Cable shall be suitable for indoor installation, between floors in vertical riser system, under access flooring, and through overhead ceiling space (in cable tray, conduit, & hangers) in innerduct.
2. Cable shall exhibit stable performance in a building environment. The optical transmission performance of the fiber shall not be significantly affected by environmental fluctuations, installation, or aging.
3. Materials used in the cable shall not emit hydrogen in quantities that will increase attenuation.

B. 50/125 μ m OM3 Multimode fiber strands shall meet or exceed the following;

1. Geometry criteria:
 - a) Core diameter = 50 μ m, ± 3.0 μ m.
 - b) Cladding diameter = 125 μ m, ± 1.0 μ m.
 - c) Core/Cladding Concentricity = ≤ 3 μ m.
 - d) Minimum Tensile Strength = 100,000 psi.
2. Performance criteria:
 - a) Attenuation = 3.0 dB/km at 850 nm and 1.0 dB/km at 1300 nm wavelengths, maximum.
 - b) Overfilled Bandwidth = 1500 MHz•km at 850 nm and 500 MHz•km at 1300 nm wavelengths, minimum.
 - c) Laser Bandwidth = 2,000 MHz•km at 850 nm and 500 MHz•km at 1300 nm wavelengths, minimum.

C. Single Mode fiber strands shall meet or exceed the following;

1. Geometry criteria:
 - a) Core diameter = 8.3 μ m.
 - b) Mode field diameter = 8.8 μ m, ± 0.5 μ m.
 - c) Cladding diameter = 125 μ m, ± 1.0 μ m.
 - d) Core/Cladding Concentricity = ≤ 0.8 μ m.
 - e) Minimum Tensile Strength = 100,000 psi.
2. Performance criteria:
 - a) Attenuation = 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm wavelengths, maximum.
 - b) Cutoff wavelength = 1260 nm.
 - c) Dispersion = 3.5 ps/nm•km at 1285-1330 nm.

D. Buffering:

1. Each fiber shall be completely covered with a "primary coating" (acrylate material). This shall constitute the "fiber strand".
2. Each fiber strand shall be fully covered with a flame retardant thermoplastic material (material = PVC, or equivalent thermoplastic). This shall constitute the "buffered strand" (tight buffer type), and shall have a diameter of 0.9 mm.
3. Buffered Strands: Buffered strands shall be individually color coded to meet the requirements of ANSI/TIA/EIA-598-A-1995. (Also, ref. ANSI/ICEA S-87-640-1992).

E. Cable Sheath:

1. Strength Element: The cable shall have an internal strength element such as aramid yarn (e.g., Kevlar).
2. Tensile Strength: The cable shall have a 150-lb, minimum, rated load.
3. Outer Jacket: The cable shall have a seamless outer jacket (material = PVC, or equivalent) applied to and completely covering the internal components (fiber strands, strength element, other).
4. Flame Rating: The cable shall be NEC (Article 770) rated as OFNR or riser or OFNP for plenum and UL listed as such. Refer to construction drawing for plenum requirements.
5. Color: Singlemode cable shall be yellow in color and laser optimized 50µm multimode shall be aqua in color.

a) Manufacturer: Corning "MIC" series cables or equal (shall be installed in innerduct).

| Manufacturer | Part Number | UL Listing | Fiber Type | Fiber Count |
|--------------|------------------|-------------|---------------|-------------|
| Corning | 006T81-31180-24 | OFNR Riser | 50 µm OM3 MM | 6 |
| Corning | 012T81-33180-24 | OFNR Riser | 50 µm OM3 MM | 12 |
| Corning | 018T81-33180-24 | OFNR Riser | 50 µm OM3 MM | 18 |
| Corning | 024T81-33180-24 | OFNR Riser | 50 µm OM3 MM | 24 |
| Corning | 036T81-61180-24 | OFNR Riser | 50 µm OM3 MM | 36 |
| Corning | 048T81-61180-24 | OFNR Riser | 50 µm OM3 MM | 48 |
| Corning | 060T81-T3180-24 | OFNR Riser | 50 µm OM3 MM | 60 |
| Corning | 072T81-T3180-24 | OFNR Riser | 50 µm OM3 MM | 72 |
| Corning | 096T81-T3180-24 | OFNR Riser | 50 µm OM3 MM | 96 |
| Corning | 144T81-T3180-24 | OFNR Riser | 50 µm OM3 MM | 144 |
| Corning | 006-T88-31180-29 | OFNP Plenum | 50 µm OM3 MM | 6 |
| Corning | 012-T88-33180-29 | OFNP Plenum | 50 µm OM3 MM | 12 |
| Corning | 018-T88-33180-29 | OFNP Plenum | 50 µm OM3 MM | 18 |
| Corning | 024-T88-33180-29 | OFNP Plenum | 50 µm OM3 MM | 24 |
| Corning | 036-T88-61180-29 | OFNP Plenum | 50 µm OM3 MM | 36 |
| Corning | 048-T88-61180-29 | OFNP Plenum | 50 µm OM3 MM | 48 |
| Corning | 060-T88-T3180-29 | OFNP Plenum | 50 µm OM3 MM | 60 |
| Corning | 072-T88-T3180-29 | OFNP Plenum | 50 µm OM3 MM | 72 |
| Corning | 096-T88-T3180-29 | OFNP Plenum | 50 µm OM3 MM | 96 |
| Corning | 144-T88-T3180-29 | OFNP Plenum | 50 µm OM3 MM | 144 |
| Corning | 006E81-31131-24 | OFNR Riser | 8.3 µm OS2 SM | 6 |
| Corning | 012E81-33131-24 | OFNR Riser | 8.3 µm OS2 SM | 12 |
| Corning | 018E81-33131-24 | OFNR Riser | 8.3 µm OS2 SM | 18 |
| Corning | 024E81-33131-24 | OFNR Riser | 8.3 µm OS2 SM | 24 |
| Corning | 036E81-61131-24 | OFNR Riser | 8.3 µm OS2 SM | 36 |
| Corning | 048E81-61131-24 | OFNR Riser | 8.3 µm OS2 SM | 48 |
| Corning | 060E81-T3131-24 | OFNR Riser | 8.3 µm OS2 SM | 60 |
| Corning | 072E81-T3131-24 | OFNR Riser | 8.3 µm OS2 SM | 72 |
| Corning | 096E81-T3131-24 | OFNR Riser | 8.3 µm OS2 SM | 96 |
| Corning | 144E81-T3131-24 | OFNR Riser | 8.3 µm OS2 SM | 144 |
| Corning | 012E88-31131-29 | OFNP Plenum | 8.3 µm OS2 SM | 6 |
| Corning | 012E88-33131-29 | OFNP Plenum | 8.3 µm OS2 SM | 12 |
| Corning | 018E88-33131-29 | OFNP Plenum | 8.3 µm OS2 SM | 18 |
| Corning | 024E88-33131-29 | OFNP Plenum | 8.3 µm OS2 SM | 24 |

| Manufacturer | Part Number | UL Listing | Fiber Type | Fiber Count |
|--------------|-----------------|-------------|---------------|-------------|
| Corning | 036E88-61131-29 | OFNP Plenum | 8.3 μm OS2 SM | 36 |
| Corning | 048E88-61131-29 | OFNP Plenum | 8.3 μm OS2 SM | 48 |
| Corning | 060E88-T3131-29 | OFNP Plenum | 8.3 μm OS2 SM | 60 |
| Corning | 072E88-T3131-29 | OFNP Plenum | 8.3 μm OS2 SM | 72 |
| Corning | 096E88-T3131-29 | OFNP Plenum | 8.3 μm OS2 SM | 96 |
| Corning | 144E88-T3131-29 | OFNP Plenum | 8.3 μm OS2 SM | 144 |

b) Manufacturer: Corning Cable Systems - "Freedm" series cables or equal (shall be installed in innerduct).

| Manufacturer | Part Number | UL Listing | Fiber Type | Fiber Count |
|--------------|-----------------|-------------|----------------------|-------------|
| Corning | 006T8F-31180-29 | OFNR Riser | 50μm OM3 Multimode | 6 |
| Corning | 012T8F-31180-29 | OFNR Riser | 50μm OM3 Multimode | 12 |
| Corning | 018T8F-31180-29 | OFNR Riser | 50μm OM3 Multimode | 18 |
| Corning | 024T8F-31180-29 | OFNR Riser | 50μm OM3 Multimode | 24 |
| Corning | 036T8F-61180-29 | OFNR Riser | 50μm OM3 Multimode | 36 |
| Corning | 048T8F-61180-29 | OFNR Riser | 50μm OM3 Multimode | 48 |
| Corning | 072T8F-T1180-29 | OFNR Riser | 50μm OM3 Multimode | 72 |
| Corning | 006T8P-31180-29 | OFNP Plenum | 50μm OM3 Multimode | 6 |
| Corning | 012T8P-31180-29 | OFNP Plenum | 50μm OM3 Multimode | 12 |
| Corning | 018T8P-31180-29 | OFNP Plenum | 50μm OM3 Multimode | 18 |
| Corning | 024T8P-31180-29 | OFNP Plenum | 50μm OM3 Multimode | 24 |
| Corning | 006E8F-31131-29 | OFNR Riser | 8.3μm OS2 Singlemode | 6 |
| Corning | 012E8F-31131-29 | OFNR Riser | 8.3μm OS2 Singlemode | 12 |
| Corning | 018E8F-31131-29 | OFNR Riser | 8.3μm OS2 Singlemode | 18 |
| Corning | 024E8F-31131-29 | OFNR Riser | 8.3μm OS2 Singlemode | 24 |
| Corning | 036E8F-61131-29 | OFNR Riser | 8.3μm OS2 Singlemode | 36 |
| Corning | 048E8F-61131-29 | OFNR Riser | 8.3μm OS2 Singlemode | 48 |
| Corning | 072E8F-T1131-29 | OFNR Riser | 8.3μm OS2 Singlemode | 72 |
| Corning | 006E8P-31131-29 | OFNP Plenum | 8.3μm OS2 Singlemode | 6 |
| Corning | 012E8P-31131-29 | OFNP Plenum | 8.3μm OS2 Singlemode | 12 |
| Corning | 018E8P-31131-29 | OFNP Plenum | 8.3μm OS2 Singlemode | 18 |
| Corning | 024E8P-31131-29 | OFNP Plenum | 8.3μm OS2 Singlemode | 24 |

2.4 COAXIAL TRUNK CABLES

A. Application:

1. Cable shall be suitable for indoor installation, between floors in vertical riser system, under access flooring, and through overhead ceiling space (in cable tray, conduit, & hangers).
2. Cable shall exhibit stable performance in a building environment.

B. RG-11/Series 11 Quad Shield

1. The CATV Trunk Coaxial cable shall be 75-ohm impedance, RG-11 type, and plenum rated CATVP Coax Cable with the following properties:
2. Construction:
 - a) Center Conductor: 14 AWG Copper/Steel
 - b) Dielectric:
 - 1) Foam FEP
 - 2) Dia. Over Dielectric: 0.278 in (7.0 mm) Nom.

c) Inner Shield:

- 1) Foil: 0.002 in (0.05 mm) Aluminum Tape
- 2) Braid: 34AWG Aluminum
- 3) 40% Coverage
- 4) Nom. Dia.: 0.312 in (8 mm)

d) Outer Shield:

- 1) Foil: 0.002 in (0.05 mm) Aluminum Tape
- 2) Braid: 34AWG Aluminum
- 3) 50% Coverage
- 4) Nom. Dia.: 0.323 in (8.3 mm)

e) Jacket:

- 1) Material: PVC
- 2) Dia. Over jacket: 0.356 in (9 mm) +/- 0.008 in (0.2 mm)
- 3) Nom. Jkt. Thickness: 0.020 in (0.51 mm)
- 4) Minimum Spot: 0.016 in (0.41 mm)
- 5) Color: White

C. Electrical Properties:

- a) Spark Test: 2500 VAC
- b) Dielectric Strength: Conductor to Shield: 4000 VDC
- c) Capacitance: 16.0 pF/Ft Nom.
- d) Impedance: 75.0 +/- 3.0 Ohms
- e) Velocity of Propagation: 86.0% Nom.
- f) DCR: Conductor: 12.6 Ohms/1000 ft (305 m) Nom.
- g) Structural Return Loss: 20 dB (5 thru 1000 MHz) 100% Sweep Tested

1. Attention:

| @ Frequency MHz | dB/100 ft. (Nom.) |
|-----------------|-------------------|
| 1 MHz | 0.15 |
| 10 MHz | 0.45 |
| 50 MHz | 0.90 |
| 100 MHz | 1.28 |
| 200 MHz | 1.85 |
| 400 MHz | 2.75 |
| 700 MHz | 3.92 |
| 900 MHz | 4.75 |
| 1000 MHz | 5.04 |
| 1450 MHz | 6.67 |
| 1800 MHz | 7.71 |
| 2200 MHz | 8.50 |
| 3000 MHz | 9.88 |

a) Manufacturer CommScope, or equal by Berk-Tek, General Cable or Belden

- 1) CommScope - #2287V, "P6" RG-11

D. 0.500 (1/2") Hard Line CATV Cable:

1. The CATV Inter-Building Trunk Coaxial cable shall be 75-ohm impedance, P3 500 type, and Plenum or Riser rated CATV Coax Cable with the following properties:

2. Construction

a) Center Conductor

- 1) Copper Clad Aluminum Center Conductor
- 2) Nominal 0.109 in Diameter
- 3) Dielectric
- 4) Expanded Polyethylene dielectric (Riser)
- 5) Foamed Fluorinated Ethylene Propylene (Plenum)
- 6) Dia. Over Dielectric: 0.450 in Nom.

b) Jacket

- 1) Continuous Aluminum Outer Jacket
- 2) Flame retardant Polyethylene Outer Jacket (Riser)
- 3) Kynar PVDF (Plenum)
- 4) Nominal Diameter over Outer Conductor 0.560 in (Riser)
- 5) Nominal Diameter over Outer Conductor 0.524 in (Plenum)
- 6) Nominal Outer Conductor thickness 0.030 in (Riser)
- 7) Nominal Outer Conductor thickness 0.012 in (Plenum)

3. Electrical Properties

a) Capacitance

- 1) Riser: 15.3 +/- 1.0 pF/Ft Nom.
- 2) Plenum: 16.0 pF/Ft Nom.

b) Impedance: 75.0 +/- 2.0 Ohms

4. Velocity of Propagation

- a) Riser: 87.0% Nom
- b) Plenum: 86.0% Nom

5. DC Resistance at 68°F

- a) Inner Conductor: 1.35 Ohms/1000 Ft. Nom.
- b) Outer Conductor: 0.37 Ohms/1000 Ft. Nom.

6. Attenuation at 68°F

| @ Frequency MHz | Riser dB/100 ft. (Nom.) | Plenum dB/100 ft. (Nom.) |
|-----------------|----------------------------|-----------------------------|
| 5 MHz | 0.16 | 0.17 |
| 10 MHz | --- | 0.23 |
| 50 MHz | --- | 0.56 |
| 55 MHz | 0.54 | --- |
| 83 MHz | 0.66 | --- |
| 100 MHz | --- | 0.83 |
| 200 MHz | --- | 1.25 |
| 211 MHz | 1.09 | --- |
| 250 MHz | 1.20 | --- |
| 300 MHz | 1.31 | --- |
| 350 MHz | 1.43 | --- |
| 400 MHz | 1.53 | 1.97 |
| 450 MHz | 1.63 | --- |
| 500 MHz | 1.73 | --- |
| 550 MHz | 1.82 | --- |

| @ Frequency MHz | Riser dB/100 ft. (Nom.) | Plenum dB/100 ft. (Nom.) |
|-----------------|----------------------------|-----------------------------|
| 600 MHz | 1.91 | --- |
| 700 MHz | --- | 2.92 |
| 750 MHz | 2.16 | --- |
| 865 MHz | 2.34 | --- |
| 900 MHz | --- | 3.47 |
| 1000 MHz | 2.52 | 3.78 |

a) Manufacturer: CommScope , or equal by Berk-Tek, General Cable, or Belden

- 1) CommScope -#P3 500 JCAR, ½ in Hard-line Riser Rated
- 2) CommScope -#P3 500 JCAP (2312K), ½ in Hard-line Plenum Rated

2.5 TERMINATION EQUIPMENT

A. Twisted Pair Cabling Patch Panel

1. Refer to Section 27.150 Part #2 for product requirements.

B. 110-Cross Connect Block

1. Application: 110- Blocks shall be suitable for installation within a telecommunication room or at a CP (Consolidation Point) for the termination of the CAT 3 UTP ISP backbone Cabling (specified herein), and shall be horizontally oriented for a Wall Field mounting configuration.
2. Cross Connect Blocks shall provide designation areas and rear cable entry.
3. Blocks shall be capable of supporting, organizing, labeling and patching/cross-connecting between the horizontal termination field and the equipment and/or the equipment termination field.
4. Manufacturer: Ortronics or equal by Hubbell and Panduit

| Manufacturer | Part Number | Description |
|--------------|--------------|---|
| Hubbell | 110BLK100BWL | 110-Block W/Legs 100-Pair (less connectors) |
| Hubbell | 110BLK100BWL | 110-Block W/Legs 300-Pair (less connectors) |
| Ortronics | 30200145 | 110-Block W/Legs 100-Pair (less connectors) |
| Ortronics | 30200007 | 110-Block W/Legs 300-Pair (less connectors) |
| Panduit | P110BW100-X | 110-Block W/Legs 100-Pair (less connectors) |
| Panduit | P110BW300-X | 110-Block W/Legs 300-Pair (less connectors) |

C. 110-Cross Connect Connecting Clips

1. Application: 110- Connecting Clips shall be compatible with the selected 110-Block Base. Used for the termination of multi-pair cable and for the cross-connect to equipment or other cabling.
2. Construction: UL 94V-O high impact polycarbonate material.
3. Electrical: Meets or exceeds TIA/EIA-568B.2 Category 5e standards
4. Manufacturer: Ortronics or equal by Hubbell and Panduit

| Manufacturer | Part Number | Description |
|--------------|-------------|-------------------------------------|
| Hubbell | 110CB4PR10 | 110 Connecting Clip Dual IDC 4-Pair |
| Hubbell | 110CB5PR10 | 110 Connecting Clip Dual IDC 5-Pair |
| Ortronics | 30200109 | 110 Connecting Clip Dual IDC 4-Pair |

| | | |
|-----------|-------------|-------------------------------------|
| Ortronics | 30200110 | 110 Connecting Clip Dual IDC 5-Pair |
| Panduit | P110CB4-XY | 110 Connecting Clip Dual IDC 4-Pair |
| Panduit | P110BW300-X | 110 Connecting Clip Dual IDC 5-Pair |

D. Rack Mounted Fiber Optic Connector Housing (Patch Panel)

1. Passive fiber optic physical equipment and apparatus used in interconnecting and cross-connecting fiber optic cables shall possess a minimum fire resistant rating of UL94V-1.
2. The equipment, apparatus, and material for fiber optic equipment an apparatus shall conform to existing OSHA Health and Safety Laws. The equipment and apparatus shall have provision for the application of safety labels such as laser identification or warning labels as required by system considerations.
3. Fiber optic patch panel shall be a fully assembled rack-mounted fiber optic enclosed housing for protecting, storing and organizing the termination of the fiber cable and all fiber strands at each end of the cable. The patch panel shall include an integrated patching facility.
4. "Fully assembled" shall include all required installation & mounting components, and include accessories such as connector panels, coupling adapters, etc. for a complete installation.
5. **When possible:** Do not mix ISP and OSP terminations (polish and pigtail) within the same fiber distribution cabinet.
6. The fiber patch panel shall:
 - a) Provide means of strain relief and support of the specified cables.
 - b) Contain slack storage facilities for fiber slack.
 - c) Provide patch cord management.
7. Manufacturer: Corning Cable Systems
 - a) Corning Cable Systems #CCH-02U; 2U fiber shelf, accepts 4 Cassettes
 - b) Corning Cable Systems #CCH-04U; 4U fiber shelf, accepts 12 Cassettes
 - 1) Corning Cable Systems #CCHA-LOCK-KIT; Door lock kit (Required for front and rear)

E. Splice Cassette

1. Splice cassette for CCH-04U or 02U fiber shelves
 - a) Application: Splice up to 12 single fibers, 12 heat shrink sleeves included.
 - b) Adapter panel required for each cassette.
 - c) Manufacturer: Corning Cable Systems.
 - 1) #CCH-CS

F. Pigtail Cassette

1. Pigtail cassette for CCH-04U or 02U fiber shelves
 - a) Application: Splice up to 12 single fibers, 12 heat shrink sleeves included
 - b) Manufacture: Corning Cable Systems
 - 1) #CCH-CS12-59-P00RE (12 Fibers, SC duplex, OS2)
 - 2) #CCH-CS12-6T-P00RE (12 Fibers, ST compatible, OS2)
 - 3) #CCH-CS12-A9-P00RE (12 Fibers, LC duplex, OS2)
 - 4) #CCH-CS12-E4-P00RE (12 Fibers, LC duplex, OM3)
 - 5) #CCH-CS24-A9-P00RE (24 Fibers, LC duplex, OS2)
 - 6) #CCH-CS24-E4-P00RE (24 Fibers, LC duplex, OM3)

G. Slack Cassette

1. Slack cassette for CCH-04U or 02U fiber shelves
 - a) Application: Field terminations, up to 12 single fibers, 12 heat shrink protective sleeves included.
 - b) Adapter panel required for each cassette.
 - c) Manufacturer: Corning Cable Systems.
 - 1) #CCH-CF

H. Wall Mounted Fiber Optic Connector Housing (Patch Panel)

1. Connector Housing
 - a) Suitable for loose tube and tight buffered cable
 - b) Cabinet Construction; Metal.
 - c) Jumper routing guides and jumper strain-relief.
 - d) Brackets for buffer tube fan-out kits.
 - e) Optional splice tray holder
2. Manufacturer: Corning Cable Systems.
 - a) #SPH-01P; accepts 1 (one) CCH panel
 - b) #WCH-02P; accepts 2 (two) CCH panels
 - c) #WCH-04P; accepts 4 (four) CCH panels
 - d) #EDC-02P-NH; for harsh environments (NEMA 11), accepts 2 CCH panels

2.6 FIBER OPTIC CONNECTOR PANELS

A. Multimode Laser Optimized 50/125µm

1. Fiber Optic Housing Pigtail Modules – LC Type:
 - a) Modules shall be loaded with 6 or 12 Duplex LC type adapters
 - b) Alignment: Ceramic.
 - c) Connector housing: Composite.
 - d) Color: Adapters shall be aqua.
 - e) Standard pigtail length of 10ft (3 meters) shall be factory terminated and tested.
 - f) Manufacturer: Corning Cable Systems.
 - 1) #CCH-RM12-E4-P03SH; 6 Duplex LC connector, laser optimized multimode 50/125µm.
2. Fiber Optic Housing Panels – LC Type:
 - a) Alignment: Ceramic.
 - b) Connector housing: Composite.
 - c) Color: Adapters shall be aqua
 - d) Manufacturer: Corning Cable Systems.
 - 1) #CCH-CP12-E4; 6 Duplex LC adapter, multimode 50/125 µm.
 - 2) #CCH-CP24-E4; 12Duplex LC adapter, multimode 50/125 µm

B. Singlemode

1. Fiber Optic Housing Pigtail Modules – SC Type:
 - a) Modules shall be loaded with 6 (six) Duplex SC type adapters

- b) Alignment: Ceramic.
- c) Connector housing: Composite.
- d) Color: Adapters shall be blue or PC and Green for APC
- e) Standard pigtail length of 10ft (3 meters) shall be factory terminated and tested.
- f) Manufacturer: Corning Cable Systems.
 - 1) #CCH-RM12-59-P03RH; SC adapters, singlemode.
 - 2) #CCH-RM12-6C-P03RH; SC APC adapters for video/DAS, singlemode
- 2. Fiber Optic Housing Panels – SC Type:
 - a) Ferrule: Ceramic.
 - b) Connector housing: Composite.
 - c) Color: Adapters shall be blue
 - d) Manufacturer: Corning Cable Systems.
 - 1) #CCH-CP12-59-UPC; SC adapter, singlemode

2.7 FIBER OPTIC CONNECTORS

A. Multimode Fiber Optic Connectors – LC Type

- 1. Materials:
 - a) Ferrule: ceramic (zirconia or alumina) with pre-radiused finish/face.
 - b) Connector housing: plastic.
 - c) Connector shall have an integral strain relief feature, including a bend limiting rear boot.
 - d) Connectors shall be aqua.
 - e) Connectors shall be installable via either epoxy or anaerobic method.
 - f) Manufacturer: Corning Cable Systems, or equal.
 - 1) #95-051-98-SP-X; LC connector, laser optimized multimode 50/125.

B. Singlemode Fiber Optic Connectors – SC Type

- 1. Materials:
 - a) Ferrule: ceramic (zirconia or alumina) with pre-radiused finish/face.
 - b) Connector housing: plastic.
 - c) Connector shall have an integral strain relief feature, including a bend limiting rear boot.
 - d) Connectors shall be blue.
 - e) Connectors shall be installable via either epoxy or anaerobic method.
 - f) Manufacturer: Corning Cable Systems, or equal.
 - 1) #95-201-41-SP; SC connector, singlemode

2.8 COAXIAL CONNECTORS

A. RG-11

- 1. RG-11 Coax cable shall be terminated with a 1 (one) piece, “F” style connector, installed in accordance with manufacturer’s recommended procedures and tools.
- 2. Manufacture: Corning Gilbert (Contractor to contact manufacture for recommended types of connectors to meet application).
 - a) Corning Gilbert #GAF-UR-11-PL

B. 0.500 (1/2”) hardline

1. 0.500in hard-line coaxial cable shall be terminated with a 3 (three) piece, "KS" style connector, installed in accordance with manufacturer's recommended procedures and tools.
2. Connector housing shall be ASTM 6262 Aluminum alloy
3. Bandwidth: 5 MHz to 1GHz
4. Nominal Impedance: 75 ohms
5. Shielding Effectiveness: 130 dB
6. Return Loss: 30 dB min.
7. Manufacture: Corning Gilbert (Contractor to contact manufacture for recommend types of connectors to meet application).
 - a) Corning Gilbert # G2-500-CH-P3 Pin Style Connector
 - b) Corning Gilbert # G2-500-BAFF-P3 Female F Connector
 - c) Corning Gilbert # G2-500-AFM-P3 Male F Connector
 - d) Corning Gilbert # G2-500-SP-P3 Splice Connector

2.9 KS SERIES ADAPTERS

1. Manufacturer: Corning-Gilbert or approved equal
 - a) Gilbert #GF-625-CH-T; KS Male to F Female
 - b) Gilbert #G-CH-BAFF-KS; KS Female to F Female
 - c) Gilbert # G-CH-AFM; KS Female to F Male

2.10 CABLE STORAGE RING

- A. General: The cable storage ring is intended to manage the slack cable required for both copper and fiber cables
- B. Construction: 16 gauge metal with 3 (three) hook/loop style fasteners.
- C. Manufacturer: Leviton or equal
 1. Leviton # 48900-0FR – 24 in (610 mm) diameter cable ring
 2. Leviton # 48900-1FR – 12 in (305 mm) diameter cable ring

2.11 FIBER OPTIC PATCH/EQUIPMENT CORDS

- A. Each Patch/Equipment Cord shall be factory assembled and tested.
- B. Patch/Equipment Cords shall match the manufacturer of the cable and termination hardware.
- C. Manufacturer: Corning Cable Systems

| Part Number | Connector 1 | Connector 2 | # of Strand | Type of Fiber |
|---------------------|-------------|-------------|-------------|--------------------|
| 0505-02-T5180-XXX-F | LC | LC | 2-Strand | 50µm OM3 Multimode |
| 0557-02-T5180-XXX-F | LC | SC | 2-Strand | 50µm OM3 Multimode |
| 7272-02-R5131-XXX-F | SC | SC | 2-Strand | OS1 Singlemode |
| 4444-01-R3131-XXX-F | SC-APC | SC-APC | 1-Strand | OS1 Singlemode |

Where XXX is the footage of the assembly

2.12 LABELS

- A. Labels for Backbone ISP Cables

1. General: Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer. Labels shall be adhesive backed and have a self-laminating feature.
2. Printable Area: 2 in (51mm) x 0.5 in (12.7 mm), minimum.
3. Color: White.
4. Manufacturer: Panduit, or equal.
 - a) S200X150YAJ; laser/ink jet labels for cable diameters 0.16-0.32 in (4.04-8.09mm), white
 - b) S200X400YAJ; laser/ink jet labels for cable diameters 0.32-0.95 in (8.09-24.26mm), white
 - c) S200X650YAJ; laser/ink jet labels for cable diameters 0.48-1.59 in (12.13-43mm), white.

OUTSIDE PLANT

2.13 MULTI-PAIR COPPER DUCT BANK CABLES

- A. Application:
 1. Cable shall be suitable for outdoor installations, within underground conduit.
 2. Cable shall be twisted pair PIC type cable, filled core, with an "ASP" sheath. Cable shall be compatible with Bell System type "ANAW"
- B. Conductors:
 1. Conductors shall be 22 AWG annealed solid copper.
 2. Conductors shall be fully insulated. Insulation shall consist of an inner layer of expanded PE, covered with an outer layer (skin) of solid PE.
 3. Conductors shall be twisted into pairs. Twisted pairs are stranded into 25-pair bundles and into units (and super units, if required by pair count).
 4. Color Coding: Twisted pairs and units (supper units, if necessary) shall be individually color coded to industry standards (ANSI/ICEA Publication S-80-576, and EIA-230).
- C. Core & Sheath:
 1. Cable core (twisted pairs) shall have a tape applied longitudinally (wrapped around its entirety). Tape Material: non-hydroscopic polypropylene film, or equivalent.
 2. Filled: Cable core and sheath shall be flooded with filling compound to protect against moisture penetration. Filling compound: "ETPR", or equivalent.
 3. Sheath Type: "ASP". Sheath shall consist of a shield and an outer jacket.
 4. Shield: Dual corrugated tape of inner aluminum and outer steel longitudinally applied, with a locking overlap.
 5. Jacket: PE, bonded to shield

D. Manufacturers: General Cable (Spec. #2100), or equal by Superior Essex or Belden.

| Manufacturer | Part Number | AWG | Pair Count | O.D. in | O.D. mm |
|---------------|-------------|-----|------------|---------|---------|
| General Cable | 6987572 | 22 | 25 | 0.70 | 18 |
| General Cable | 6987580 | 22 | 50 | 0.86 | 22 |
| General Cable | 6987606 | 22 | 100 | 1.10 | 29 |
| General Cable | 6987622 | 22 | 200 | 1.40 | 35.8 |
| General Cable | 6987630 | 22 | 300 | 1.70 | 43.2 |
| General Cable | 6987648 | 22 | 400 | 2.00 | 51 |
| General Cable | 6987655 | 22 | 600 | 2.40 | 61 |

2.14 MULTI-PAIR COPPER AERIAL CABLES

A. Application:

1. Cable shall be suitable for outdoor aerial and Cable tray installations.
2. Cable shall be twisted pair PIC type cable, air core, with an "aluminum shield". Cable shall be compatible with RUS type "PE-22 AL".

B. Conductors:

1. Conductors shall be 22 AWG annealed solid copper.
2. Conductors shall be fully insulated. Insulation shall consist of solid PE.
3. Conductors shall be twisted into pairs. Twisted pairs are stranded into 25-pair bundles and into units (and super units, if required by pair count).
4. Color Coding: Twisted pairs and units (supper units, if necessary) shall be individually color coded to industry standards (ANSI/ICEA Publication S-80-576, and EIA-230).

C. Core & Sheath:

1. Cable core (twisted pairs) shall have a tape applied longitudinally (wrapped around its entirety). Tape Material: non-hydrosopic polypropylene film, or equivalent.
2. Sheath Type: Sheath shall consist of a shield and an outer jacket.
 - a) Shield: Corrugated tape of aluminum longitudinally applied, with a locking overlap.
 - b) Jacket: PE, bonded to shield

D. Manufacturers: General Cable (Spec. #2003), or equal by Superior Essex or Belden

| Manufacturer | Part Number | AWG | Pair Count | O.D. in | O.D. mm |
|---------------|-------------|-----|------------|---------|---------|
| General Cable | 7527021 | 22 | 25 | 0.63 | 15.5 |
| General Cable | 7527039 | 22 | 50 | 0.90 | 20 |
| General Cable | 7527054 | 22 | 100 | 1.10 | 29 |
| General Cable | 7527062 | 22 | 200 | 1.40 | 38 |

2.15 GEL-FILLED OUTSIDE PLANT FIBER OPTIC CABLES

A. Application:

1. Cable shall be suitable for outdoor installations within underground conduits in innerduct, aerially lashed and High-line cable tray in innerduct.

2. Cable and fiber strands shall exhibit stable performance in an outdoor environment. The optical transmission performance of the fiber shall not be significantly affected by environmental fluctuations, installation, or aging.
 3. Materials used in the cable shall not emit hydrogen in quantities that will increase attenuation.
- B. Singlemode fiber strands shall meet or exceed the following geometry criteria:
1. Core diameter = 8.3 μm .
 2. Mode field diameter = 8.8 μm , $\pm 0.5 \mu\text{m}$.
 3. Cladding diameter = 125 μm , $\pm 1.0 \mu\text{m}$.
 4. Core/Cladding Concentricity = $\leq 0.8 \mu\text{m}$.
 5. Minimum Tensile Strength = 100,000 psi.
- C. Singlemode fiber strands shall meet or exceed the following performance criteria:
1. Attenuation = 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm wavelengths, maximum.
 2. Cutoff wavelength = 1260 nm.
 3. Dispersion = 3.5 ps/nm•km at 1285-1330 nm.
- D. Multimode fiber strands shall meet or exceed the following performance criteria:
1. Attenuation = 3.0 dB/km at 850 nm and 1.0 dB/km at 13000 nm wavelengths, maximum.
- E. Buffering:
1. Fibers shall be loosely buffered, either in a core tube or in multiple tubes around a dielectric central member.
 2. The buffer tube/tubes shall be flooded with filling compound to protect against moisture penetration. Filling compound: "FLEXGEL", or equal.
 3. Buffer Tubes (if applicable): Each buffer tube shall be color coded to allow identification, and shall meet the requirements of ANSI/TIA/EIA-598-A-1995. (Also, ref. ANSI/ICEA Publication S-80-576, and EIA-230).
- F. Sheath <for non-armored>:
1. Sheath shall consist of a central member, strength member and an outer jacket. Sheath shall be dielectric and contain no metallic components.
 2. Strength Member: Aramid yarn (e.g., Kevlar®), or reinforced fiberglass rods.
 3. Jacket: UV-resistant and listed OFNR and FT-4; meets National Electrical Code (NEC Article 770)
 4. Rated tensile load: 600 lb. maximum rated load.
 5. Operating Temperature Range: -40 to 158°F (-40 to 70°C)
- G. Sheath <for armored>:
1. Sheath shall consist of central member (as applicable), strength member, inner jacket (as applicable), armor, and an outer jacket.
 2. Strength Member: Aramid yarn (e.g., Kevlar®), or reinforced fiberglass rods.
 3. Armor: corrugated aluminum tape
 4. Jacket: UV-resistant & listed OFCR & FT-4; meets National Electrical Code (NEC Article 770)
 5. Rated tensile load: 600 lb. maximum rated load.
 6. Operating Temperature Range: -40 to 158°F (-40 to 70°C)

H. Manufacturer: Corning Cable Systems, or equal.

1. #xxxEW4-T4101D20; (xxx = strand count) singlemode outdoor 'ALTOS' dielectric sheath
2. #xxxEWC-T4101D20; (xxx = strand count) singlemode outdoor 'ALTOS' armored sheath.

2.16 GEL-FREE OUTSIDE PLANT FIBER OPTIC CABLE

A. Application:

1. Cable shall be suitable for outdoor installations aerially lashed or High-line cable tray in innerduct.
 - a) Cable shall NOT be installed in duct banks or underground installations.
2. Cable and fiber strands shall exhibit stable performance in an outdoor environment. The optical transmission performance of the fiber shall not be significantly affected by environmental fluctuations, installation, or aging.
3. Materials used in the cable shall not emit hydrogen in quantities that will increase attenuation.

B. Singlemode fiber strands shall meet or exceed the following geometry criteria:

1. Core diameter = 8.3 μm .
2. Mode field diameter = 8.8 μm , $\pm 0.5 \mu\text{m}$.
3. Cladding diameter = 125 μm , $\pm 1.0 \mu\text{m}$.
4. Core/Cladding Concentricity = $\leq 0.8 \mu\text{m}$.
5. Minimum Tensile Strength = 100,000 psi.

C. Singlemode fiber strands shall meet or exceed the following performance criteria:

1. Attenuation = 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm wavelengths, maximum.
2. Cutoff wavelength = 1260 nm.
3. Dispersion = 3.5 ps/nm•km at 1285-1330 nm.

D. Multimode fiber strands shall meet or exceed the following performance criteria:

1. Attenuation = 3.0 dB/km at 850 nm and 1.0 dB/km at 1300 nm wavelengths, maximum.

E. Buffering:

1. Fibers shall be loosely buffered, either in a core tube or in multiple tubes around a dielectric central member.
2. Buffer Tubes (if applicable): Each buffer tube shall be color coded to allow identification, and shall meet the requirements of ANSI/TIA/EIA-598-A-1995. (Also, ref. ANSI/ICEA Publication S-80-576, and EIA-230).

F. Sheath <for non-armored>:

1. Sheath shall consist of a dielectric central member, water swellable tape/yarn and an outer jacket. Sheath shall be dielectric and contain no metallic components.
2. Strength Member: Aramid yarn (e.g., Kevlar®), or reinforced fiberglass rods.
3. Jacket: UV-resistant and listed OFNR and FT-4; meets National Electrical Code (NEC Article 770)
4. Rated tensile load: 600 lb. maximum rated load.
5. Operating Temperature Range: -40 to 158°F (-40 to 70°C)

G. Manufacturer: Corning Cable Systems, Altos Series or equal.

| Manufacturer | Part Number | Fiber Type | Strand Count | Construction | O.D. in |
|---------------|-----------------|------------|--------------|----------------|---------|
| Corning Cable | 012EU4-T4101D20 | Singlemode | 12 | All-Dielectric | 0.41 |
| Corning Cable | 024EU4-T4101D20 | Singlemode | 24 | All-Dielectric | 0.41 |
| Corning Cable | 036EU4-T4101D20 | Singlemode | 36 | All-Dielectric | 0.41 |
| Corning Cable | 048EU4-T4101D20 | Singlemode | 48 | All-Dielectric | 0.41 |
| Corning Cable | 060EU4-T4101D20 | Singlemode | 60 | All-Dielectric | 0.41 |
| Corning Cable | 072EU4-T4101D20 | Singlemode | 72 | All-Dielectric | 0.41 |
| Corning Cable | 084EU4-T4101D20 | Singlemode | 84 | All-Dielectric | 0.48 |
| Corning Cable | 096EU4-T4101D20 | Singlemode | 96 | All-Dielectric | 0.48 |
| Corning Cable | 012TU4-T4180D20 | Multimode | 12 | All-Dielectric | 0.41 |
| Corning Cable | 024TU4-T4180D20 | Multimode | 24 | All-Dielectric | 0.41 |
| Corning Cable | 036TU4-T4180D20 | Multimode | 36 | All-Dielectric | 0.41 |
| Corning Cable | 048TU4-T4180D20 | Multimode | 48 | All-Dielectric | 0.41 |
| Corning Cable | 060TU4-T4180D20 | Multimode | 60 | All-Dielectric | 0.41 |
| Corning Cable | 072TU4-T4180D20 | Multimode | 72 | All-Dielectric | 0.41 |
| Corning Cable | 084TU4-T4180D20 | Multimode | 84 | All-Dielectric | 0.48 |
| Corning Cable | 096TU4-T4180D20 | Multimode | 96 | All-Dielectric | 0.48 |

2.17 GEL-FREE INDOOR/OUTDOOR FIBER OPTIC CABLE

A. Application:

- Cable shall be suitable for outdoor installations, aerially lashed or High-line cable tray in innerduct.
 - Cable shall NOT be installed in duct banks or underground installations.
- The cable shall be rated for the appropriate indoor application: Plenum or Riser.
- Cable and fiber strands shall exhibit stable performance in an outdoor environment. The optical transmission performance of the fiber shall not be significantly affected by environmental fluctuations, installation, or aging.
- Materials used in the cable shall not emit hydrogen in quantities that will increase attenuation.

B. Singlemode fiber strands shall meet or exceed the following geometry criteria:

- Core diameter = 8.3 μm .
- Mode field diameter = 8.8 μm , $\pm 0.5 \mu\text{m}$.
- Cladding diameter = 125 μm , $\pm 1.0 \mu\text{m}$.
- Core/Cladding Concentricity = $\leq 0.8 \mu\text{m}$.
- Minimum Tensile Strength = 100,000 psi.

C. Singlemode fiber strands shall meet or exceed the following performance criteria:

- Attenuation = 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm wavelengths, maximum.
- Cutoff wavelength = 1260 nm.
- Dispersion = 3.5 ps/nm•km at 1285-1330 nm.

- D. Multimode fiber strands shall meet or exceed the following performance criteria:
1. Attenuation = 3.0 dB/km at 850 nm and 1.0 dB/km at 13000 nm wavelengths, maximum.
- E. Buffering:
1. Fibers shall be loosely buffered, either in a core tube or in multiple tubes around a dielectric central member.
 2. Buffer Tubes (if applicable): Each buffer tube shall be color coded to allow identification, and shall meet the requirements of ANSI/TIA/EIA-598-A-1995. (Also, ref. ANSI/ICEA Publication S-80-576, and EIA-230).
- F. Sheath <for non-armored>:
1. Sheath shall consist of a dielectric central member, water swellable tape/yarn and an outer jacket. Sheath shall be dielectric and contain no metallic components.
 2. Strength Member: Aramid yarn (e.g., Kevlar®), or reinforced fiberglass rods.
 3. Jacket: UV-resistant and listed OFNR/FT4 or OFNP/FT6; meets National Electrical Code (NEC Article 770)
 4. Rated tensile load: 600 lb. maximum rated load.
 5. Operating Temperature Range: -40 to 158°F (-40 to 70°C)
- G. Manufacturer: Corning Cable Systems, Freedm Series or equal.
1. The Corning Cable System Freedm One cable series is NOT approved for any OSP installation.

| Manufacturer | Part Number | Fiber Type | Strand Count | NEC/UL |
|---------------|-----------------|------------|--------------|-------------|
| Corning Cable | 012EWF-T4101D20 | Singlemode | 12 | OFNR/Riser |
| Corning Cable | 024EWF-T4101D20 | Singlemode | 24 | OFNR/Riser |
| Corning Cable | 036EWF-T4101D20 | Singlemode | 36 | OFNR/Riser |
| Corning Cable | 048EWF-T4101D20 | Singlemode | 48 | OFNR/Riser |
| Corning Cable | 072EWF-T4101D20 | Singlemode | 72 | OFNR/Riser |
| Corning Cable | 096EWF-T4101D20 | Singlemode | 96 | OFNR/Riser |
| Corning Cable | 120EWF-T4101D20 | Singlemode | 120 | OFNR/Riser |
| Corning Cable | 144EWF-T4101D20 | Singlemode | 144 | OFNR/Riser |
| Corning Cable | 012ESP-T4101D20 | Singlemode | 12 | OFNP/Plenum |
| Corning Cable | 024EWP-T4101D20 | Singlemode | 24 | OFNP/Plenum |
| Corning Cable | 036EWP-T4101D20 | Singlemode | 36 | OFNP/Plenum |
| Corning Cable | 048EWP-T4101D20 | Singlemode | 48 | OFNP/Plenum |
| Corning Cable | 060EWP-T4101D20 | Singlemode | 60 | OFNP/Plenum |
| Corning Cable | 072EWP-T4101D20 | Singlemode | 72 | OFNP/Plenum |
| Corning Cable | 012TWF-T4180D20 | Multimode | 12 | OFNR/Riser |
| Corning Cable | 024TWF-T4180D20 | Multimode | 24 | OFNR/Riser |
| Corning Cable | 036TWF-T4180D20 | Multimode | 36 | OFNR/Riser |
| Corning Cable | 048TWF-T4180D20 | Multimode | 48 | OFNR/Riser |
| Corning Cable | 072TWF-T4180D20 | Multimode | 72 | OFNR/Riser |
| Corning Cable | 096TWF-T4180D20 | Multimode | 96 | OFNR/Riser |
| Corning Cable | 120TWF-T4180D20 | Multimode | 120 | OFNR/Riser |
| Corning Cable | 144TWF-T4180D20 | Multimode | 144 | OFNR/Riser |

| Manufacturer | Part Number | Fiber Type | Strand Count | NEC/UL |
|---------------|-----------------|------------|--------------|-------------|
| Corning Cable | 012TSP-T4180D20 | Multimode | 12 | OFNP/Plenum |
| Corning Cable | 024TWP-T4180D20 | Multimode | 24 | OFNP/Plenum |
| Corning Cable | 036TWP-T4180D20 | Multimode | 36 | OFNP/Plenum |
| Corning Cable | 048TWP-T4180D20 | Multimode | 48 | OFNP/Plenum |
| Corning Cable | 060TWP-T4180D20 | Multimode | 60 | OFNP/Plenum |
| Corning Cable | 072TWP-T4180D20 | Multimode | 72 | OFNP/Plenum |

2.18 MULTI-PAIR COPPER SLICE CLOSURES AND ACCESSORIES

A. Splice Closure – Underground Vault Type

1. Application: Splice closure system shall be suitable for outdoor installation within underground vault and/or maintenance hole.
2. Enclosure:
 - a) Enclosure shall be re-enterable.
 - b) Through-splice or butt-splice configurations will be accepted.
 - c) Size enclosure based on splice bundle diameter and largest incoming cable.
 - d) End caps shall accept one cable per end / one incoming cable and two outgoing cables.
3. Manufacturer: 3M Telcom, or equal:

| Manufacturer | Part Number | Type of Splice | Max Cable Sheath in inches | Length X Height X Width in inches |
|--------------|-------------|----------------|----------------------------|-----------------------------------|
| 3M | 50AA3P-510 | Straight | 1.0 | 21.5x4.5x3.25 |
| 3M | 50B3P-510 | Straight | 1.6 | 28.5x6.0x4.0 |
| 3M | 50C3P-510 | Straight | 2.2 | 28.5x7.5x5.0 |
| 3M | 50D3P-510 | Straight | 2.8 | 28.5x9.25x6.75 |
| 3M | 51AA3P-510 | Branch | 1.0 | 21.5x5.5x4.5 |
| 3M | 51B3P-510 | Branch | 1.6 | 28.5x8.0x5.5 |
| 3M | 51D3P-510 | Branch | 2.8 | 28.5x10.25x7.75 |

- a) 3M #4460; shield bond connector for cables 100-pair or larger
- b) 3M #4460-D (80-6104-1486-6); shield bond connector for cables 100-pair (0.8 in (20 mm)) or smaller
- c) 3M #25T Ground Braid or #25T Ground Braid with Eyelets

B. Splice Closure – Building Entrance Type

1. Application: Splice closure system shall be suitable for indoor installation within entrance facilities for splicing between OSP and ISP cable.
2. Closure:
 - a) Enclosure shall be re-enterable.
 - b) Through-splice or butt-splice configurations will be accepted.
 - c) Size enclosure based on splice bundle diameter and largest incoming cable.
 - d) End caps shall accept eight single collared or shall have multiple holes.

3. Include all required accessories, such as collars, grommets, bushings, bonding connectors, etc. for a complete installation.
4. Closure system shall be air and water tight. Closure system shall be RUS listed and UL approved.
5. Manufacturer: 3M Telcom, or equal:
 - a) 3M #4460-S; shield bond connector for cables 100-pair or larger
 - b) 3M #4460-D; shield bond connector for cables 100-pair or smaller
 - c) 3M #25T Ground Braid or #25T Ground Braid with Eyelets

C. Splice Closure – Aerial Type, Straight or Butt Splices

1. Application: Splice closure system shall be suitable for outdoor installation in an aerial installation for straight splicing of OSP cables.
2. Bond Assembly: Includes 4462-SN for 100-pairs or more.
 - a) For cables under 100-pairs (0.8") the 4460-DS shall be utilized.
3. Construction: Double wall molded polyethylene.
4. End Seal: Spiral for a wide range of cables.
5. Manufacturer: 3M Telcom, or equal:

| Manufacturer | Part Number | Approx. Splice Capacity | | Max Cable O.D. in | Diameter/Length |
|--------------|-------------|-------------------------|--|-------------------|-----------------|
| 3M | R-3 | 300 Pair | | 1.2 | 3 in/24 in |
| 3M | R-5 | 900 Pair | | 2.0 | 5 in/26 in |
| 3M | R-7 | 1800 Pair | | 3.1 | 7 in/26 in |

- a) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 2 in x 19 in, for up to 100 pair.
- b) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 3 in x 19 in, for up to 200 pair.
- c) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 3 in x 33 in, for up to 400 pair.
- d) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 5 in x 33 in, for up to 1200 pair.

D. Splice Closure – Aerial Type, Straight or Butt Splices

1. Application: Splice closure system shall be suitable for outdoor installation in an aerial installation for straight splicing of OSP cables.
2. Bond Assembly: Includes 4462-SN for 100-pairs or more.
 - a) For cables under 100-pairs (0.8") the 4460-DS shall be utilized.
3. Construction: Double wall molded polyethylene.
4. End Seal: Spiral for a wide range of cables.
5. Manufacturer: 3M Telcom, or equal:
 - a) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 2 in x 19 in, for up to 100 pair.
 - b) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 3 in x 19 in, for up to 200 pair.
 - c) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 3 in x 33 in, for up to 400 pair.

- d) 3M #BA/SES, SliC™ aerial closure with attached bond assembly, 5 in x 33 in, for up to 1200 pair.

E. Encapsulant

- 1. Application: Encapsulant shall be suitable for outdoor installation within underground splice closures (vault and/or maintenance hole).
- 2. Encapsulant shall be re-enterable.
- 3. Manufacturer: 3M Telcom, or equal:
 - a) #8882; "High Gel" re-enterable encapsulant.

2.19 MULTI-PAIR COPPER SPLICE MODULES

A. Splice Module – 710 Dry Straight Type

- 1. Application: Cable transition (OSP to ISP) in telecom rooms.
- 2. Modules shall accept mixed solid wire gauges (22 AWG – 24 AWG).
- 3. Modules shall accept mixed insulation types (PIC, PVC, pulp or paper insulated conductors).
- 4. Manufacturer: 3M Telcom, or equal:
 - a) #3M710-SDL-25; 25-pair 710 dry straight splicing module.

B. Splice Module – 710 Filled Straight Type

- 1. Application: In-line or branch splicing of OSP cables in underground vaults or manholes.
- 2. Modules shall accept mixed solid wire gauges (22 AWG – 24 AWG).
- 3. Modules shall accept PIC or PVC insulation.
- 4. Modules shall be "preloaded" (filled) with water resistant compound.
- 5. Manufacturer: 3M Telcom, or equal:
 - a) #3M710-SCL-25; 25-pair 710 filled straight splicing module

2.20 MULTI-PAIR COPPER BUILDING ENTRANCE PROTECTION

A. General: All BEP terminals shall offer 110-compatible "input and output" connection type.

B. For 4-Pair Category 6 cables see 27.150 section 2

C. BEP Terminal – 190 Type

- 1. Application: BEP terminal shall be suitable for indoor installation, within a telecom room (such as an Entrance Facility or 'MPOE'). BEP terminals shall provide termination of the backbone twisted pair cables and shall protect premises equipment against induced voltages and stray currents.
- 2. Configuration: BEP terminal shall be designed for a wall mounted configuration, shall have the capacity to accept 25, 50 or 100 incoming and outgoing pairs, and shall accept 5-pin type protector modules.
- 3. Media Interfaces:
 - a) Input shall be 110 block.
 - b) Output shall be 110 block.

4. Manufacturers: Circa Telecom, TII Network Technologies/Porta Systems or CommScope/Systimax.

| Manufacturer | Part Number | Number Of Pairs | Dimensions H x W x D |
|---------------|--------------------------|-----------------|-------------------------|
| Circa Telecom | 1880ECA1-25 | 25 | 9.20 x 15.25 x 4.75 |
| Circa Telecom | 1880ECA1-50 | 50 | 9.20 x 15.25 x 4.75 |
| Circa Telecom | 1880ECA1-100 | 100 | 11.00 x 14.75 x 6.25 |
| Porta Systems | 25025-110-M110C | 25 | 7.87 x 9.75 x 3.83 |
| Porta Systems | 24050-110-M110C | 50 | 6.75 x 14.5 x 6.11 |
| Porta Systems | 24100-110-M110C | 100 | 10.75 x 14.5 x 6.11 |
| Systimax | 110-ANA1-025 / 105736490 | 25 | --- |
| Systimax | 110-ANA1-050 / 760096476 | 50 | --- |
| Systimax | 110-ANA1-100 / 760096487 | 100 | --- |

D. Over 75 volts BEP Modules – With Sneak Current Protection

- Constructed to handle surges higher than 240 volts, this module shall be used with equipment requiring more than 75 volts to operate.
- BEP modules shall be standard 5-pin type, and be suitable for installation into BEP terminals.
- Over voltage Device: solid state. DC Breakdown Voltage: 240 V. Response time: 3 to 5 nsec.
- Sneak Current Device: heat coil. Sneak Current: 1 A. Response Time: < 15 sec.
- Manufacturers:
 - Circa #4B1FS-240 solid state module, 240V
 - Porta Systems
 - SYSTIMAX

E. Under 75 volts BEP Modules – With Sneak Current Protection

- Constructed to handle surges as low as 75 volts, this module shall be used with equipment requiring less than 75 volts to operate.
- BEP modules shall be standard 5-pin type, and be suitable for installation into BEP terminals.
- Over voltage Device: solid state. DC Breakdown Voltage: 75 V. Response time: 3 to 5 nsec.
- Sneak Current Device: heat coil. Sneak Current: 1 A. Response Time: < 15 sec.
- Manufacturers:
 - Circa #4B3S-75 solid state module, 75V
 - Porta Systems # 113SCN-75
 - SYSTIMAX

2.21 FIBER OPTIC TERMINATION EQUIPMENT

A. Fiber Optic Patch Panels

- Refer to Section 27.130.001 for product requirements.

B. Fiber Connections

- All OSP Fiber connections shall be fusion spliced.

2. Each fusion splice shall be protected in a splice tray or similar protective device that is designed to mount within the specified enclosure.
3. Bare/stripped optical fiber strands shall be protected with a heat shrink with a support strand to prevent exposure and damage to splice.
4. Test the OSP-FIBER for compliance to all applicable standards.
5. Cable tests shall be performed on the reel prior to installation and shall be performed again after installation:

C. Connectors

1. Refer to Section 27.130.001 for product requirements.

2.22 Miscellaneous Materials

A. OSP Backbone Cable Labels (At Termination Point for both copper and fiber)

1. General: Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer.
2. Labels shall be adhesive backed and have a self-laminating feature.
3. For indoor use only.
4. Labels shall fit the backbone fiber cables listed above (i.e., shall fully wrap around the cable's jacket).
5. Printable Area: 2 in x 0.5 in, minimum.
6. Color: White.
 - a) Manufacturer: Panduit, or approved equivalent.
 - b) S200X150YAJ; laser/ink jet labels for cable diameters 0.16-0.32 in (4.04-8.09 mm), white
 - c) S200X400YAJ; laser/ink jet labels for cable diameters 0.32-0.95 in (8.09-24.26 mm), white
 - d) S200X650YAJ; laser/ink jet labels for cable diameters 0.48-1.59 in (12.13-40.43 mm), white

B. OSP Backbone Cable Labels (Outdoor both copper and fiber)

1. Identifier assignment and scope of labeling shall conform to TIA/EIA-606-A. Labels shall conform to TIA/EIA-606-A.
2. Labels shall be permanent and machine-generated; hand written labels will not be accepted
3. Labels shall be a Field Embossed with a Metal Indenting Machine.
4. Labels shall be of Stainless Steel material.
5. Labels shall be attached with Stainless Steel cable ties.
6. Printable Area shall be 3.5 in (90 mm) X 0.75 in (19 mm), minimum, in size.
7. Manufacturer: Panduit or approved equal.
 - a) #MMP350-C; Pan-Steel Stainless Steel Marker Plates

C. Simplex entry seals for 4 in (101.6 mm) conduit

1. Seal shall create a water-tight seal between the inside of the conduit or duct and the cable. Provide plug sized appropriately (1 in (101.6 mm) may be used for existing installations only).

2. Manufacturer: Tyco Electronics/Jackmoon, or equal by Thomas & Betts/Carlton or Condux,.

| Manufacturer | Part Number | Conduit /Duct I.D. Inches | Cable Range Inches |
|------------------|-------------|------------------------------|--------------------|
| Tyco Electronics | 10S035S | 1.00-1.14 | 0.20-0.35 |
| Tyco Electronics | 10S057SB | 1.00-1.14 | 0.35-0.57 |
| Tyco Electronics | 10S070SB | 1.00-1.14 | 0.50-0.70 |
| Tyco Electronics | 12S035S | 1.22-1.36 | 0.20-0.35 |
| Tyco Electronics | 12S057SB | 1.22-1.36 | 0.35-0.57 |
| Tyco Electronics | 12S070SB | 1.22-1.36 | 0.57-.070 |
| Tyco Electronics | 12S090SB | 1.22-1.36 | 0.70-0.90 |
| Tyco Electronics | 40S136S | 3.93-4.16 | 1.19-1.36 |
| Tyco Electronics | 40S196SB | 3.93-4.16 | 1.38-1.96 |
| Tyco Electronics | 40S256SB | 3.93-4.16 | 1.92-2.56 |
| Tyco Electronics | 40S291SB | 3.93-4.16 | 2.56-2.91 |
| Tyco Electronics | 40S327SB | 3.93-4.16 | 2.91-3.27 |
| Carlton | MAFPG3 | 1.22-1.36 | 0.35-0.57 |
| Carlton | MAFPG4 | 1.22-1.36 | 0.57-.070 |
| Carlton | MAFPG41 | 1.22-1.36 | 0.70-0.90 |
| Condux | 08043910 | 1.22-1.36 | 0.35-0.57 |
| Condux | 08043911 | 1.22-1.36 | 0.57-.070 |

D. Duct/Conduit Plug

- Seal shall create a water-tight seal within the inside of the conduit or duct in the absence of a cable. Provide plug sized appropriately (1 in (101.6 mm) may be used for existing installations only).
- Manufacturer: Tyco Electronics/Jackmoon, or equal by Thomas & Betts/Carlton or Condux.

| Manufacturer | Part Number | Conduit /Duct I.D.. Inches |
|------------------|-------------|----------------------------|
| Tyco Electronics | 10D104U | 0.96-1.16 |
| Tyco Electronics | 12D148U | 1.14-1.48 |
| Tyco Electronics | 35D400U | 3.94-4.33 |
| Carlton | MAEPG2 | 0.96-1.16 |
| Carlton | MAEPG4 | 1.14-1.48 |
| Carlton | MAEPG7 | 3.94-4.33 |
| Condux | 08067811 | 0.96-1.16 |
| Condux | 08067812 | 1.14-1.48 |
| Condux | 08067840 | 3.94-4.33 |

E. Innerduct Organizer Plug

- Seal shall create a water-tight seal within the inside of the conduit or duct with 3 (three) 1-1/4 in (32 mm) innerducts. Provide organizer plug sized appropriately
- Manufacturer: Tyco Electronics/Jackmoon, or equal by Thomas & Betts/Carlton or Condux

| Manufacturer | Part Number | Conduit /Duct I.D.. Inches | Innerduct O.D. Range Inches |
|------------------|-------------|-------------------------------|--------------------------------|
| Tyco Electronics | | | |
| Carlton | | | |
| Condux | 08093467 | 3.97-4.09 | 1.53-1.67 |

F. Hook and Loop Cable Wraps

- Width: 0.75 in (19mm).

2. Color: Hook and Loop cable ties shall be the same color as the cable to which it is being applied.
3. Manufacturers: Panduit
 - a) #HLS-15R-0 Black, 15 ft (4.6m) roll, cut to length.
- G. Cable Slack Storage Ring:
 1. Refer to Section 27.130.001 for product requirements.
- H. Aerial Cable Sno-Shoe
 1. Application: For the proper management and storage of aerial cable slack and service loops. May be used with either copper or fiber products.
 2. Material: Molded plastic body with strand support hardware.
 3. Manufacturer: Multilink or equal
 - a) Multilink #2116-SSPTB – Sno-Shoe 16 in (406mm) for use with fiber cable only
 - b) Multilink #2121-SSPTB – Sno-Shoe 21 in (533mm) for use with fiber or copper cable

PART 3 EXECUTION

3.1 GENERAL

- A. Comply with General Execution requirements of Section 27100.
- B. Comply with General Execution requirements of Division 1.
- C. Install products, components, accessories, hardware, etc, according to the manufacturer's instructions.

3.2 EXAMINATION

- A. Pathways: Prior to installation, verify pathways (cable trays, conduits, underground conduits, etc.) exist and are 'ready' to accept backbone cables.
- B. Telecommunications Rooms: Prior to installation, verify equipment rooms are 'ready' to accept the backbone cables and terminations.
- C. Equipment Rooms: Prior to installation, verify equipment rooms are complete and "ready" to accept the backbone cables, splice closures and/or BEP terminals and terminations.

3.3 PREPARATION

- A. The Contractor is solely responsible to verify that twisted pair cables and fiber optic cables are fully operational – both cable sheath and conductors (twisted pair and optical) prior to installation.
- B. Ensure fiber continuity of all fiber strands prior to installation.
- C. Documentation of pre-installation testing is not a close out requirement, and shall be the responsibility of the Contractor.

3.4 INSTALLATION – INTERNAL TWISTED PAIR CABLING

- A. Backbone Cables
 1. General
 - a) Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
 2. Placement
 - a) Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
 - b) Maintain pulling tension within manufacturer's limits.

- c) Protect cable during installation. Replace cable if damaged during installation.
- d) Place cables with no kinks, twists, or impact damage to the sheath.
- e) Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of the pull rope.

3. Routing

- a) Maximum cable length from the termination within the Entrance Facility to the termination in Telecommunications Room shall be 1,640 ft (500 m).
- b) Install cables within designated pathways and in a neat manner.
- c) When routing horizontally within telecommunications rooms, utilize the overhead cable support. When routing vertically within telecommunications rooms, utilize the wall mounted vertical cable runway and support every 24 in (610 mm) on center using the appropriate (plenum/non-plenum) hook and loop fastener.
- d) Place and suspend cables in a manner to protect them from physical interference or damage.
- e) Route cables a minimum of 6 in (152 mm) away from power sources to reduce interference from EMI.
- f) Provide a 10 ft (3 m) (minimum) sheathed cable service loop at each end of the run. Place the slack in the overhead cable support or in a cable storage ring as detailed in the drawings.
 - 1) Storage rings may be placed on the backboard, on the wall or secured to the side or underneath a cable tray as not to violate the bend radius or impede the installation of future cables. The cable storage ring shall not be placed in the tray.

4. Termination

- a) Properly strain relieve cables at termination points per manufacturer's instructions.
- b) Perform terminations in accordance with manufacturer's instructions and TIA/EIA-568-C standard installation practices.
- c) Perform post-installation testing as described in the Telecommunication Testing specification.

B. Termination Apparatus

- 1. Provide accessories required for a complete installation.
- 2. Terminate twisted pair backbone cables onto Category 5e 24-port patch panels, terminating one pair to positions 4 and 5, violet and slate pairs to be abandoned.
- 3. Install the patch panels as shown on the drawing. If not shown, install voice patch panels at the top of the each rack or cabinet. (Refer to EMTN 27.100.006.004)

3.5 INSTALLATION – **INTERNAL** FIBER OPTIC CABLING

A. Backbone Cable

1. General

- a) Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
- b) Protect fibers during installation & termination. Fibers damaged beyond repair during installation or termination shall result in replacement of the affected cable at no additional cost.
- c) Place ALL (both MIC and Freedm series) cables within innerduct the entire route unless specified otherwise.

2. Placement

- a) Bend Radius: Maintain a minimum bend radius of 20 times the cable diameter during installation, and a minimum bend radius of 10 times the cable diameter after installation.
 - b) Pulling: Maintain pulling tension within manufacturer's limits.
 - c) Protection: Place and suspend cables in a manner to protect them from physical interference or damage. Replace cable if damaged during installation.
 - d) Place cables with no kinks, twists, or impact damage to the sheath.
 - e) Do not use cable-pulling compounds for indoor installations unless approved by owner.
 - f) Provide 10 ft (3 m) (minimum) sheathed cable service loop at each end of the run within the Telecommunications Rooms; place the slack in the overhead cable support or in a fiber optic ring as detailed in the drawings.
 - 1) Storage rings may be placed on the backboard, on the wall or secured to the side or underneath a cable tray as not to violate the bend radius or impede the installation of future cables (see drawings). The cable storage ring shall not be placed in the tray.
 - g) Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of the pull rope.
3. Routing
- a) Maximum cable length from the termination within the Entrance Facility to the termination in Telecommunications Room shall be 1,640 ft (500 m).
 - b) Route cables in innerduct between points of termination throughout entire length (except at the fiber take up reel).
 - c) Install cables within designated pathways.
 - d) Neatly dress and organize cables using designated cable routing facilities, and fasten to support devices via hook and loop-type straps.
 - e) When routing horizontally within telecom rooms, utilize the overhead cable support. When routing vertically within telecommunications rooms, utilize the wall mounted vertical cable runway and properly fasten. "Properly fasten" shall consist of cable ties in a 'crossed' configuration per cable or cable bundle (up to three cables or innerducts) every 24 in (610 mm) on center.
 - f) Place and suspend cables in a manner to protect them from physical interference or damage.
 - g) Provide a 10 ft (3 m) (minimum) sheathed cable service loop at each end of the run. Store slack in slack storage ring mounted on the wall.
4. Termination
- a) Properly strain relieve cables at termination points (at/within the fiber optic termination panels) per manufacturer's instructions.
 - b) Terminate/connectorize fiber strands at both ends using the specified fiber optic connectors appropriate for the mode type of the fiber. Perform terminations in accordance with manufacturer's instructions.
 - 1) Fusion splicing is the only approved splicing method for pre-connectorized or pig-tail fiber connectors.
 - c) Provide required accessories and consumables for the complete termination of fiber strands.
 - 1) Use of optical fiber fan-out kits required.

- d) Provide 3 ft (0.91 m) of tight buffered fiber (unsheathed) slack at each end of the run within the patch panel/termination enclosure. Properly store fiber slack in rear of patch panel into the 'routing rings', per manufacturer's instructions.

B. FIBER OPTIC CABLE TERMINATION PANEL

1. Provide the termination panel in designated equipment rack; locate per drawings (if not shown, locate at the top). (Refer to EMTN 27.100.006.004)
2. Provide accessories required for proper installation of each termination panel, including connector panels and adapters.
3. The cable strength member of all fiber cables shall be securely attached to the strain relief bracket in/on the enclosure.

3.6 INSTALLATION – **EXTERNAL** (OUTSIDE PLANT) CABLING

A. OSP Inter-building Multi-Pair Copper Backbone Cable

1. Each and every cable run between either termination points or designated splices points shall be a continuous single cable, homogenous in nature. Only splices as noted on the Construction Documents will be permitted.
2. Provide Slack Storage/Service Loop as follows:

| Application/ Pathway | At the Building | Along the Pathway | At a Splice Point | Method of Storage |
|-------------------------|---|---|---------------------------------|---|
| Highline Cable Tray | Minimum of 10 ft (3 m) | None | Minimum of 20-50 ft (6.-15.2 m) | Underneath tray in a coil depending on length |
| Aerial Pole | Minimum of 20-50 ft (6.1-15.2 m) on last span | Minimum of 20-50 ft (6.1-15.2 m) every 1,000 ft (305 m) | Minimum of 20-50 ft (6.-15.2 m) | Sno-shoe for all applications |
| Underground Duct Bank | At last the last maintenance hole a minimum of 10-30 ft (3-9 m) | Minimum of 10-30 ft (3-9 m) every 1,000 ft (305 m) | Minimum of 10-30 ft (3-9 m) | Utilize racking with maintenance hole |

3. Placement
 - a) Bend Radius: Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
 - b) Pulling: Maintain pulling tension within manufacturer's limits. Only use UL approved cable-pulling compounds when necessary to reduce pulling tensions.
 - c) Protection: Protect cable during installation. Place and suspend cables in a manner to protect them from physical interference or damage. Replace cable if damaged during installation.
 - d) Place cables with no kinks, twists, or impact damage to the sheath.
 - e) Cables shall be neatly dressed and organized in the cable routing facilities, and fastened to support devices via tie wraps.
4. Routing:
 - a) Maintain maximum conductor length of 4,920 ft (1,500 m) from the termination at the MC to the termination in any TR.
 - b) Install cables within designated pathways.

- c) Route cables a minimum of 6 in (152 mm) away from power sources to reduce interference from EMI.
 - d) When routing vertically within telecom rooms, properly fasten the cable to the cable runway mounted vertically on the wall. "Properly fasten" shall consist of cable ties in a 'crossed' configuration per cable or cable bundle (up to three cables) every 24 in (610 mm) inches on center.
 - e) When routing horizontally within telecom rooms, utilize the overhead cable tray / cable runway. Route all backbone cables to avoid crossing over horizontal cabling or horizontal cabling crossing backbone cabling.
 - f) Termination: Terminate copper pairs at both ends on the specified BEP / termination apparatus.
 - g) Properly strain-relieve cables at designated points per manufacturer's instructions.
5. Labeling:
- a) Provide labels on each end of the cable and at all transition points, no more than 4 in (101.6 mm) from where the cable enters the specified splicing enclosure / termination apparatus or raceway.
 - b) Place labels such that they are visible by a technician from a normal stance.

B. Multi-Pair Copper Underground Splicing Systems

1. Provide underground splice systems either as shown on the Drawings or as shown on shop drawing submittal, including closure, end caps, splice modules, grounding components, and all accessories required for a complete installation. Install splice closure and splice modules per manufacturer's instructions using tools intended for the purpose. Provide re-enterable encapsulant within enclosure.
2. Install closure onto rack system within maintenance hole, as shown on drawings.
3. Grounding and Bonding
 - a) Bond cable shield to splice closure bond assembly. Provide bonding conductor from splice closure bond terminal to ground terminal within maintenance hole, if available.
 - b) Size bonding conductor 6 AWG up to 25 ft (7.6m) in length; size as 1000 circular mils per foot if longer than 25 ft (7.6m). See section 27.800 for additional information.
4. Labeling
 - a) Provide labels on each splice module and binder group within the splice closure.

C. Building Entrance Splicing Systems

1. Provide entrance splice system as shown on the Drawings, including closure, end caps, splice modules, grounding components, and all accessories required for a complete installation. Install splice enclosure and splice modules per manufacturer's instructions using tools intended for the purpose.
2. Fill unused end cap entry holes with appropriate plug (intended for purpose) for future use.
3. Thoroughly clean and separate all binder groups prior to installing splice modules.
4. Grounding and Bonding
 - a) Bond splice enclosure and cable shield to closest bus-bar (TMGB/TGB) using bonding conductor per manufacturer's instructions and/or TIA-607 requirements.
 - b) Size bonding conductor 6 AWG up to 25 ft (7.6m) in length; size as 1000 circular mils per foot if longer than 25 ft (7.6 m).
5. Labeling
 - a) Provide labels on each splice module and binder group in splice closure.

D. Building Entrance Protection Terminals

1. Provide BEP system as shown on the Drawings, including terminals, modules, and all accessories required for a complete installation. Install BEP per manufacturer's instructions.
2. Install BEP terminals plumb and square, and at height shown on Drawings. If no height is shown, install such that bottom row is at 24 in (610 mm) AFF (+/- 3 in (77 mm)).
3. Provide quantity of protector modules to completely populate terminals.
4. Grounding and Bonding
 - a) Bond BEP terminal to closest Busbar (TMGB/TGB) using bonding conductor per manufacturer's instructions and/or TIA-607 requirements.
 - b) Size bonding conductor 6 AWG up to 25 ft (7.6 m) in length; size as 1000 circular mils per foot if longer than 25 ft (7.6 m). (See 27.800.001 for additional information).
 - 1) The primary protector grounding conductor shall be as short as practicable

E. Fiber Optic Backbone Cable

1. General
 - a) Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted, unless approved in writing by the Owner.
2. Provide Slack Storage/Service Loop as follows:

| Application/ Pathway | At the Building | Along the Pathway | At a Splice Point | Method of Storage |
|-------------------------|--|---|----------------------|---------------------------------------|
| Highline Cable Tray | Store on communications backboard a minimum of 20-50 feet (6.1-15.2m) using a cable ring | None | Not Permitted | Underneath tray in a cable slack ring |
| Aerial Pole | Minimum of 20-50 feet (6.1-15.2m) on last full span | Minimum of 20-50 (6.1-15.2m) feet every 1,000 feet (305m) | Not Permitted | Sno-shoe for all applications |
| Underground Duct Bank | At the last maintenance hole a minimum of 10-30 feet (3-9m) | Minimum of 10-30 feet (3-9m) every 1,000 feet (305m) | Not Permitted | Utilize racking with maintenance hole |

- a) Protect fibers during installation & termination. Fibers damaged during installation or termination shall result in replacement of the affected cable at no additional cost.
3. Placement
 - a) Place dielectric outside plant fiber optic cables within subduct/innerduct.
 - b) Bend Radius: Maintain a minimum bend radius of 20 times the cable diameter during installation, and a minimum bend radius of 10 times the cable diameter after installation.
 - c) Pulling: Maintain pulling tension within manufacturer's limits. Use a pulling tension meter when using mechanical assistance during installation. Record maximum pulling tension for each cable run and submit to the Owner for review if requested. Replace runs when manufacturer's maximum pulling tension is exceeded.
 - d) Protection: Place and suspend cables in a manner to protect them from physical interference or damage. Replace cable if damaged during installation.
 - e) Place cables with no kinks, twists, or impact damage to the sheath.

- f) Only use UL listed cable-pulling compounds when necessary to reduce pulling tensions.
- g) Secure cables at each telecommunications vault and building entrance with duct plugs.
- h) Provide a minimum of 20 ft (6.1m) (range of 20-50 ft(6.1-15.2 m)) sheathed cable service loop at each end of the run within the Communications Rooms; place the slack underneath the overhead cable tray/runway in a cable management ring per the drawing.

4. Routing

- a) Maintain maximum cable length of 4,920 ft (1500 m) from the termination at the MC to the termination in any TR.
- a) Route cables in conduit/innerduct/multi-guard between points of termination throughout entire length (except at the fiber take up reel).
- b) Install cables within designated pathways.
- c) Neatly dress and organize cables using designated cable routing facilities, and fasten to support devices via tie wraps or hook and loop-type straps.
- d) When routing horizontally within telecom rooms, utilize the overhead cable tray/runway. When routing vertically within telecom rooms, utilize the wall mounted vertical cable runway and properly fasten. "Properly fasten" shall consist of cable ties in a 'crossed' configuration per cable or cable bundle (up to three cables or innerducts) every 24 in (610 mm) on center.
- e) Secure cabling to communication vault sidewall by use of racking. Provide racking if not already present in vault.
- f) Place and suspend cables in a manner to protect them from physical interference or damage.
- g) Provide a 30 ft (9 m) (minimum) sheathed cable service loop at each end of the run. Store slack in slack storage ring mounted on the wall.

5. Termination

- a) Properly strain relieve cables at termination points (at/within the fiber optic termination panels) per manufacturer's instructions.
- b) Terminate/connectorize fiber strands at both ends using the specified fiber optic connectors appropriate for the mode type of the fiber. Perform terminations in accordance with manufacturer's instructions.
- c) Provide required tools, consumables and accessories for complete termination of fiber strands.
 - 1) The use of Optical fiber fan out kits is required.
- d) Provide 3 ft (0.91m) of unsheathed fiber slack within the patch panel/termination enclosure at each end of the run. Properly store fiber slack in rear of patch panel into the 'routing rings', per manufacturer's instructions. Include 'extension' service loop/fold in the rear of the shelf to allow the drawer to be pulled out without putting tension on the fibers.
- e) Do not mix ISP and OSP within the same fiber distribution cabinet.

6. Duct Plugs

- a) Provide duct plugs at each telecommunications vault and building entrance.
- b) Provide blank plugs for unused conduits and innerducts.

7. Fiber Optic Cable Termination Panel

- a) Provide the termination panel in designated equipment rack; per drawings (if not shown, locate at the top of inside rack).
- b) Provide accessories required for proper installation of each termination panel, including connector panels and adapters.

F. Innerduct

1. General

- a) Innerduct runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted, unless approved in writing by the Owner.
- b) Protect duct during installation. Innerduct damaged during installation shall result in replacement of the affected cable at no additional cost.
- c) Label exterior of innerduct with a metal embossed tag identifying the contents of the innerduct.
 - 1) The cable identifier shall be recorded on the innerduct label and secured to the outside of the innerduct at both ends and at all transition points.

2. Placement

- a) Corrugated Innerduct stretches during installation. It is the responsibility of the Contractor to make allowance for this phenomenon by planning for extra slack.
- b) When innerduct is placed in cable tray it shall be securely attached to cable tray every 5ft (1.52 m).
- c) Excessive pulling tension shall be avoided.
- d) Innerduct showing evidence of excessive pulling tension shall be replaced by the Contractor at no additional cost to the Owner.
- e) Innerduct pulled through Underground Conduit Vault's shall be racked and secured in the UCV's.
- f) Immediately after placement, innerduct shall be capped in order to prevent debris from entering.
- g) Innerduct shall only be uncapped when cable is to be installed.
- h) Do not place innerduct in within empty conduits slated for future use or expansion, unless otherwise specified.
- i) Innerducts are to be contiguous sections end to end. If it is absolutely necessary to splice innerduct together, use approved innerduct couplers.
- j) Install duct plug over the cable(s) and secure the plug.
- k) Install a blank plug in unused innerducts.

3.7 LABELING INTERNAL PLANT (ISP)

A. General Requirements

- 1. Labeling and identifier assignment shall conform to the TIA/EIA-606-A Administration Standard and as approved by Owner's Representative before installation. Label shall conform to the TIA/EIA-606-A Administration Standard.
- 2. Provide permanent and machine-generated labels; hand written labels will not be accepted.

B. Label Formats

1. Cable Labels

- a) Text Attributes: Black, 1/8 in (3 mm) high, minimum, or #12 font size.

- b) Provide labels on both ends of cables and all transition points. Install labels no more than 4 in (101.6 mm) from the edge of the cable jacket. Fully wrap label around the cable jacket. Install labels such that they are visible by a technician from a normal stance.

2. Termination Apparatus Labels

- a) Use labels included in the product packaging. Request approval by the Owner for substitutions.
- b) Provide white label respective field type, per TIA/EIA-606-A.
- c) Text Attributes: Black, 3/32 in (2.3 mm) high, minimum, or #10 font size.

C. Identifier Assignment

1. General: Separate label fields of the identifier with a hyphen.

2. Backbone ISP Cables

- a) First field shall identify the originating closet or cross connect as shown on the plans; for example, "MC".
- b) Second field shall identify the originating termination cabinet/rack as shown on the plans; for example the second cabinet in the Equipment Room, "B".
- c) Third field shall identify the position with-in the originating termination cabinet/rack as shown on the plans; for example the second position in the rack, "B".
- d) Forth field shall identify the destination termination cabinet/rack location as shown on the plans; for example Telecommunications Room, "TRxxxx".
- e) Fifth field shall identify the designation Telecommunications Rooms unique identifier as shown on the plans; for example the South wing 1st floor, "S1".
- f) Sixth field shall identify the designation termination cabinet/rack as shown on the plans; for example the first cabinet in the Telecommunications Room, "A".
- g) Seventh field shall identify the position with-in the designation termination cabinet/rack as shown on the plans; for example the First position in the rack, "B".
- h) Eighth field of the identifier shall be the cable type identifier; for example, "FOxxxx"
 - 1) UTP (Blank): "Uxxx"
 - 2) Single Mode Fiber: "FSxxx"
 - 3) Multi Mode Fiber: "FMxxx"
 - 4) Coax Cable: "COxxx"
- i) Ninth field of the identifier shall be the building pair count; for example, "012"
- j) Tenth field of the identifier shall identify the starting port on the termination device; for example, "121"
- k) Example: "MCBB/TRSIAB-FM012. 121"

D. Termination Positions at the Termination Panels

1. First field of the identifier shall be the destination light self; for example "FDC-A".
2. Second field of the identifier shall be the strand count range; for example, "S025-S036"
3. Identifier Example: "To FDC-A S025-S036".

3.8 LABELING EXTERNAL PLANT (OSP)

A. General Requirements

1. Labeling and identifier assignment shall conform to the TIA/EIA-606-A Administration Standard and as approved by Owner's Representative before installation. Label shall conform to the TIA/EIA-606-A Administration Standard.

2. Install labels no more than 4 in (101.6mm) from the edge of the cable jacket and at transition points (i.e. building entrance, hand/maintenance hole and raceway type changes). Fully wrap label around the cable jacket.
3. Label aerial cables at each pole and at all transition points with metal identification labels.
4. Label shall be between 6 in (152 mm) to 12 in (305 mm) below clinching clamp.
5. Label aerial cables adjacent to the cable slack at a sno-shoe.
6. Label all cables adjacent to each splice enclosure.
7. Label all cables adjacent to the cable slack ring as they enter and exit the ring.
8. Install labels such that they are visible by a technician from a normal stance.

B. BEP Labels – “Output” Connection

1. Text shall black, and shall be 3/32 in (2.3 mm) high, minimum, or #10 font size.
2. Labels shall either be included in the product packaging or shall be fully compatible, in the opinion of the Owner with the specified termination apparatus.
3. Provide and permanently affix label on the terminal's cover.
4. Provide label in the label holder at the terminal's “outgoing” connection

C. Identifier Assignment

1. General: Separate all label fields of the identifier as shown.
2. Backbone OSP Twisted Pair Cables
 - a) First field shall identify the originating building termination location identifier as shown on the plans; for example, “S300”.
 - b) Second field shall identify the originating building closet or cross connect as shown on the plans; for example Main Cross connect, “MC” (*if cable is terminated on a wall field then the room number the wall field is located in should be used*).
 - c) Third field shall identify the originating termination cabinet/rack as shown on the plans; for example the second cabinet in the Equipment Room, “B”.
 - d) Fourth field shall identify the position with-in the originating termination cabinet/rack as shown on the plans; for example the second position in the rack, “B”.
 - e) Fifth field shall identify the destination building termination location identifier as shown on the plans; for example, “P107”.
 - f) Sixth field shall identify the destination termination cabinet/rack location as shown on the plans; for example Main Cross connect, “MCxx”.
 - g) Seventh field shall identify the destination termination cabinet/rack as shown on the plans; for example the first cabinet in the Main Cross connect, “A”.
 - h) Eighth field shall identify the position with-in the destination termination cabinet/rack as shown on the plans; for example the Second position in the rack, “B”.
 - i) Ninth field of the identifier shall be the cable type identifier; for example, “Uxxxx”
 - 1) UTP (Blank): “Uxxx”
 - j) Tenth field of the identifier shall be the building pair count; for example, “012”
 - k) Example: “S300-MCBB/P107-MCAB.U050
3. Termination Positions at the Patch Panels
 - a) Each port shall be labeled with the pair count of the building infrastructure.
 - b) BEP Terminal Cover

- 1) The field identifier shall be as listed above under Backbone OSP Twisted Pair Cables.
- 2) Example: "092/300.UTP050"

D. Fiber Optic Identifier Assignment

1. General: Separate all label fields of the identifier with a hyphen.
2. Backbone OSP Fiber Optic Cables
 - a) First field shall identify the originating building termination location identifier as shown on the plans; for example, "S300".
 - b) Second field shall identify the originating building closet or cross connect as shown on the plans; for example Main Cross connect, "MC".
 - c) Third field shall identify the originating termination cabinet/rack as shown on the plans; for example the second cabinet in the Equipment Room, "B".
 - d) Fourth field shall identify the position with-in the originating termination cabinet/rack as shown on the plans; for example the second position in the rack, "B".
 - e) Fifth field shall identify the destination building termination location identifier as shown on the plans; for example, "P107".
 - f) Sixth field shall identify the destination termination cabinet/rack location as shown on the plans; for example Main Cross connect, "MCxx".
 - g) Seventh field shall identify the destination termination cabinet/rack as shown on the plans; for example the first cabinet in the Main Cross connect, "A".
 - h) Eighth field shall identify the position with-in the destination termination cabinet/rack as shown on the plans; for example the Second position in the rack, "B".
 - i) Ninth field of the identifier shall be the cable type identifier; for example, "FSxxx"
 - 1) Single Mode Fiber: "FSxxx"
 - 2) Multi Mode Fiber: "FMxxx"
 - j) Tenth field of the identifier shall be the building pair count; for example, "012"
 - 1) Example: "S300-MCBB/P107-MCAB.FS012"

E. Termination Positions at the Termination Panels

1. Labels shall either be included in the product packaging or shall be fully compatible, in the opinion of the Engineer, with the system.
2. Provide brown label respective field type, per TIA/EIA-606-A.
3. Text shall black, and shall be 3/32 in (2.3mm) high, minimum, or #10 font size.
 - a) The first field of the identifier shall be the fiber strand count; e.g., "0025-0048".
 - b) The second field of the identifier shall be cable's other end room; e.g., "FROM B01-TDA".

3.9 FINAL INSPECTION

- A. Inspect installed products and work in conjunction with the Owner to develop a punch list for items needing correction.
- B. Provide punch-list to Owner, or Owner's Representative. For review prior to performing punch-list with the Owner.
- C. Repair defects prior to system acceptance.
- D. Inspect installed products and work in conjunction with the Owner, or Owner's representative for sign off.

3.10 DEMONSTRATION

- A. On completion of the acceptance test, schedule a time convenient with the Owner, or Owner's Representative, for instruction in the layout and maintenance of the system.

3.11 CERTIFICATION

- A. Provide the Owner, or Owner's Representative, with a written form of acceptance for signature.

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. Section Includes: Horizontal Cabling (subsystem of Communications Cabling Infrastructure).
- B. Related Sections
 - 1. Comply with the Related Sections paragraph of Section 27100
 - 2. Section 27052 – Pathways for Communications Systems
- C. Products Furnished and Installed Under separate contract (unless called for on the Construction Documents):
 - 1. Conduits, sleeves, and other pathway systems for building distribution.
 - 2. Conduit stubs and device (back) boxes for devices/outlets.
 - 3. Surface raceway – base, cover, and device plates.

1.2 REFERENCES

- A. Comply with the References requirements of Section 27100.
- B. In addition to those codes, standards, etc., listed in 27100, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. 27.100.002.002 General Administration and Labeling Detail
 - 2. 27.150.002.001 Typical Connection Details Sheet (1 of 7)
 - 3. 27.150.002.002 Typical Connection Details Sheet (2 of 7)
 - 4. 27.150.002.003 Typical Connection Details Sheet (3 of 7)
 - 5. 27.150.002.004 Typical Connection Details Sheet (4 of 7)
 - 6. 27.150.002.005 Typical Connection Details Sheet (5 of 7)
 - 7. 27.150.002.006 Typical Connection Details Sheet (6 of 7)
 - 8. 27.150.002.007 Typical Connection Details Sheet (7 of 7)
 - 9. 27.150.002.008 LIU Enclosure Layout Network Enclosure Detail
 - 10. 27.150.002.009 MCC IntelliCENTER Devicenet Connections
 - 11. 27.150.002.010 VFD Communication Enclosure Detail
 - 12. 27.150.002.011 Dust Cyclone Scale Enclosure Detail
 - 13. 27.150.002.012 Heat Trace Network Connection Detail
 - 14. 27.150.002.013 Typical ABB Controller Cabinet Layout
 - 15. 27.150.002.014 Typical SIS Cabinet Layout
 - 16. 27.150.002.015 UPS Copper (Eaton) Network Enclosure Detail
 - 17. 27.150.002.050 Copper & Fiber Work Area Outlet (WAO) and
Media Interface Cable Labels.
 - 18. 27.150.002.051 Copper & Fiber Horizontal Patch Cable Labels
 - 19. 27.150.002.052 Process Communications Cable Labels

1.3 DEFINITIONS

- A. Refer to Section 27100 for Definitions.
- B. In addition, the following list of terms as used in this specification shall be defined as follows:
 - 1. "BEP": Building Entrance Protector/Primary Protector
 - 2. "CAT 6": Category 6 [UTP]

3. "Channel": End to end transmission path; e.g., the entire portion of the horizontal cabling to each outlet consisting of the Permanent Link, line cord (at the workstation), patch cord, and, if a full cross-connection is implemented, the cross-connect termination/connecting apparatus and equipment cord.
4. "CMP": Communications Multipurpose Plenum, plenum rating; synonymous with "MPP"
5. "CMR": Communications Multipurpose Riser, riser rating; synonymous with "MPR"
6. "FEP": Fluorinated Ethylene Propylene
7. "Permanent Link": Test configuration for a horizontal cabling link excluding test cords, connections at the ends of the test cords, patch cords, equipment cords, line cords; e.g., the 'permanent' portion of the horizontal cabling to each outlet consisting of cable, consolidation point (if used), termination/connecting apparatus in the Telecommunications Room and the connector at the outlet.
8. "PVC": Polyvinyl Chloride
9. "ScTP": Screened or Shield Twisted Pair typically associated with category 6 cable
10. "UTP": Unshielded Twisted Pair

1.4 SYSTEM DESCRIPTION

A. Base Bid Work

1. Refer to specification section 27100, 1.03, A for a detailed description of work.

1.5 SUBMITTALS

A. Comply with the Submittals article of Section 27100 for procedural, quantity, as-built and format requirements.

B. Preconstruction Submittal Requirements:

1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications and specifications.
2. Shop Drawings Submittal, consisting of proposed changes to cable routing, or termination locations/configurations.
3. Typical Outlet Sample, including faceplate, faceplate label, connectors/jacks, port labels, cables (about 12" (305mm) sample), and cable label.

C. Project Completion Manual Requirements:

1. As-Built Drawings.
 - a) Work Area Outlet additions.
 - b) Cross-connection records/cut sheets.
 - c) Final Cable routing.
 - d) Tagging changes
2. Test results of the installed cable – both printed copies and electronic copies.
3. O & M Manuals.

1.6 QUALITY ASSURANCE

A. Comply with the Quality Assurance requirements of Section 27100, 1.04, F.

1. Corning Cable Systems Preferred Installer
2. Hubbell Contractor Qualifications
3. Ortronics Contractor Qualifications
4. Panduit Certified Installer Qualifications

5. Or approved equal by owner.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Comply with the Delivery, Storage and Handling requirements of Section 27100.

1.8 WARRANTY

- A. The communications horizontal cabling system, as specified in this section, shall receive a manufacturer's system warranty. This extended warranty shall cover parts and labor for the duration of the extended warranty. This extended warranty shall also cover electrical performance of cabling system to the specific category per ANSI/TIA/EIA-568-C performance criteria for Permanent Link.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

- A. Comply with the Substitutions requirements of Section 27100.

2.2 HORIZONTAL CABLE

- A. Category 6 UTP

1. Application: Suitable for indoor installation. (Outdoor installation is noted below as OSP)
2. Conductors:
 - a) Insulated Conductors: 23 AWG solid-copper fully-insulated with a flame retardant thermoplastic material (material = PVC, or equivalent).
 - b) Twisted Pairs: Two insulated conductors twisted to form a pair (twisted pair), and individually color-coded to industry standards (ANSI/ICEA Publication S-80-576-1994, and EIA-230).
3. Cable Sheath:
 - a) The cable shall be unshielded.
 - b) Outer jacket shall be seamless (material = LS-PVC, or similar) applied to and completely covering the internal components (four twisted pairs).
 - c) Cable shall be NEC rated as CMR for riser applications or CMP for Plenum, and UL listed as such. Refer to construction drawing for plenum requirements.
 - d) Cable sheath shall be round.
4. Electrical Performance: Meet or exceed TIA/EIA-568-C.2-1 and ISO/IEC 11801 requirements for CAT 6 UTP cabling.
5. Packaging: Cable shall come as 1,000 foot (305m) put-ups packaged in a box as a minimum.
6. Manufacturer: General Cable Gen SPEED 6000, or equal by Berk-Tek LanMark 1000, CommScope Ultra Media, or Belden DataTwist 2400

| Manufacturer | Part Number | Rating | Color |
|---------------|----------------|------------|-------|
| Belden | 2413 012 A1000 | CMP Plenum | Pink |
| Belden | 2412 006 A1000 | CMR Riser | Blue |
| Belden | ----- | OSP | Black |
| Berk-Tek | 10033811 | CMP Plenum | Pink |
| Berk-Tek | 10032455 | CMR Riser | Blue |
| Berk-Tek | 10139885 | OSP | Black |
| CommScope | 7504 Pink | CMP Plenum | Pink |
| CommScope | 75N4 Blue | CMR Riser | Blue |
| CommScope | 6NF4+ Black | OSP | Black |
| General Cable | 7131948 | CMP Plenum | Pink |

| Manufacturer | Part Number | Rating | Color |
|---------------|-------------|-----------|-------|
| General Cable | 7133940 | CMR Riser | Blue |
| General Cable | 7136100 | OSP | Black |

B. Category 6 ScTP Shielded

1. Application: Suitable for indoor installation only.
2. Conductors:
 - a) Insulated Conductors: 23 AWG solid-copper fully-insulated with a FEP type material.
 - b) Twisted Pairs: Two insulated conductors twisted to form a pair (twisted pair), and individually color-coded to industry standards (ANSI/ICEA Publication S-80-576-1994, and EIA-230).
3. Cable Sheath:
 - a) The cable shall have an overall foil shield and a drain wire.
 - b) Outer jacket shall be seamless (material = LS-PVC, or similar) applied to and completely covering the internal components (four twisted pairs).
 - c) Cable shall be NEC rated as CMP for Plenum, and UL listed as such. Refer to construction drawing for plenum requirements.
 - d) Cable sheath shall be round.
4. Electrical Performance: Meet or exceed TIA/EIA-568-C.2-1 and ISO/IEC 11801 requirements for CAT 6 UTP cabling.
5. Packaging: Cable shall come as 1,000 foot (305m) put-ups packaged in a box as a minimum.
6. Manufacturer: General Cable, or equal by Berk-Tek, CommScope, or Belden

| Manufacturer | Part Number | Rating | Color |
|---------------|---------------|------------|--------|
| Belden | 1351A | CMP Plenum | Yellow |
| Berk-Tek | LANmark-6 FTP | CMP Plenum | Yellow |
| CommScope | 65S4+ Yellow | CMP Plenum | Yellow |
| General Cable | 6131788 | CMP Plenum | Yellow |

C. Fiber Optic Cables

1. Application:
 - a) Cable shall be suitable for indoor installation, between floors in vertical riser system, under access flooring, and through overhead ceiling space (in cable tray, conduit, & hangers).
 - b) Cable shall exhibit stable performance in a building environment. The optical transmission performance of the fiber shall not be significantly affected by environmental fluctuations, installation, or aging.
 - c) Materials used in the cable shall not emit hydrogen in quantities that will increase attenuation.
2. 50/125 μm Multimode fiber strands shall meet or exceed the following:
 - a) Geometry criteria:
 - 1) Core diameter = 50 μm , $\pm 3.0 \mu\text{m}$.
 - 2) Cladding diameter = 125 μm , $\pm 1.0 \mu\text{m}$.
 - 3) Core/Cladding Concentricity = $\leq 3 \mu\text{m}$.
 - 4) Minimum Tensile Strength = 100,000 psi.

- b) Performance criteria:
 - 1) Attenuation = 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm wavelengths, maximum.
 - 2) Overfilled Bandwidth = 500 MHz•km at 850 nm and 500 MHz•km at 1300 nm wavelengths, minimum.
 - 3) Laser Bandwidth = 2,000 MHz•km at 850 nm and 500 MHz•km at 1300 nm wavelengths, minimum.
- 3. Single Mode fiber strands shall meet or exceed the following;
 - a) Geometry criteria:
 - 1) Core diameter = 8.3 μm .
 - 2) Mode field diameter = 8.8 μm , $\pm 0.5 \mu\text{m}$.
 - 3) Cladding diameter = 125 μm , $\pm 1.0 \mu\text{m}$.
 - 4) Core/Cladding Concentricity = $\leq 0.8 \mu\text{m}$.
 - 5) Minimum Tensile Strength = 100,000 psi.
 - b) Performance criteria:
 - 1) Attenuation = 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm wavelengths, maximum.
 - 2) Cutoff wavelength = 1260 nm.
 - 3) Dispersion = 3.5 ps/nm•km at 1285-1330 nm.
- 4. Buffering:
 - a) Each fiber shall be completely covered with a "primary coating" (acrylate material). This shall constitute the "fiber strand".
 - b) Each fiber strand shall be fully covered with a flame retardant thermoplastic material (material = PVC, or equivalent thermoplastic). This shall constitute the "buffered strand" (tight buffer type).
 - c) Buffered Strands: Buffered strands shall be individually color coded to meet the requirements of ANSI/TIA/EIA-598-A-1995. (Also, ref. ANSI/ICEA S-87-640-1992).
- 5. Cable Sheath:
 - a) Strength Element: The cable shall have an internal strength element such as aramid yarn (e.g., Kevlar).
 - b) Tensile Strength: The cable shall have a 150-lb, minimum, rated load.
 - c) Outer Jacket: The cable shall have a seamless outer jacket (material = PVC, or equivalent) applied to and completely covering the internal components (fiber strands, strength element, other).
 - d) Flame Rating: The cable shall be NEC (Article 770) rated as OFNR or riser or OFNP for plenum and UL listed as such. Refer to construction drawing for plenum requirements.
- 6. Manufacturer: Corning Cable Systems
 - a) Installed in innerduct:

1) Corning "MIC" series cables or equal.

| Corning Part Number | Fiber Type | Number of Fiber Strands | UL or NEC |
|---------------------|----------------------|-------------------------|-------------|
| 002T81-31180-24 | 50µm OM3 Multimode | 2 | Riser OFNR |
| 004T81-31180-24 | 50µm OM3 Multimode | 4 | Riser OFNR |
| 006T81-31180-24 | 50µm OM3 Multimode | 6 | Riser OFNR |
| 008T81-31180-24 | 50µm OM3 Multimode | 8 | Riser OFNR |
| 012T81-33180-24 | 50µm OM3 Multimode | 12 | Riser OFNR |
| 018T81-33180-24 | 50µm OM3 Multimode | 18 | Riser OFNR |
| 024T81-33180-24 | 50µm OM3 Multimode | 24 | Riser OFNR |
| 002T88-33190-29 | 50µm OM3 Multimode | 2 | Plenum OFNP |
| 004T88-33190-29 | 50µm OM3 Multimode | 4 | Plenum OFNP |
| 006T88-33190-29 | 50µm OM3 Multimode | 6 | Plenum OFNP |
| 008T88-33190-29 | 50µm OM3 Multimode | 8 | Plenum OFNP |
| 012T88-33190-29 | 50µm OM3 Multimode | 12 | Plenum OFNP |
| 018T88-33190-29 | 50µm OM3 Multimode | 18 | Plenum OFNP |
| 024T88-33190-29 | 50µm OM3 Multimode | 24 | Plenum OFNP |
| 002E81-31131-24 | 8.3µm OS2 Singlemode | 2 | Riser OFNR |
| 004E81-31131-24 | 8.3µm OS2 Singlemode | 4 | Riser OFNR |
| 006E81-31131-24 | 8.3µm OS2 Singlemode | 6 | Riser OFNR |
| 008E81-31131-24 | 8.3µm OS2 Singlemode | 8 | Riser OFNR |
| 012E81-33131-24 | 8.3µm OS2 Singlemode | 12 | Riser OFNR |
| 018E81-33131-24 | 8.3µm OS2 Singlemode | 18 | Riser OFNR |
| 024E81-33131-24 | 8.3µm OS2 Singlemode | 24 | Riser OFNR |
| 002E88-31131-29 | 8.3µm OS2 Singlemode | 2 | Plenum OFNP |
| 004E88-31131-29 | 8.3µm OS2 Singlemode | 4 | Plenum OFNP |
| 006E88-31131-29 | 8.3µm OS2 Singlemode | 6 | Plenum OFNP |
| 008E88-31131-29 | 8.3µm OS2 Singlemode | 8 | Plenum OFNP |
| 012E88-33131-29 | 8.3µm OS2 Singlemode | 12 | Plenum OFNP |
| 018E88-33131-29 | 8.3µm OS2 Singlemode | 18 | Plenum OFNP |
| 024E88-33131-29 | 8.3µm OS2 Singlemode | 24 | Plenum OFNP |

b) Installed with-out innerduct:

1) Corning "Freedm One" series cables, or equal

| Corning Part Number | Fiber Type | Number of Fiber Strands | UL or NEC |
|---------------------|----------------------|-------------------------|-------------|
| 006T8F-31180-29 | 50µm OM3 Multimode | 6 | Riser OFNR |
| 012T8F-31180-29 | 50µm OM3 Multimode | 12 | Riser OFNR |
| 018T8F-31180-29 | 50µm OM3 Multimode | 18 | Riser OFNR |
| 024T8F-31180-29 | 50µm OM3 Multimode | 24 | Riser OFNR |
| 006T8P-31180-29 | 50µm OM3 Multimode | 6 | Plenum OFNP |
| 012T8P-31180-29 | 50µm OM3 Multimode | 12 | Plenum OFNP |
| 018T8P-31180-29 | 50µm OM3 Multimode | 18 | Plenum OFNP |
| 024T8P-31180-29 | 50µm OM3 Multimode | 24 | Plenum OFNP |
| 006E8F-31131-29 | 8.3µm OS2 Singlemode | 6 | Riser OFNR |
| 012E8F-31131-29 | 8.3µm OS2 Singlemode | 12 | Riser OFNR |
| 018E8F-31131-29 | 8.3µm OS2 Singlemode | 18 | Riser OFNR |
| 024E8F-31131-29 | 8.3µm OS2 Singlemode | 24 | Riser OFNR |
| 006E8P-31131-29 | 8.3µm OS2 Singlemode | 6 | Plenum OFNP |
| 012E8P-31131-29 | 8.3µm OS2 Singlemode | 12 | Plenum OFNP |

| Corning Part Number | Fiber Type | Number of Fiber Strands | UL or NEC |
|---------------------|----------------------|-------------------------|-------------|
| 018E8P-31131-29 | 8.3µm OS2 Singlemode | 18 | Plenum OFNP |
| 024E8P-31131-29 | 8.3µm OS2 Singlemode | 24 | Plenum OFNP |

D. Coaxial Cables

1. Application: Suitable for indoor installation.
 - a) Cable shall be suitable for indoor installation, between floors in vertical riser system, under access flooring, and through overhead ceiling space (in cable tray, conduit, & hangers).
 - b) Unless specified otherwise on the Drawings or in contract documents, the Coax Cables shall be as specified herein. Refer to the Detailed Engineering Drawings and Schedules for quantities and types to be provided.
2. RG-6 Quad Shield Cable
 - a) The CATV Horizontal Coaxial cable shall be 75-ohm impedance, RG-6 type, and riser-CATVR or plenum rated CATVP Coax Cable with the following properties:
 - 1) Construction: Center conductor shall be at minimum 18 AWG Copper-Clad Steel.
 - b) Dielectric:
 - 1) Foam FEP
 - 2) Dia. Over Dielectric: 0.170" Nom.
 - c) Inner Shield:
 - 1) Foil: 0.003" Aluminum/Poly Tape, 100% Coverage
 - 2) Braid: 34AWG Aluminum, 60% Coverage
 - 3) Nom. Dia.: 0.205"
 - d) Outer Shield:
 - 1) Foil: 0.002" Aluminum/Poly Tape, 100% Coverage
 - 2) Braid: 34AWG Aluminum, 40% Coverage
 - 3) Nom. Dia.: 0.232"
 - e) Jacket:
 - 1) Kynar Flex or Flame Retardant PVC
 - 2) Dia. Over jacket: 0.300" +/- 0.006" Riser
 - 3) Dia. Over jacket: 0.260" +/- 0.006" Plenum
 - 4) Nom. Jacket Thickness: 0.016"
 - 5) Minimum Spot: 0.012"
 - f) Impedance:
 - 1) 76.0 +/- 2.0 Ohms
 - g) Velocity of Propagation:
 - 1) 84.0% Nom.
 - h) DCR:
 - 1) Conductor: 28.6 Ohms/1000 Ft. Nom.
 - 2) Shield: 5.30 Ohms/1000 Ft. Nom.
 - i) Attenuation:

| @ Frequency MHz | Riser Rated Cable dB/100 ft. (Nom.) | Plenum Rated Cable dB/100 ft. (Nom.) |
|-----------------|--|---|
| 1 MHz | 0.38 dB | 0.37 dB |

| @ Frequency MHz | Riser Rated Cable dB/100 ft. (Nom.) | Plenum Rated Cable dB/100 ft. (Nom.) |
|-----------------|--|---|
| 10 MHz | 0.70 dB | 0.66 dB |
| 50 MHz | 1.48 dB | 1.41 dB |
| 100 MHz | 2.01 dB | 1.92 dB |
| 200 MHz | 2.86 dB | 2.64 dB |
| 400 MHz | 4.23 dB | 3.73 dB |
| 700 MHz | 5.96 dB | 5.05 dB |
| 900 MHz | 6.96 dB | 5.79 dB |
| 1000 MHz | 7.45 dB | 6.11 dB |

j) Manufacturer: CommScope , or equal by Berk-Tek, General Cable, or Belden

- 1) #2227V, "P6" RG-6 Quad Shield CATVP (Plenum)
- 2) #5740R, "P6" RG-6 Quad Shield CATVR (Riser)

3. CCTV RG6 Cable

a) The CCTV Horizontal Coaxial cable shall be 75-ohm impedance, RG-6 type, Non-Plenum or Plenum Coax Cable with the following properties:

b) Construction:

- 1) Center conductor shall be at a minimum 18 AWG Copper.

c) Dielectric:

- 1) Foam PE (Riser) or Foam FEP (Plenum)
- 2) Dia. Over Dielectric: 0.180 in (Riser) or 0.170 in Plenum Nom.

d) Outer Shield:

- 3) Braid: Bare Copper, min 95% Coverage

e) Jacket: PVC

f) Impedance: 75 Ohms

g) Velocity of Propagation: 82.0% Riser or 84% Plenum Nom.

h) DCR:

- 1) Conductor: 6.5 Ohms/1000 ft Nom.
- 2) Shield: 2.00 Ohms/1000 ft Nom.

i) Attenuation:

| @ Frequency MHz | Riser Rated dB/100 ft (Nom.) | Plenum Rated dB/100 ft (Nom.) |
|-----------------|---------------------------------|----------------------------------|
| 1 MHz | 0.19 dB | 0.38 dB |
| 10 MHz | 0.65 dB | 0.70 dB |
| 50 MHz | 1.50 dB | 1.48 dB |
| 100 MHz | 2.16 dB | 2.01 dB |
| 200 MHz | 3.13 dB | 2.86 dB |
| 400 MHz | 4.55 dB | 4.23 dB |
| 700 MHz | 6.23 dB | 5.96 dB |
| 900 MHz | 7.23 dB | 6.96 dB |
| 1000 MHz | 7.75 dB | 7.45 dB |

j) Manufacturer: Belden , or equal by Berk-Tek, General Cable, or CommScope

- 1) Belden - #533945, RG-6 (Non-Plenum)

- 2) CommScope #5730, RG6 White (Non-Plenum)
- 3) CommScope # 2275V, RG6 White (Plenum)
- 4. CCTV RG6 Composite/Siamese Cable
 - a) Construction: Consists of a RG6 cable and a 18 AWG 1-pair cable in a composite/Siamese construction. Overall diameter of 0.485in.
 - b) RG-6 Cable
 - 1) The CCTV Horizontal Composite/Siamese Coaxial cable shall be 75-ohm impedance, RG-6 type, Non-Plenum or Plenum Coax Cable with the following properties:
 - 2) Construction:
 - (i) Center conductor shall be at a minimum 18 AWG Copper.
 - 3) Dielectric:
 - (i) Foam PE (Riser) or Foam FEP (Plenum)
 - 4) Dia. Over Dielectric: 0.180 in (Riser) or 0.170 in Plenum Nom.
 - 5) Outer Shield:
 - (i) Braid: Bare Copper, min 95% Coverage
 - 6) Jacket: PVC
 - 7) Impedance: 75 Ohms
 - 8) Velocity of Propagation: 83.0% Riser or 84% Plenum Nom.
 - 9) DCR:
 - (i) Conductor: 6.4 Ohms/1000 ft Nom.
 - (ii) Shield: 2.20 Ohms/1000 ft Nom.

10) Attenuation:

| @ Frequency MHz | Riser Rated dB/100 ft (Nom.) |
|-----------------|---------------------------------|
| 1 MHz | 0.20 dB |
| 10 MHz | 0.64 dB |
| 50 MHz | 1.46 dB |
| 100 MHz | 2.10 dB |
| 200 MHz | 3.00 dB |
| 400 MHz | 4.30 dB |
| 700 MHz | 5.80 dB |
| 900 MHz | 6.70 dB |
| 1000 MHz | 7.10 dB |

- c) Twisted Pair
 - 1) Construction: 18AWG stranded 1 pair cable
 - 2) Color: Black and red
- d) Manufacturer: Belden , or equal by Berk-Tek, General Cable, or CommScope
 - 1) Belden - #539945, RG-6/18-1 Pair (Non-Plenum)
 - 2) Belden # 639948, RG-6/18-1 Pair (Plenum)
- 5. Five Conductor Mini Coax
 - a) The 25 AWG CM Rated,
 - 1) Construction: Five (5) conductor mini coax cable shall consist of five individually shielded, 75 ohm coax cables.

- 2) Shield: 100% foil and 98% copper braid shield each, with overall aluminum polyester foil and Drain wire.
- 3) Conductors: PVC insulated.
- 4) Resistance: 30 Ohms per M'.
- 5) Jacket: Black PVC
 - (i) This cable shall be installed in conduit only.
- 6) Manufacturer: West Penn Wire, or equal by Berk-Tek, General Cable, CommScope or Belden;
 - (i) West Penn Wire - WP8255
- b) The 25 AWG. CMP Rated;
 - 1) Construction: Five (5) conductor mini coax cable shall consist of five individually shielded, 75 ohm coax cables.
 - 2) Shield: 100% foil and 98% copper braid shield each, with overall aluminum polyester foil and Drain wire. Foam FEP insulated.
 - 3) Resistance: 30 Ohms per M'.
 - 4) Jacket: Blue Flex Plenum.
 - (i) This cable shall be used above ceilings when not in conduit.
 - 5) Manufacturer: West Penn Wire, or equal by Berk-Tek, General Cable, CommScope or Belden;
 - (i) West Penn Wire - WP258255
6. S-Video Coax
 - a) The 25 AWG CM Rated;
 - 1) Construction: Two (2) conductor mini coax cable shall consist of two individually shielded, 75 ohm coax cables.
 - 2) Shield: 95% copper braid shield each
 - 3) Conductors: PVC insulated.
 - 4) Resistance: 30 Ohms per M'
 - 5) Jacket: Blue PVC Jacket.
 - (i) This cable shall be installed in conduit only.
 - 6) Manufacturer: West Penn Wire, or equal by Berk-Tek, General Cable, CommScope or Belden;
 - (i) West Penn Wire - 2825
 - b) The 25 Ga. CMP Rated;
 - 1) Construction: Two (2) conductor mini coax cable shall consist of two individually shielded, 75 ohm coax cables.
 - 2) Shield: 95% copper braid shield each.
 - 3) Conductors: PVC insulated.
 - 4) Resistance: 30 Ohms per M'.
 - 5) Jacket: Blue Flex Plenum Jacket.
 - (i) This cable shall be used above ceilings when not in conduit.
 - 6) Manufacturer: West Penn Wire, or equal by Berk-Tek, General Cable, CommScope or Belden;
 - (i) West Penn Wire - 25825
7. 50 Ohm Coaxial Cables
 - a) The Wireless Broadband Horizontal Coaxial cable shall be 50-ohm impedance, RG-8 type (400 series), and plenum/riser rated CNT Coax Cable with the following properties:

- 1) Construction: Center conductor shall be at a minimum .108" in. nominal diameter Copper-Clad Aluminum.
- b) Dielectric:
 - 1) Plenum - Foam FEP, Riser – Foam PE
 - 2) Dia. Over Dielectric: 0.285" Nom.
- c) Inner Shield:
 - 1) Foil: Aluminum/Poly Tape
 - 2) 90% Coverage
 - 3) Braid: 34AWG Tin/Copper
 - 4) Nom. Dia.: 0.320"
- a) Jacket:
 - 1) Riser- Black Flame retardant PVC, Plenum- White PVDF
 - 2) Dia. Over jacket: 0.400"
 - 3) Nom. Jkt. Thickness: 0.043"
- b) Impedance: 50.0 +/- 2.0 Ohms
- c) Velocity of Propagation: Plenum 84.0% Nom., Riser 85.0% Nom
- d) DCR:
 - 1) Conductor: 1.32 Ohms/1000 Ft. Nom.
 - 2) Shield: 2.10 Ohms/1000 Ft. Nom.
- e) Attenuation :

| @ Frequency MHz | Plenum dB/100 ft. (Nom.) | Riser dB/100 ft. (Nom.) |
|------------------------|-------------------------------------|------------------------------------|
| 50 MHz | 0.93 dB | 0.90 dB |
| 150 MHz | 1.63 dB | 1.50 dB |
| 200 MHz | 1.95 dB | -- |
| 220 MHz | 2.03 dB | 1.90 dB |
| 300 MHz | 2.47 dB | -- |
| 400 MHz | 2.93 dB | -- |
| 450 MHz | 3.21 dB | 2.70 dB |
| 500 MHz | 3.43 dB | -- |
| 900 MHz | 5.17 dB | 3.90 dB |
| 1500 MHz | 7.31 dB | 5.10 dB |
| 1800 MHz | 8.02 dB | 5.70 dB |
| 1900 MHz | 8.55 dB | -- |
| 2000 MHz | 9.07 dB | 6.00 dB |
| 2500 MHz | 10.57 dB | 6.80 dB |

8. Manufacturer: CommScope/Andrews , or equal by Berk-Tek, General Cable, or Belden
 - a) CommScope #CNT-400-R, 50 ohm braided coaxial cable (Riser Rated)
 - b) CommScope #CNT-400-P, 50 ohm braided coaxial cable (Plenum Rated)

E. Stereo Speaker Shielded Cable-Two Conductor

1. Application: 22AWG may be used for 3.5mm stereo jacks when used with a projector or computer. 12AWG may be used from an amplifier to a junction block for high powered audio functions.
2. Jacket Color: Gray for both riser and plenum applications.
3. Manufacture: West Penn or approved equal:

| Manufacturer | Part Number | Conductor/Stranding | Conductor Color | UL Listing |
|--------------|-------------|----------------------------|-----------------|------------|
| West Penn | 291 | 22 AWG Bare Copper (7X30) | Black/Red | CMR Riser |
| West Penn | 296 | 12 AWG Bare Copper (19X25) | Black/White | CL2R |
| West Penn | 25291B | 22 AWG Bare Copper (7X30) | Black/Red | CMP Plenum |
| West Penn | 25296B | 12 AWG Bare Copper (19X25) | Black/White | CL2P |

F. Speaker Cable Unshielded-Two Conductor

1. Application: Indoor for: Intercom, Sound, Audio, Background Music, and Sound masking.
2. Jacket Color: Gray for both riser and plenum applications.
3. Manufacture: West Penn or approved equal:

| Manufacturer | Part Number | Conductor/Stranding | Conductor Color | UL Listing |
|--------------|-------------|----------------------------|-----------------|------------|
| West Penn | 224 | 18 AWG Bare Copper (7X26) | Black/Red | CMR Riser |
| West Penn | 225 | 16 AWG Bare Copper (19X29) | Black/Red | CMR Riser |
| West Penn | 226 | 14 AWG Bare Copper (19X27) | Black/White | CMR Riser |
| West Penn | 25224B | 18 AWG Bare Copper (7X26) | Black/Red | CMP Plenum |
| West Penn | 25225B | 16 AWG Bare Copper (19X29) | Black/Red | CMP Plenum |
| West Penn | 25226B | 14 AWG Bare Copper (19X27) | Black/Red | CMP Plenum |

G. Process Communications Cable

1. Profibus Cable;
 - a) Two (2) conductor Shielded cable shall consist of two parallel copper conductors
 - b) Copper Shielding Braid
 - c) 22 AWG, PVC insulated
 - d) 110 Ohms per km.
 - e) Color: Purple
 - f) This cable shall be installed in conduit.
 - g) Manufacturer: Siemens;
 - 1) #6XV1-830-0EH10
2. Modbus Plus EIA-485 Cable;
 - a) CM Rated;
 - b) 1 pair 22AWG (7X30) stranded tinned copper conductors.
 - 1) White/Blue Stripe and Blue/White Strip
 - c) Shield:
 - 1) 100% Tape/Foil
 - 2) 65% Braid

- d) 120 Ohms per 1000 ft.
- e) Jacket: PVC UV Resistant
- f) Manufacturer: Belden;
 - 1) Belden 3105A
- 3. DeviceBus Cable
 - a) TC-ER Rated
 - b) Construction : 2 pair unshielded
 - 1) Pair 1: 16 AWG (19X29) Red/Black
 - 2) Pair 2: 18 AWG (19X30) Blue/White
 - c) Shield: None
 - d) Jacket: PVC sunlight and oil-resistant
 - e) Manufacturer: Belden
 - 1) Belden – 7900A
- 4. DeviceNet Thick Trunk Cable
 - a) Application: Thick Trunk cable is generally used as the trunk line on the DeviceNet network. Thick cable can be used for trunk lines and drop lines.
 - b) Construction : 2 pair shielded
 - 1) Pair 1: 15 AWG (19X28) Red/Black
 - 2) Pair 2: 18 AWG (19X30) Blue/White
 - c) Shield:
 - 1) 100% Tape/Foil
 - 2) 65% Braid
 - d) Jacket Color: Gray
 - e) Manufacture: Allen Bradley
 - 1) Allen Bradley 185C-P1A50; Class 2 Thick Cable 164' (50 meter) spool
 - 2) Allen Bradley 185C-P1A150; Class 2 Thick Cable 492' (150 meter) spool
 - 3) Allen Bradley 185C-P1A300; Class 2 Thick Cable 984' (300 meter) spool
 - 4) Allen Bradley 185C-P1A500; Class 2 Thick Cable 1640' (500 meter) spool

2.3 PATCH PANEL

A. Cat 6 UTP Patch Panel;

1. Application: Patch panel shall be suitable for installation within a telecommunication room for the termination of the CAT 6 UTP 4-Pair Cable (specified herein), and shall be horizontally oriented for a rack-mounted configuration.
2. Patch panel shall have 110 style terminations on the back.
3. Patch panels shall be capable of supporting, organizing, labeling and patching/cross connecting between the horizontal termination field and the equipment and/or the equipment termination field.
4. Contractor shall install all stuffer caps on terminated ports
5. Manufacturers: Hubbell, Ortronics, Panduit or approved equal.

| Manufacturer | Part Number | Description |
|--------------|-------------|------------------------------|
| Hubbell | P624U | 24-Port, 1U, 110 Termination |
| Ortronics | OR-PHD66U24 | 24-Port, 1U, 110 Termination |
| Panduit | DP24688TGY | 24-Port, 1U, 110 Termination |

B. Cat 6 Shielded Patch Panel;

1. Application: Patch panel shall be suitable for installation within a telecommunication room for the termination of the CAT 6 shielded 4-Pair Cable (specified herein), and shall be horizontally oriented for a rack-mounted configuration.
2. Patch panel shall have discrete ports, fully compatible with the connectors / modular jacks – refer to this section for connectors.
3. Patch panels shall be capable of supporting, organizing, labeling and patching/cross connecting between the horizontal termination field and the equipment and/or the equipment termination field.
4. Contractor shall install all stuffer caps on terminated ports
5. Contractor shall install black blanks for all unused ports
6. Manufacturers: Hubbell, Ortronics, Panduit or approved equal.

| Manufacturer | Part Number | Description |
|--------------|-------------|--------------------------------------|
| Hubbell | PSJ24BK | 24-Port Discrete Panel 1U Less Jacks |
| Ortronics | OR-PHDPJU24 | 24-Port Discrete Panel 1U Less Jacks |
| Panduit | CPP24FMWBLY | 24-Port Discrete Panel 1U Less Jacks |

C. Cat 5e UTP Patch Panel (Voice only applications);

1. Application: Patch panel shall be suitable for installation within a telecommunication room for the termination of the Voice Cable (specified in section 27.130), and shall be horizontally oriented for a rack-mounted configuration.
2. Patch panel shall have 110 style terminations on the back.
3. Patch panels shall be capable of supporting, organizing, labeling and patching/cross connecting between the horizontal termination field and the equipment and/or the equipment termination field.
4. Contractor shall install all stuffer caps on terminated ports
5. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|--------------|------------------------------|
| Hubbell | P5E24UE | 24-Port, 1U, 110 Termination |
| Ortronics | OR-PHD5E6U24 | 24-Port, 1U, 110 Termination |
| Panduit | DP245E88TGY | 24-Port, 1U, 110 Termination |

D. Discrete Patch Panel for Coaxial Cables

1. Application: Patch panel shall be suitable for installation within a telecommunication room for the termination of the Coaxial Cables (specified herein), and shall be horizontally oriented for a rack-mounted configuration.
2. Patch panel shall have discrete ports, fully compatible with the connectors / coupler – refer to this section for components.
3. Patch panels shall be capable of supporting, organizing, labeling and patching between the horizontal termination field and the equipment and/or the equipment termination field.
4. Contractor shall install black blanks for all unused ports.
5. When populating the panel with both “F” and “BNC” connectors the “BNC” shall start in the first position of the panel and the “F” shall start in the last port. The panel shall be populated towards the center.
6. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|--------------------------------------|
| Hubbell | UDX24E | 24-Port Discrete Panel 1U Less Jacks |
| Ortronics | OR-PHDPJU24 | 24-Port Discrete Panel 1U Less Jacks |
| Panduit | CPPL24M6BLY | 24-Port Discrete Panel 1U Less Jacks |

2.4 110 CROSS CONNECT BLOCK

- A. Application: 110 Blocks shall be suitable for installation within a telecommunication room or at a CP (Consolidation Point applications only unless approved by Owner) for the termination of the CAT 6 UTP 4-Pair Cable (specified herein), and shall be horizontally oriented for a rack-mounted configuration.
- B. 110 Blocks shall be capable of supporting, organizing, labeling and patching/cross connecting between the horizontal termination field and the equipment and/or the equipment termination field.
- C. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|---------------|------------------------------------|
| Hubbell | 6110FTK64WL | 64-Pair (16 Port) W/Legs |
| Ortronics | OR-110ABC6100 | 96-Pair (24 Port) W/Legs |
| Panduit | GPKBW24Y | 96-Pair (24 Port) W/Legs |
| Panduit | GPB484R2Y | 192-Pair (48 Port) 19in Rack Mount |

2.5 WORKSTATION OUTLETS

- A. Faceplate for Professional office spaces.
1. Refer to Work Area Outlet schedule in the drawings for port quantity per outlet type.
 2. Faceplate shall include required accessories, such as icons, blank inserts, and labels.
 3. Faceplate shall be by the same manufacturer as the connectors.
 4. Faceplate shall be "Executive" series and have an insert label field.
 5. Color shall match electrical device and/or cover plate.
 6. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|-------------------------------|
| Hubbell | IMF1** | iSTATION Single Gang 3 Module |
| Hubbell | IMF2** | iSTATION Double Gang 6 Module |
| Ortronics | 40300158 | Series II Single Gang |
| Ortronics | 40300159 | Series II Double Gang |
| Panduit | CBE**Y | Mini-Com Single Gang 3 Module |
| Panduit | CBE**-2GY | Mini-Com Double Gang 6 Module |

B. Faceplate for Wall Phone Outlets

1. Faceplate for wall phone outlets shall come equipped with 1 modular Category 6 jack and two mounting studs.
2. Material: Stainless Steel
3. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|--------------|-----------------------|
| Hubbell | P630SRGC6 | With Gray CAT 6 Jack |
| Ortronics | OR-403STJ1WP | Without Modular Jack. |
| Panduit | KWP6PY | With Black CAT 6 Jack |

C. Faceplate for Open Office Furniture Outlets (Bezels)

1. Application: Faceplate shall be compatible with the base-plate and beltway of the selected open office furniture, and shall "snap" into the furniture opening.
2. Refer to Work Area Outlet schedule in the drawings for port quantity per outlet type.
3. Faceplate shall include required accessories, such as icons, blank inserts, and labels.
4. Color shall match electrical device and/or cover plate.
5. Faceplate shall be by the same manufacturer as the connectors.
6. Faceplate shall have 4 ports and have an insert label field.
7. Manufacturer (example – confirm open office system): Ortronics or equal by Hubbell and Panduit or approved equal.

| Manufacturer | Part Number | Description |
|--------------|-------------|--------------------------------|
| Hubbell | FP4BBK | Modular Furniture Plate 4-Port |
| Ortronics | 40300633-00 | Modular Furniture Plate 4-Port |
| Panduit | CFFPL4BL | Modular Furniture Plate 4-Port |

D. Wall Adapter Plates for Open Office Furniture

1. Application: The wall adapter plate shall be used a method of concealing the opening in the wall for the cable routing to the open office furniture.
2. Configuration: Double gang, flat plates shall be stainless steel. Plates offering a bend radius form may be non-metallic or stainless steel
3. Manufactures; Arlington, Semtron or equal
 - a) Arlington #CER2 Non-metallic external radius split white plate
 - b) Semtron # WP805-2.00L Stainless steel split plate with 2" grommet hole
 - c) Semtron # 2-0L-2.00 Stainless steel plate with 2" grommet hole

E. Faceplate for industrial type applications.

1. Refer to Work Area Outlet schedule in the drawings for port quantity per outlet type.
2. Faceplate shall be by the same manufacturer as the connectors.
3. Faceplate shall include required accessories, such as icons, blank inserts, and labels.
4. Faceplate shall be Stainless Steel and have an insert label field.
5. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|---------------------------|
| Hubbell | SSFL12 | Stainless Steel SG 2-Port |
| Hubbell | SSFL14 | Stainless Steel SG 4-Port |
| Hubbell | SSFL16 | Stainless Steel SG 6-Port |
| Hubbell | SSFL29 | Stainless Steel DG 9-Port |
| Ortronics | 403STJ12 | Stainless Steel SG 2-Port |
| Ortronics | 403STJ14 | Stainless Steel SG 4-Port |
| Ortronics | 403STJ16 | Stainless Steel SG 6-Port |
| Ortronics | 403STJ28 | Stainless Steel DG 8-Port |
| Panduit | CFPL2SY | Stainless Steel SG 2-Port |
| Panduit | CFPL4SY | Stainless Steel SG 4-Port |
| Panduit | CFPL6SY | Stainless Steel SG 6-Port |
| Panduit | CFPL6S-2GY | Stainless Steel DG 8-Port |

F. Adapters for Surface Mounted Raceway Outlets (Wiremold 4000 Designer Series)

1. Application: Adapter / module insert shall be compatible with the surface raceway opening designated for telecom use. Refer to the Outlet Schedule of the Drawings for additional information.
2. Color shall match electrical device and/or cover plate.
3. Refer to the electrical drawings for raceway information.
4. Manufacturer: Wiremold or approved equal
 - a) Wiremold- ALDS4047MAB; Single Chanel MAB module insert for Wiremold "Open Systems" devices

G. Adapter Insert for Wiremold Floor Boxes

1. Application: Adapter / module insert shall be compatible with the floor box opening designated for telecom use. Refer to the Outlet Schedule of the Drawings for additional information.
2. Color shall match electrical device and/or cover plate.
3. Refer to the electrical drawings for floor box information.
4. Manufacturer: Wiremold or approved equal.

| Manufacturer | For Floor Box | Part Number | Description |
|--------------|---------------|---------------|------------------------|
| Wiremold | RFB4 | RFB4-LPB | Comm. Frame 3-Space |
| Wiremold | RFB11 | RFB119-AB | Comm. Frame 3-Space |
| Wiremold | RFB11 | RFB119-MAAP | Extron Adapter Frame |
| Manufacturer | For Floor Box | Part Number | Description |
| Wiremold | RFB11 | RFB119-SPACER | 7/8 in (69.8mm) Spacer |
| Wiremold | RFB11 | RFB119-SB | Single Gang Blank |
| Wiremold | RFB11 | RFB119-2SB | Double Gang Blank |
| Wiremold | RFB11 | RFB119-3SB | Triple Gang Blank |

2.6 CONNECTORS / MODULAR JACKS (OFFICE BUILDINGS)

A. Cat 6 / Modular Jacks;

1. Modular Jacks shall be 8-position 8-conductor modular 110, IDC type, shall be CAT 6 rated, and shall be intended for the termination of 4-pair UTP/shielded cables.
2. Connectors shall be by the same manufacturer as the faceplates and patch panels.
3. Modular Jacks shall be T568B wired.
4. Each Modular Jacks shall be installed with stuffer and dust caps.
5. Color shall match electrical device and/or cover plate.
 - a) Jacks used for HDMI applications shall be blue and green in color.
6. Manufacturers: Hubbell, Ortronics, Panduit or approved equal
 - a) Ortronics Tech Choice Jacks are NOT approved

| Manufacturer | Part Number | Description |
|--------------|-------------|----------------------------------|
| Hubbell | HXJ6** | NEXTSPEED 6 UTP Jack Module |
| Hubbell | SJ62B | NEXTSPEED 6 Shielded Jack Module |
| Ortronics | OR-TJ600 | Clarity 6 UTP Jack Module |
| Ortronics | OR-TJS600 | TracJack 6 Shielded Jack Module |
| Panduit | CJ688TG** | TX6 PLUS UTP Jack Module |
| Panduit | CJS688TGY | TX6 PLUS Shielded Jack Module |

B. S-Video / Modular Jacks;

1. Modular Jacks shall be 4-position 4-conductor modular 110, IDC type, and shall be intended for the termination of 4-pair UTP cables.
2. Connectors shall be by the same manufacturer as the faceplates.
3. Modular Jacks shall be 4-pin DIN to 110 termination.
4. Each Modular Jacks shall be installed with stuffer and dust caps.
5. Color shall match electrical device and/or cover plate.
6. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|-----------------------------|
| Hubbell | SFSV110 | S-Video Module 110 |
| Ortronics | OR-63700025 | S-Video TracJack Module 110 |
| Panduit | CJSV** | S-Video Mini-Com Module 110 |

C. RCA / Modular Jacks;

1. Modular Jacks shall be 4-position 4-conductor modular 110, IDC type, and shall be intended for the termination of 4-pair UTP cables.
2. Connectors shall be by the same manufacturer as the faceplates.
3. Modular Jacks shall be RCA to 110 termination.
4. Each Modular Jacks shall be installed with stuffer and dust caps.
5. Module color shall match electrical device and/or cover plate if possible.
 - a) Red insert shall be designated as right audio
 - b) White insert shall be designated as left audio
 - c) Yellow insert shall be utilized as composite video with the owners approval only
6. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|---|
| Hubbell | SFRC110R** | Red RCA Module 110 (Black bezel only) |
| Hubbell | SFRC110W** | White RCA Module 110 (Black bezel only) |
| Ortronics | OR-63700071 | Red RCA TracJack Module 110 |
| Ortronics | OR-63700070 | White RCA TracJack Module 110 |
| Panduit | CJRR** | Red RCA Mini-Com Module 110 |
| Panduit | CJRW** | White RCA Mini-Com Module 110 |

D. HD-15 Connectors;

1. Modular Jacks shall be 10-position 10-conductor modular type and shall be intended for the termination of 5 conductor Mini Coax cables.
2. Connectors shall be by the same manufacturer as the faceplates.
3. Connector shall screw terminal type connectors.
4. Color shall match electrical device and/or cover plate.
5. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|---|
| Hubbell | | |
| Ortronics | OR-60900375 | HD-15 with crimp pins |
| Panduit | CMD15HD**Y | HD-15 Mini-Com Module Screw (requires CHI2M**-X) for raceway/floor box applications |
| Panduit | CHD15HDS**Y | HD-15 Mini-Com Module Screw |

E. "BNC" Modular Coupler;

1. Modular Couplers shall be modular type and shall be intended for the termination of 75-ohm Coaxial cables.
2. Connectors shall be by the same manufacturer as the faceplates.
3. BNC Modular Coupler shall be Female to Female type.
4. Color shall match electrical device and/or cover plate. Black shall be used for patch panel applications.
5. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|--------------------------|-----------------------|
| Hubbell | SFB** | Xcelerator BNC Module |
| Ortronics | 63700023 | TracJack BNC Module |
| Ortronics | 60900018 | Series II BNC Module |
| Panduit | CMBA75**Y | Mini-Com BNC Module |

F. "F" Modular Coupler;

1. Modular Couplers shall be modular type and shall be intended for the termination of 75-ohm Coaxial cables.
2. Connectors shall be by the same manufacturer as the faceplates.
3. Modular Coupler shall be Female to Female type.
4. Color shall match electrical device and/or cover plate. Black shall be used for patch panel applications.
5. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|---|
| Hubbell | SF**L | Xcelerator Module, 75 ohm F |
| Ortronics | 60900073 | Series II Module, 75 ohm F |
| Ortronics | 63700006 | Tracjack Module, 75 ohm F |
| Panduit | CMFSR**Y | Mini-Com self-terminating module, 75 ohm F (faceplate only) |
| Panduit | CMF** | Mini-Com, 75 ohm F (patch panel only) |

G. 3.5mm Stereo Modular Connector;

1. Modular connector shall be modular type and shall be intended for the solder termination of the 2-conductor shielded audio cables.
2. Connectors shall be by the same manufacturer as the faceplates.
3. Modular connector shall be solder type.
4. Color shall match electrical device and/or cover plate.
5. Manufacturers: Hubbell, Ortronics, Panduit or approved equal

| Manufacturer | Part Number | Description |
|--------------|-------------|----------------------------|
| Hubbell | SF35SJ** | Modular Jack, 3.5mm solder |
| Ortronics | N/A | Feed Thru Only |
| Panduit | CM35MSC**Y | Mini-Com, 3.5mm solder |

2.7 ZONE PANEL ENCLOSURE

A. Ceiling Mount

1. Application: For use as an consolidation point for zone cabling (less panels and cabling)
2. Size: 23.5in H x 23.5in x 13.43in D (596.9mm x596.9mm x 341.1mm)
3. Plenum Rated: Yes, UL2043
4. Rack Mount Spaces: Min of 5U
5. Manufacturer: Panduit or equal
 - a) Panduit # PZICE 23.5in H x 23.5in x 13.43in D 5U Zone Panel Enclosure
 - b) Panduit #CICZCBRKT Optional mounting bracket to increase capacity to 9 rack units.

B. Wall Mount (Surface/Flush)

1. Application: For use as an consolidation point for zone cabling (less panels and cabling)
2. Size: 38.5in H x 27.92in W x 8.61in D (977.9mm x 709.2mm x 218.7mm)
3. Plenum Rated: No
4. Rack Mount Spaces: Min of 6U
5. Manufacturer: Panduit or equal
 - a) Panduit # PZAEWM3 38.5in H x 27.92in W x 8.61in D 6U Wall Mount

C. Wall Mount (Surface/Flush or Recessed)

1. Application: For use as an consolidation point for zone cabling (less panels and cabling)
2. Size 25.0in H x 14.5in W x 4.65in D (635.0mm x 368.3mm x 118.1mm)
3. Plenum Rated: No
4. Rack Mount Spaces: Min of 2U or four 100-pair punch down bases.
5. Manufacturer: Panduit or equal
 - a) Panduit # PZB4 25.0in H x 14.5in W x 4.65in D Wall Box (less door)
 - b) Panduit # PZB4-HC door for recessed applications (requires PZB4)
 - c) Panduit #PZB4-FC door for flush/surface mounted applications (requires PZB4)
 - d) Panduit # PZBPPB patch panel bracket (2U) for use with PZB4

D. Raised Floor Mount

1. Application: For use as an consolidation point for zone cabling (less panels and cabling)
2. Size 22.62in H x 22.62in W x variable D (575mm x 575mm x variable)
 - a) Unit shall fit into standard 24in x 24in (600mm x600mm) floor tile opening.
3. Plenum Rated: Yes UL2043
4. Rack Mount Spaces: Min of 4U.
5. Manufacturer: Panduit or equal
 - a) Panduit # PZRFE8 Size: 22.62in H x 22.62in W x 8.5in D 8 rack units (requires 9.5in of depth for proper mounting) less cover
 - b) Panduit # PZRFE12 Size: 22.62in H x 22.62in W x 12.0in D 12 rack units (requires 13in of depth for proper mounting) less cover
 - c) Panduit #PZRFC lockable cover for above.

2.8 FIBER OPTIC CONNECTORS

A. Multimode Fiber Optic Connectors – LC Type

1. Materials:
 - a) Ferrule: ceramic (zirconia or alumina) with pre-radiused finish/face.

- b) Connector housing: plastic.
- c) Connector shall have an integral strain relief feature, including a bend limiting rear boot.
- d) Connectors shall be aqua.
- e) Connectors shall be installable via either epoxy or anaerobic method.
- f) Manufacturer: Corning Cable Systems, or approved equal.
 - 1) #95-051-98-SP-X; LC connector, multimode 50/125.

B. Singlemode Fiber Optic Connectors – SC Type

- 1. Materials:
 - a) Ferrule: ceramic (zirconia or alumina) with pre-radiused finish/face.
 - b) Connector housing: plastic.
 - c) Connector shall have an integral strain relief feature, including a bend limiting rear boot.
 - d) Connectors shall be blue.
 - e) Connectors shall be installable via either epoxy or anaerobic method.
 - f) Manufacturer: Corning Cable Systems, or approved equal.
 - 1) #95-201-41-SP; SC connector, singlemode.

2.9 COAXIAL CONNECTORS

A. RG-6 “F” Connectors

- 1. Materials:
 - a) The RG-6 Coax cable shall be terminated with a Snap-N-Seal type “F” style connector.
 - b) Electrical Properties;
 - 1) Return loss: 30dB up to 1 GHz.
 - 2) Insertion Loss: -0.18 dB up to 1 GHz.
 - c) Connector shall have a Brass Nut and Collar.
 - d) Connector shall provide 360 deg. compression.
 - e) Minimum of 40 lb of Cable retention as specified by SCTE
 - f) Manufacturer: Belden or approved equal
 - 1) #SNS1P6U, Snap-N-Seal F connector (Contractor shall verify size to match cable used)

B. F Right Angle Adapter

- 1. Application: Right angle M-F short radius adapters are for use in raceways and faceplates where a straight connection would violate the bend radius of the series 6 coaxial cable.
- 2. Construction: M-F nickel plated adapter with screw threads
- 3. Manufacturer: Eagle, L-Com or approved equal
 - a) Eagle # COF90A
 - b) L-Com # BA123

C. RG-6 “BNC” Connectors

- 1. Materials:
 - a) The RG-6 Coax cable shall be terminated with a Snap-N-Seal type “BNC” style connector.
 - b) Electrical Properties;

- 1) Return loss: 30dB up to 1 GHz.
- 2) Insertion Loss: -0.2 dB up to 1 GHz.
- c) Connector shall have a Brass Nut and Collar.
- d) Connector shall provide 360 deg. compression.
- e) Minimum of 40 lb of Cable retention as specified by SCTE
- f) Manufacturer: Belden or approved equal.
 - 1) #SNS61PBNB, Snap-N-Seal BNC connector (Contractor shall verify size to match cable used)

D. LMR "400" Series Connectors

1. Materials:

- a) The RG-8 Wireless Broadband Coax cable shall be terminated with a SC-400-NM LMR-400 series Crimp style connector.
- b) Interface; N Male
- c) Straight plug
- d) Electrical Properties;
 - 1) VSWR: 2.5 GHz.
 - 2) Insertion Loss: -0.18 dB up to 1 GHz.
- e) Connector shall have a Knurl Coupling Nut.
- f) Attachment
 - 1) Inner Contact: Solder.
 - 2) Outer Contact: Crimp
- g) Manufacturer: Amphenol or equal by RF Industries, Hyperlink, Rosenberger, or Telegartner;
 - 1) Amphenol #82-6142-1000, N Male type "LMR-400 series Connector

2.10 PROCESS COMMUNICATION CONNECTORS

1. Profibus Connectors

- a) The following Profibus connectors are approved only for horizontal intra-building installations. Substitutions to the following connectors will NOT be accepted.
- b) Connector shall have an integral switch for either a resistor or isolating function.
- c) Connector shall be UL listed.
 - 1) 45 degree cable outlet (12 M Baud) PROFIBUS connector.
 - (i) Manufacture; Gridconnect
 - Part # GC-PB-EASY-45
 - MPN # PA003121
 - 2) 90 degree cable outlet (12 M Baud) PROFIBUS connector.
 - (i) Manufacture; Gridconnect
 - Part # GC-PB-EASY-RECT
 - MPN # PA003135
 - 3) 180 degree cable outlet (12 M Baud) PROFIBUS connector.
 - (i) Manufacture; Gridconnect
 - Part # GC-PB-EASY-180
 - MPN # PA003122
 - 4) PROFIBUS termination tool

(i) Manufacture; Siemens

- Part # 6GK 1905-6AA00

2.11 CATEGORY 6 BEP/PRIMARY PROTECTOR

- A. Application: For the primary (lightning) protection of category 6 cabling that is outside the cone of protection.
- B. Configuration: 4-Pair solid state
- C. Manufacturer: ITW Linx, L-COM, TTI Network/Porta Systems or equal

| Manufacturer | Part Number | Connection | UL497 Listed | PoE Approved |
|---------------------------|---------------|------------|--------------|--------------|
| ITW Linx | CAT6-LAN | 110 | Yes | No |
| L-COM | AL-CAT6PW | 110 | -- | No |
| L-COM | HGLN-CAT6-HP | Modular 8 | -- | Yes |
| Phoenix Contact | DT-LAN-CAT.6+ | Modular 8 | Surge only | Yes |
| TTI Network/Porta Systems | 606-18 | 110 | Yes | No |
| TTI Network/Porta Systems | 606-27 | 110 | Yes | No |
| TTI Network/Porta Systems | 606-65 | 110 | Yes | Yes |

2.12 UTP CATEGORY 6 PATCH/EQUIPMENT CORDS

- A. Patch/Equipment Cords shall meet/exceed ANSI/EIA/TIA-568-C2-1 Category 6 and ISO 11801 Class E Standards.
- B. Each Patch/Equipment Cord shall be factory assembled and tested.
- C. The 8P8C plug (RJ45) shall be plated with 50 micro inches of gold.
- D. The connector plug shall be of snag less design.
- E. Patch/Equipment Cords shall match the manufacturer of the work area outlet and jacks.
- F. Patch/Equipment Cords shall be of the same category rating as the highest grade component/cable in the permanent link.
- G. Manufacturer: Ortronics or equal by Hubbell and Panduit

| Manufacturer | Part Number | Length | Color | Application |
|-----------------------------|-------------|---------------------------|---------------|---|
| Panduit – or approved equal | UTPSP3Y | 3 feet (lengths may vary) | Blue | Process Control (ex. EQP, PPK, XA1 & XA2) |
| Panduit – or approved equal | UTPSP3BLY | 3 feet (lengths may vary) | Black | CCTV – P.O.E |
| Panduit – or approved equal | UTPSP3GRY | 3 feet (lengths may vary) | Green | Business LAN |
| Panduit – or approved equal | UTPSP3RDY | 3 feet (lengths may vary) | Red | Analog Phone |
| Panduit – or approved equal | UTPSP3YLY | 3 feet (lengths may vary) | Yellow | Visitor Internet |

2.13 LABELS

- A. Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer.
- B. Horizontal/Patch Cable Wrap Labels

1. Labels shall be adhesive backed and have a self-laminating feature.
2. Labels shall wrap around the cable's jacket.
3. Printable Area: size: 2 in x 0.5 in, minimum; color: white.
4. Manufacturer; or equal: Panduit.
 - a) Panduit #S200X150YAJ; laser/ink jet labels for cable diameters 0.16 in-0.32 in, white

C. Outlet Faceplate and Port Labels

1. Labels shall be supplied in 8.5 in x 11 in sheets of laser feed paper or use of hand-held printer.
2. Port labels shall fit above the port without overlap to the next port or to the port itself.
3. Manufacturer; or equal: Ortronics, Panduit or approved equal.
 - a) Ortronics #OR-70400411; "Equipment Room Identifier" label, for laser printer
 - b) Panduit # C195X040Y1J; Single gang insert label
 - c) Panduit # C288X040Y1J; Double gang insert label
 - d) Panduit # C261X035Y1J; For modular furniture adapter plates
 - e) Panduit # C125X030FJJ; For 2-port surface mount box
 - f) Panduit # C252X030FJJ; For 4-port surface mount box
 - g) Panduit # C379X030FJJ; For 6 and 12-port surface mount box

D. Patch Panels

1. Labels shall be supplied in 8.5 in x 11 in sheets of laser feed paper or use of hand-held printer.
2. Labels shall fit above the port without overlap to the next port or to the port itself.
3. Printable Area: size: 0.61 in x 0.33 in, minimum; color: white.
4. Manufacturer; or equal: Panduit.
 - a) Panduit # C379X030FJJ; laser labels for modular patch panels, white

E. Modular Patch Panels

1. Labels shall be supplied in 8.5 in x 11 in sheets of laser feed paper or use of hand-held printer.
2. Labels shall fit above the port without overlap to the next port or to the port itself.
3. Printable Area: size: 0.61 in x 0.33 in, minimum; color: white.
4. Manufacturer; or equal: Ortronics.
 - a) Ortronics #OR-70400408; laser labels for modular patch panels, white
 - b) Panduit # C252X030FJJ; laser labels for modular patch panels, white

F. Modular 12-Port 89D Style Patch Panels

1. Labels shall be supplied in 8.5 in x 11 in sheets of laser feed paper or use of hand-held printer.
2. Labels shall fit above the port without overlap to the next port or to the port itself.
3. Manufacturer; or equal: Panduit.
 - a) Panduit # C261X030FJJ; laser labels for modular patch panels, white

G. 110 Termination Block Labels

1. Color: Blue for horizontal termination field.

2. Manufacturer, or equal: Panduit
 - a) Panduit #C750X050Y1J for standard 110-blocks
 - b) Panduit # C788X050Y1J for Panduit Giga Punch Series

2.14 MISCELLANEOUS COMPONENTS

A. Hook and Loop Cable Wraps

1. Width: .75 in (19 mm).
2. Color: Black
3. Approved for air-handling spaces: No
4. Manufacturer, or equal: Panduit
 - a) #HLS-15R-0 Black, 15 ft (4.6 m) roll, cut to length.

B. Hook and Loop Cable Wraps Plenum Rated

1. Width: .75 in (19 mm).
2. Color: Maroon
3. UL Listing: UL 94V-2
4. Approved for air-handling spaces: Yes
5. Manufacturer, or equal: Panduit
 - a) Panduit - HLSP1.5S-X12 Maroon 6 in (152 mm) long (100 pack)
 - b) Panduit – HLSP3S-X12 Maroon 12 in (305 mm) long (100 pack)
 - c) Panduit - HLSP5S-X12 Maroon 18 in long (457 mm) (100 pack)

PART 3 EXECUTION

3.1 GENERAL

- A. Comply with the Execution requirements of Section 27100
- B. Install products, components, accessories, hardware, etc, according to the manufacturer's instructions.

3.2 EXAMINATION

- A. Pathways: Prior to installation, verify pathways are complete and ready for cables.
- B. Equipment Rooms: Prior to installation, verify equipment rooms are complete and ready for cables.

3.3 INSTALLATION

A. Horizontal Cable (Category 6)

1. General
 - a) Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
 - b) Maintain maximum cable length of 295 ft (90m) from the termination in the Telecommunications Room to the termination at the outlet.
 - c) A cable bundle shall contain no more than 24 individual cables.
2. Color:
 - a) Provide Pink plenum cables for plenum areas.
 - b) Provide Blue non-plenum cables for non-plenum areas.
 - c) Provide Black gel-filled for OSP installations.

- d) Provide Yellow plenum ScTP/Shielded cables for required installations.

3. Installation

- a) Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
- b) Maintain pulling tension within manufacturer's limits.
- c) Protect cable during installation. Replace cable if damaged during installation.
- d) Place cables with no kinks, twists, or impact damage to the sheath.
- e) Place and suspend cables in a manner to protect them from physical interference or damage.

4. Routing

- a) When routing horizontally within Telecommunications Room, utilize the overhead cable support. When routing vertically within Telecommunications Room, fasten the cable bundles using approved Velcro cable ties to the wall-mounted vertical cable support every 24 in (610 mm) on center.
- b) Route cables a minimum of 6 in (152 mm) away from power sources to reduce interference from EMI.
- c) When routing cables in areas without primary horizontal pathways, install cables onto secondary pathways or approved support devices, such as cable hangers (J-hooks).
- d) Route cables at 90-degree angles, allowing for bending radius along corridors for ease of access. Do not route through an adjacent space if a corridor borders at least one wall of the room. All cables shall be routed through corridors whenever possible.
- e) Provide a 10 ft (3 m) (minimum) sheathed cable service loop in the Telecommunications Room, Place the service in the overhead cable support.
- f) Provide 12 in (305 mm) (minimum) of sheathed cable service loop in the accessible ceiling space above each work area outlet faceplate. Place cable in ceiling space before the device conduit stub supported from a cable hanger or on the device conduit stub fastened with hook and loop with the appropriate rating (plenum or non-plenum), in accordance with the cabling manufacturer's installation standards.
- g) At the equipment bay in the Telecommunications Rooms where floor-standing racks and cabinets are used, divide horizontal cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination on the patch panel. At the equipment bay in the Telecommunications Room where wall-mounted racks are used, route the horizontal cables down the hinged side of the equipment rack.

5. Termination

- a) Properly (per manufacturer's instructions and TIA/EIA-568-C standard installation practices) strain relieve cables at termination points.
- b) Terminate pairs on the specified connecting hardware. Perform terminations in accordance with manufacturer's instructions and TIA/EIA-568-C standard installation practices.

B. Patch Panels and Horizontal Management Panels

1. Provide specified patch panels in a quantity to allow termination of data cables served from respective MC and TR locations.
2. Install all patch panels and horizontal management panels in the configuration as shown on the Drawings. Install panel's level.
3. Contractor shall install all stuffer caps on terminated ports. All remaining non-installed caps shall be returned to the Owner.

C. Patch/Equipment Cords

1. Provide and install per patching schedule all required patch and equipment cords.
 - a) Note: Patching schedule may not be required per project verify with owners rep.
2. Utilize horizontal and vertical cable management panels.
3. Maintain 1 in (25 mm) bend radius at all times.
4. Patch cords shall not route past the midpoint of a rack/cabinet.
 - a) i.e. Patch cords routed from the left vertical wire manager shall service the first 12 ports of a 24-port patch panel. Patch cords routed from the right side shall service ports 13-24 of a 24-port patch panel.

D. Outlet Faceplates

1. Install faceplates plumb, square, and at the same level as adjacent device faceplates.
2. Patch gaps around faceplates so that faceplate covers the entire opening.
3. For surface raceway, color shall match electrical device and/or cover plate.
4. Outlet Modular Connectors
 - a) Terminate pairs on the specified modular connector. Perform terminations in accordance with manufacturer's instructions and TIA/EIA-568-C standard installation practices.
 - b) Replace terminations and connectors not passing the required media test.
 - c) Provide blank fillers for all unused openings.

E. Building Entrance Protector

1. Install BEP in a suitable location in a non-hazardous location in close proximity to a TMGB/TGB.
2. Terminate protector module in accordance with industry standards and manufacture instructions.
 - a) Bond protector to an approved busbar.

3.4 AV Cabling/Terminations**A. HD15:**

1. Provide shrink tube or other means of insulating the shields from each other and from the drain wire (cable shield).
 - a) Electrical or other forms of tape are NOT considered as an appropriate means of insulating the shields.
 - b) Heat shrink tubing is highly suggested.
 - 1) Do NOT tin the conductors when inserting into a screw terminal
 - 2) Ensure that the cable clamp on the connector is fully open (counter clockwise) prior to inserting the conductors. Tighten the cable clamp (clockwise) to secure the conductors.
 - 3) Follow all manufacturers' instructions.

B. 3.5mm Stereo:

1. Solder all terminations with a low wattage soldering iron being careful with the amount of heat applied to the connector.
2. Provide a means of insulating the conductors to ensure that there are no shorts.
 - a) Electrical or other forms of tape are NOT considered as an appropriate means of insulating the shields.

- b) Heat shrink tubing is highly suggested.

C. RCA:

1. Strip the UTP cable with the appropriate tool.
 - a) Follow the established color code on the connector.
 - b) Terminate cables with an appropriate punch down tool.

D. Coaxial:

1. Strip the cable in accordance with the manufactures instructions.
 - a) Use an approved tool being careful not to cut the braid/foil shield
 - b) Utilize the appropriate compression tool to install the connectors

3.5 Zone Panel Enclosure

A. Wall Mount

1. Install wall mount enclosures plumb and square at the height detailed on the drawings
2. Route cables via conduit through provided knockouts.
3. All equipment and system components mounted to walls, ceilings, floors etc., will require approved seismic restraints, in accordance with, requirements established for the Project.
4. Provide products and components in accordance with seismic requirements. Provide supporting documentation from the manufacturer.

B. Ceiling Mount

1. Install ceiling mounted zone panel enclosures level to the ceiling grid.
2. Support enclosure independently of grid in accordance with code and manufacturer mounting instructions.
3. Coordinate with ceiling tile contractor for location and the insertion of a tile onto the door of the panel.
4. All equipment and system components mounted to walls, ceilings, floors etc., will require approved seismic restraints, in accordance with, requirements established for the Project.
5. Provide products and components in accordance with seismic requirements. Provide supporting documentation from the manufacturer.

3.6 INSTALLATION - PROFIBUS

A. Terminating

1. When terminating Profibus cabling this ontactor shall utilize ONLY the Siemens striping tool.
2. Provide all required tools, consumables and accessories for a complete and operational connection.
3. Properly strain relieve cables at termination points.
4. Terminate conductors on the specified connecting hardware.
5. Perform termination in accordance with the manufactures instructions and standard installation practices.

B. Training

1. To become eligible to terminate PROFIBUS cabling on HSC property, this contractor will be responsible to become HSC PROFIBUS trained.
2. All personal terminating PROFIBUS cabling shall be required to attend HSC sponsored PROFIBUS training. Training will require approximately 15 minutes.

3.7 LABELING

A. General Requirements

1. Labeling, identifier assignment, and label colors shall conform to TIA/EIA-606-A Administration Standard and as approved by Owner's Representative before installation.
2. Labels shall be permanent with machine-generated text; hand-written labels will not be accepted.

B. Label Formats**1. Horizontal Cable Labels**

- a) Text Attributes:
 - 1) Black,
 - 2) 1/8 in (3 mm) high, minimum, or #12 font size.
 - 3) Font: Verdana preferred, or SansSerif or Arial acceptable.
- b) Install labels on both ends of cables no more than 4 in (101.6 mm) from the edge of the cable jacket. Install labels such that they are visible by a technician from a normal stance.

2. Patch Panel Labels

- a) Use modular patch panel labels included in the product packaging. (Approval by the Owner shall be required for other labels.)
- b) Use a label color for the respective field type, per TIA/EIA-606.
- c) Text Attributes: Black, 3/32 in (2.3 mm) high, minimum, or #10 font size.

3. Outlet Labels

- a) Text Attributes: Black, 1/8 in (3 mm) high, minimum, or #12 font size.
- b) Provide an "Equipment Room Identifier" label at the top of the faceplate with the serving telecommunication room's identifier (refer to plans for telecommunication room identifier assignment).
- c) Provide a "Unique Cable Number" label above each port with the link's unique cable number.
- d) Refer to construction drawing floor plans for port identifiers.

C. Identifier Assignment

1. General: Separate label fields of the identifier with a hyphen.

D. Horizontal Cables / Cabling Link

1. First field shall identify the originating termination cabinet/rack location identifier as shown on the plans; for example, "MC".
2. Second field shall identify the cabinet within the communications room; for example the second cabinet in the room would be, "B".
3. Third field shall identify the ending termination Room identifier as shown on the plans; for example the room the Work Area Outlet is located in, "A101".
4. Fourth field of the identifier shall be the cable type identifier; for example, "FOxxxx"
 - a) UTP (Blank): "Uxxx"
 - b) Single Mode Fiber: "FOSxxx"
 - c) Multi Mode Fiber: "FOMxxx"
 - d) Coax Cable; "COxxx"
5. Fifth field of the identifier shall be the patch panel port number; for example, "024"
 - a) Example: "MCB-A101-U024"

E. Outlet Ports

1. The outlet ports shall be identical to the unique cable number.

F. Modular Patch Panel Ports

1. The modular patch panel ports shall be identical to the unique cable number.
2. Assign each cable a unique number, in ascending order beginning with the number 1.

G. Zone Panel Enclosure Label Requirements: Provide a label on the metal portion of the door.

1. Permanently affix label plate and position the label plate in an aesthetically pleasing location on the exterior metal portion of the door.
 - a) The label shall be readable from the floor with the technician standing at a normal stance.
2. Lamicoid label shall be 11in x 2in with black 1in characters on a white background

3.8 INSPECTION AND ADJUSTMENTS

- A. Comply with Inspection and Adjustments requirements of Section 27100, 3.04

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. Section Includes: Bonding telecommunications infrastructure, devices and equipment to Telecommunications Grounding and Bonding System.

1.2 REFERENCES

- A. Comply with the References requirements of Section 27100.
- B. See section 27900 for testing requirements.
- C. Reference SSG's;
 - 1. 27.800.002.001 Communications Ground System one-line Diagram
 - 2. 27.800.002.002 Communication Conduit Grounding and Torque Detail
 - 3. 27.110.002.001 Communications Equipment Cabinet Detail Arrangement
 - 4. 27.100.002.002 General Administration and Labeling Detail
- D. In addition to those codes, standards, etc., listed in Section 27100, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. NFPA 70, National Electric Code:
 - a) Chapter 8: Communications Systems
 - b) Article 250: Grounding
 - 2. Underwriters Laboratories, Inc. (UL) UL 467: Grounding and Bonding Equipment
 - 3. TIA/EIA, J-STD-607-A; Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
 - 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a) IEEE 467: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - b) IEEE P1100: IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems

1.3 DEFINITIONS

- A. Definitions as described shall apply to this section.
- B. In addition, the following list of terms as used in this specification shall be defined as follows:
 - 1. "ACEG": Alternating Current Equipment Ground.
 - 2. "BC": Bonding Conductor.
 - 3. "TBB": Telecommunications Bonding Backbone.
 - 4. "TBC": Telecommunications Bonding Conductor.
 - 5. "EF": Entrance Facility.
 - 6. "ER": Equipment Room.
 - 7. "BBC": Backbone Bonding Conductor.
 - 8. "GEC": Grounding Electrode Conductor.
 - 9. "SBB": Secondary Bonding Busbar.
 - 10. "PBB": Primary Bonding Busbar.
 - 11. "RBB": Rack Grounding Busbar
 - 12. "MC": Main Cross-connect.

13. "TR": Telecommunications Room.

1.4 SYSTEM DESCRIPTION

A. Telecommunications Grounding and Bonding System – Provided for under a separate contract.

1. Refer to Electrical Division 16020 "Grounding and Lighting Protection" for further information regarding the Telecommunications Grounding Backbone system.
2. The Telecommunications Grounding and Bonding System contain grounding bus bars, grounding conductors, bonding conductors, and connecting devices (including but not limited to pressure connectors, lugs, clamps, or exothermic welds). These components provide a low impedance path to ground for stray voltages or spurious signals present on telecommunications media and equipment.
3. PBB: Primary Bonding Busbar The PBB is located in the Entrance Facility (EF) Room or Main Cross-connect (MC) location. The PBB shall be connected to the following:
 - a) Overhead cable tray within the room, via TBC.
 - b) Ground bushings installed on each entrance conduit within the Entrance Facility, via TBC.
 - c) Dedicated power panels within the Entrance Facility serving telecommunication equipment, via TBC.
 - d) Each TBB.
4. TBB: Telecommunication Bonding Backbone TBBs originates in EF or MC, and routed to each Telecommunications Room (TR) location with a connection to each SBB.
5. SBB: Secondary Bonding Busbar a SBB exists in each of the TR locations.

1.5 BASE BID WORK

- A. Provide labor, materials and equipment necessary to bond telecommunications infrastructure devices and equipment to Telecommunications Grounding and Bonding System.
- B. BC's within each telecommunications room from the PBB or SBB's to the following components:
 1. Equipment Rack or Cabinet to PBB/SBB.
 2. Overhead cable support to PBB/SBB.
 3. Ground bushings installed on each conduit opening within the space if conduit is provided by Contractor to PBB/SBB.
 4. Phone systems and/or network electronics to PBB/SBB
- C. Bonding jumpers between cable basket and cable raceway joints and splices, and between overhead cable support and equipment racks.
- D. Provide shield bond connectors on all shielded cables susceptible to stray voltages per the NEC and NESC.

PART 2 PRODUCTS

2.1 BONDING CONDUCTORS

- A. Construction of the TBC (Telecommunications Bonding Conductor) and Grounding/Earthing System
 1. Avoid routing grounding/earthing conductors in metal conduits.
 2. If the grounding/earthing conductor must be routed through a metal conduit, bond each end of the conduit to the grounding/earthing conductor.
 3. Use a #6 AWG copper conductor to connect the grounding clamp.
 4. In telecommunications spaces with a small number of racks or cabinets, it may be most convenient to bond the grounding/earthing jumper cable directly to the PBB.

5. Larger spaces require a mesh Common Bonding Network.

| CABLE SIZES FOR OTHER GROUNDING/EARTHING APPLICATIONS NOT SPECIFICALLY DESCRIBED ELSEWHERE IN THIS DOCUMENT | |
|--|---|
| PURPOSE | COPPER CODE CABLE SIZE |
| Aisle grounds (overhead or under floor) of the common bonding network | #1/0 |
| Bonding conductor to each PDU or panel board serving the room. | Size per NEC 250.122 & manufacturer recommendations |
| Bonding conductor to HVAC equipment | #6 AWG |
| Building columns | #4 AWG |
| Cable ladders and trays | #6 AWG |
| Conduit, water pipe, duct | #6 AWG |
| ESD Floors | #6 AWG |

B. TBB (Telecommunications Bonding Backbone)

1. The gauge of the connecting ground/earth cable, known as the Telecommunications Bonding Backbone (TBB) will follow NEC 800.100 guidelines.
2. Route the TBB to each SBB in as straight a path as possible.
3. The TBB should be installed as a continuous conductor, avoiding splices where possible.
4. When more than one TBB is used, bond them together using the SBB's on the top floor and every third floor in between with a conductor known as a "Backbone Bonding Conductor" (BBC).

C. BC (equipment Bonding Conductor)

1. Conductor: #6 AWG stranded copper.
 - a) For distances longer than 25 ft (7.6m), conductors should be calculated for a size that to the guidelines set by the NEC.
2. Insulation: Low-smoke, green in color. The following shall be printed on the conductor's jacket: insulation grade, conductor gauge, and applicable UL jacket listings.
 - a) Type THHN, or approved similar.

D. Bonding Straps for Cable Basket, Cable Runway, and/or Cable Tray

1. Conductor: Flexible braided straps with factory terminated connectors.
2. Utilize the equivalent of a 2/0 conductor for all primary cable tray runs.
3. Utilize the equivalent of a #6 AWG conductor for all secondary or branch cable tray runs.

2.2 CONNECTORS

A. General: Connectors shall be UL listed.

B. Cable Shield Bond Connector.

1. Manufacture: 3M, or Equal
 - a) #4460-D; for cables 100 pair or less
 - b) #4406-D/FO; for fiber cables 0.80 in (20mm) or less in diameter

C. Cabinet/Rack Rail Grounding Strip.

1. Manufacture: Panduit, or Equal

- a) #RGS134-1Y; 78.65in (2m) Long x 0.67in (17mm) wide x 0.05in (1.27mm) (thick with EIA universal mounting hole pattern for threaded rails.
- b) #RGS134B-1; 78.70in (2m) Long x 0.67in (17mm) wide x 0.05in (1.27mm) thick with EIA universal mounting hole pattern for use with cage nut style rails.

D. Cabinet/Rack Horizontal Grounding Strip.

1. Manufacture: Panduit, or Equal

- a) #RGRB19U; 19 in (483mm) Long grounding bus bar with (20) holes mounted between the 19 in (483mm) rails.

E. BC-To-SBB/PBB Connection

1. Lug, two-hole standard barrel compression lug.

2. Manufacturer: Panduit, or equal:

- a) #LCC6-14AW-L; two holes (1/4 in (6.3mm) dia. x 5/8 in (16mm) on center) standard barrel lug for #6 AWG conductor.

F. TBB-To-SBB/PBB Connection

1. Lug, two-hole standard barrel compression lug.

2. Manufacturer: Panduit, or equal:

| Part Number | Conductor Size | Stud Hole Size | Stud Hole Spacing |
|---------------|----------------|----------------|-----------------------|
| LCC6-14AW-L | #6 AWG | 1/4" (6.3mm) | 5/8" (16mm) on center |
| LCC6-38DW-L | #6 AWG | 3/8" (9.5mm) | 1" (25mm) on center |
| LCC4-14AW-L | #4 - #3 AWG | 1/4" (6.3mm) | 5/8" (16mm) on center |
| LCC4-38DW-L | #4 - #3 AWG | 3/8" (9.5mm) | 1" (25mm) on center |
| LCC2-14AW-Q | #2 | 1/4" (6.3mm) | 5/8" (16mm) on center |
| LCC2-38DW-Q | #2 | 3/8" (9.5mm) | 1" (25mm) on center |
| LCC1/0-14AW-X | 1/0 AWG | 1/4" (6.3mm) | 5/8" (16mm) on center |
| LCC1/0-38DW-X | 1/0 AWG | 3/8" (9.5mm) | 1" (25mm) on center |
| LCC2/0-14AW-X | 2/0 AWG | 1/4" (6.3mm) | 5/8" (16mm) on center |
| LCC2/0-38DW-X | 2/0 AWG | 3/8" (9.5mm) | 1" (25mm) on center |
| LCC3/0-38DW-X | 3/0 AWG | 3/8" (9.5mm) | 1" (25mm) on center |

G. BC-To-Continuous Conductor Connection

1. HTAP, Parallel and Multiple tap connections on Code and Flex conductors.

2. Wire strand type and size;

a) Run;

- 1) Code: #2 to #6 AWG, STR/SOL
- 2) Flex: #2 to #8 AWG

b) Tap #1;

- 1) Code: #2 to #6 AWG
- 2) Flex: #2 to #6 AWG

3. Manufacturer: Panduit, or equal:

- a) #HTCT2-2-1; Tap connector for #6 AWG.

H. BC-To-Equipment Rack Connection

1. Lug, Two-hole standard barrel compression lug with paint piercing ground washer kit.

2. Manufacturer: Panduit, or equal:

- a) #LCC6-14AW-L; Two hole (1/4" (6.3mm)) standard barrel compression lug for #6 AWG.
- b) #RGW-12-1, 3/8" (9.5mm) stud size, .875 O.D. provided with antioxidant.

2.3 BUSBAR

A. Tin plated high conductivity UL 467 listed bus bar with brackets and standoff insulators.

1. PBB 1/4 in (6.3mm) X 4 in (101.6) X length as required)
 - a) Manufacturer: Panduit, or equal:
 - 1) GB4B0624TPI-1; 1/4 in (6.3mm) X 4 in (101.6mm) X 20 in (508mm) with 24 1/4 in (6.3mm) holes on 5/8 in (16mm) centers and 6 3/8 in (9.5mm) holes on 1 in (25mm) centers.
 - 2) GB4B0632TPI-1; 1/4 in (6.3mm) X 4 in (101.6mm) X 24 in (610mm) with 28 1/4 in (6.3mm) holes on 5/8 in (16mm) centers and 10 3/8 in (9.5mm) holes on 1 in (25mm) centers.
 - b) Manufacturer: Harger, or equal:
 - 1) TGBI14420TMGB; 1/4 in (6.3mm) X 4 in (101.6mm) X 20 in (508mm) with 24 1/4 in (6.3mm) holes on 5/8 in (16mm) centers and 6 3/8 in (9.5mm) holes on 1 in (25mm) centers.
 - 2) TGBI14424TMGB; 1/4 in (6.3mm) X 4 in (101.6mm) X 24 in (610mm) with 28 1/4 in (6.3mm) holes on 5/8 in (16mm) centers and 10 3/8 in (9.5mm) holes on 1 in (25mm) centers.
2. SBB 1/4 in (6.3mm) X 2 in (51mm) X length as required)
 - a) Manufacturer: Panduit, or equal:
 - 1) G2B0312TPI-1; 1/4 in (6.3mm) X 2 in (51mm) X 20 in (508mm) with 12 1/4 in (6.3mm) holes on 5/8 in (16mm) centers and 3 3/8 in (9.5mm) holes on 1 in (25mm) centers.
 - 2) GB2B0314TPI-1; 1/4 in (6.3mm) X 2 in (51mm) X 24 in (610mm) with 14 1/4 in (6.3mm) holes on 5/8 in (16mm) centers and 5 3/8 in (9.5mm) holes on 1 in (25mm) centers.
 - b) Manufacturer: Harger, or equal:
 - 1) TGBI14212TGB; 1/4 in (6.3mm) X 2 in (51mm) X 12 in (305mm) with 6 1/4 in (6.3mm) holes on 5/8 in (16mm) centers and 3 3/8 in (9.5mm) holes on 1 in (25mm) centers.

2.4 MISCELLANEOUS

A. Wire Clamp

1. Material: nylon, UV stabilized.
2. Color: black
3. Size: 0.25 in (6.3mm) holding diameter for 6 AWG; or size as required based on conductor size.
4. Manufacturer, Richco Inc or equal:
 - a) #N-4B-UVB; clamp for 6 AWG.

PART 3 EXECUTION

3.1 GENERAL

A. Comply with the Execution requirements of Section 27100 Part 3.

3.2 EXAMINATION

A. Examine existing Telecommunications Grounding Backbone system prior to the start of work within this section. The Telecommunications Contractor is solely responsible to ensure work

proposed within this section is fully compatible, in the opinion of the Engineer, with the existing Telecommunications Grounding Backbone system.

- B. Contractor shall inspect, verify and service the existing service entrance ground "EF" at the "ER" or "MC", cleaning, labeling, re-tightening, or re-installation of all connections as required.
- C. Contractor shall verify that all other electrical system grounds, structural building steel and metallic piping systems are bonded together. This is a requirement of the project electrical contractor and should be already accomplished. Refer discrepancies to the Owner for resolution. This contractor will not be required to perform major ground system repairs as a part of this contract.

3.3 INSTALLATION

- A. Contractor shall provide all grounding hardware from telecommunication conduit, cable tray, cable runway, equipment racks, cable shields, and other metallic telecommunication infrastructure components to the nearest PBB/SBB as shown on Drawings.
- B. Telecommunication Bonding Conductors
 - 1. Refer to Construction Drawings for Bonding Conductor sizing. If not shown, size BCs to the latest version of the NEC article 250 and NEC 800.
 - 2. Install BCs in a manner that will protect them from physical and mechanical damage.
 - a) The use of non-metallic conduit is suggested where appropriate.
 - 3. Routing:
 - a) Route BCs in the shortest possible path, using right-angles for turns and routed parallel to building lines.
 - b) Maintain a minimum 1-ft (0.3m) bend radius at all times.
 - 4. At PBB/SBBs:
 - a) Thoroughly clean non electro tin-plated Busbar prior to fastening the conductors, bolts, or connectors to the Busbar.
 - b) Attach lugs to Busbar with appropriate size stainless steel bolt, flat washer and Belleville washer.
 - c) Torque connections to manufactures specifications.
 - d) Typical torque for a ¼ in (6.3mm) stainless steel bolt is approximately 75 foot pounds. The 3/8in (9.5mm) stainless steel bolt is approximately 238 foot pounds.
 - e) Permanently label all PBB/SBB. Affix label as close as practical to each grounding bus bar. The label shall read "IF CABLE OR CONNECTOR IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE PLANT TELECOMMUNICATIONS MANAGER".
- C. Equipment Rack/Cabinet & Overhead Cable Support Bonding
 - 1. Refer to Drawings and SSG 27.110.002.001 for detailed diagrammatic requirements for equipment Rack/Cabinet bonding.
 - 2. Equipment Rack/Cabinet: Bond equipment racks, frames, frame bays, cabinets, server racks, and other similar support systems located within the same room or space as the PBB/SBB to the Busbar.
 - a) Each cabinet shall be individuality grounded to the local PBB/SBB. At no time shall multiple cabinets be grounded in series.
 - b) Install cabinet bonding kits to bond all parts of the cabinet together.
 - 3. Overhead Cable Support:
 - a) Bond overhead Cable-tray/Raceways located within the same room or space as the PBB/SBB to the Busbar.

- b) Provide “grounding kit” (straps & connectors) to bond sections of cable runway for ground continuity. This requirement shall apply to sections of cable runway within a single communication room.
 - c) Provide “equipment jumper kits” (#6 jumpers and connectors) to bond all contractor installed equipment for ground continuity. This requirement shall apply to all equipment whether installed on the backboard or in the equipment rack/cabinet within a single communication room.
4. BEP (Building Entrance Protectors)
- a) Bond each BEP individually to the PBB/SBB ensuring that the bus bar has a BCT connection with a minimum of a 6AWG wire.
 - b) Bond the armor or shields of all cables to the PBB/SBB.

3.4 LABELING

A. General Requirements

- 1. Labeling and identifier assignment shall conform to TIA/EIA-606-A Administration Standard and as approved by Owner’s Representative before installation.
- 2. Permanently label all bonding conductors. Affix label as close as practical to each end of the conductor.

B. Label Format

- 1. Labels shall be permanent with machine-generated text; hand written labels will not be accepted.
- 2. Labels on BC’s shall fully wrap around conductors with a self-laminating feature to provide permanent marking.

C. Identifier Assignment

- 1. Separate label fields of the identifier with a hyphen.
- 2. TBC:
 - a) First field: “TBC” (the Telecommunication Bonding Conductor type).
 - b) Second field: The room identity where TBC exists; for example: “B01-TRA”.
 - c) Third field: A unique sequential number; for example: “01”, “02”, etc.
 - d) Example: “TBC–B01-TRA–01”

3.5 RECORDS

- A. Communication Bonding System records shall conform to TIA/EIA-606-A Administration Standards. Each component shall have as a minimum, the information as outlined in 6.2.3 and 6.2.4 of TIA/EIA-606-A
- 1. Record final torque readings of all lugs on the bus bar.

END OF SECTION

PART 1 GENERAL**1.1 SUMMARY**

- A. Section Includes: Testing of Telecommunications Backbone and Horizontal Cabling subsystems.

1.2 RELATED SECTIONS

- A. Consult all other Sections and Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to completely test a complete and operable system.
 - 1. Section 27100 – Low Voltage Communications Cabling Practices
 - 2. Section 27150 – Communications Horizontal Cabling
 - 3. Section 27130 – Communications Backbone Cabling
 - 4. Section 27800 – Grounding and Bonding of Communications Systems
- B. Consult the following Engineering sections when required by owner.
 - 1. Section 27213 - (Engineering section) Data Communications - Wireless
 - 2. Section 27410 – (Engineering section) Audio & Video Systems
 - 3. Section 27420 – (Engineering section) CATV Distribution
 - 4. Section 27519 – (Engineering section) Sound Masking Systems
- C. Products Furnished and Installed Under Other Sections:
 - 1. Process Communications Cabling

1.3 REFERENCES

- A. Comply with Section 27100 References requirements. Additional references to those listed in Section 27900.
 - 1. NFPA 70, "National Electrical Code" (NEC)
 - 2. TIA/EIA-526-14 ("OFSTP-14") Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
 - 3. TIA/EIA-526-7 ("OFSTP-7") Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant
 - 4. TIA/EIA-455-171 Attenuation by Substitution Measurement – For Short-Length Multimode Graded-Index And Single-Mode Optical Fiber Cable Assemblies (a.k.a., FOTP-171)
 - 5. EIA IS-132, Cable Television Channel Identification Plan
 - 6. Code of Federal Regulations, Title 47 – Telecommunication Chapter 1 – Federal Communications Commission Subchapter C – Broadcast Radio Services 1. Part 76 – Cable Television Service
 - 7. Telecommunications Distribution Methods Manual (TDMM) 13th Edition.
 - 8. Customer-Owner Outside Plant Design Reference Manual (COSPDM) 5th Edition.

1.4 DEFINITIONS

- A. Refer to Definitions of Sections 27100, 27150, 27130.
- B. In addition, the following list of terms as used in this specification shall be defined as follows:
 - 1. "Adapter" (associated with fiber connectivity): Shall mean a mechanical device designed to align and join two optical fiber connectors (plugs) to form an optical connection.
 - 2. "Channel": Shall mean a testing configuration which includes the Permanent Link and the line cord (at the workstation), the equipment cord, and, if a full cross-connection is implemented, a patch cord and the cross-connect termination/connecting apparatus.

3. "Connect": Shall mean install all required patch cords, equipment cords and cross-connect wire, etc. to complete an electrical or optical circuit.
4. "Connections": Shall mean the joint made by two mating optical fibers terminated with remateable connectors (e.g., LC, SC, etc) also known as a "Mated Pair".
5. "Cord": Shall mean a length of cordage having connectors at each end. The term "Cord" shall be synonymous with the term "Jumper". The cord may be:
 - a) Unshielded twisted pair
 - b) Fiber (multimode or singlemode), jacketed & buffered
6. "Launch Cord": Shall mean the cord certified for use in fiber optic characterization testing, as described in this section.
7. "OTDR": Shall mean Optical Time Domain Reflectometer.
8. "Passive Link Segment": Shall mean the cable, connectors, couplings, and splices between two fiber optic termination units.
9. "Permanent Link": Shall mean the 'permanent' portion of the Horizontal cabling to each outlet with the test cords de-embedded from the measurements; this includes cable, consolidation point (if used), termination/connecting apparatus in the MC/TR and the connector at the outlet.
10. "System Cord": Shall mean the cord used in the operating electrical or optical circuit.
11. "Test Cord": Shall mean the cord certified for use in testing, as described in this section.
12. "CATV" Community Antenna or Cable Television system. In the HSC context it is a private distribution system fed through a variety of different inputs or channels.
13. "dB" is a logarithmic unit that indicates the ratio of a physical quantity (usually power or intensity) relative to a specified or implied reference level. Used in both optical fiber and RF signal measurements.
14. "dBmv" is a unit of measure dB-millivolts usually expressed as dBmv/m or dB-millivolts per meter.
15. "WAP": Wireless Access Point
16. "WLAN": Wireless Local Area Network
17. "EMI": Electromagnetic Interference

1.5 SYSTEM DESCRIPTION

A. Work Provided Under Other Sections

1. Refer to Section 27001 "Intra/Inter Building Communications Scope of Work" for a more complete System Description.
2. Backbone Cabling
3. The Backbone Cabling includes twisted pair and fiber cabling.
4. Horizontal Cabling
 - a) The Horizontal Cabling, in general, consists of multiple 4-pair Category 6 UTP and Category 6 ScTP/shielded cables to each outlet. Refer to the Drawings for specific requirements.
 - 1) The use of both singlemode and multimode fiber optic cable is also permitted.
 - 2) The use of RG6 for CATV distribution is also permitted.
 - 3) The use of specialized AV cables is also permitted.

1.6 BASE BID WORK

A. Testing of a completed Telecommunications Cabling System, including:

1. Equipment Submittals.

B. Testing Requirements:

1. Fiber optic passive link segment(s):

| Table 27.900.001.1: Tests for fiber optic passive link segments | | | | | |
|--|-------------|------------------------|-----------------|------------------|-------------------|
| Subsystem | Type | Test | Location | Direction | Wavelength |
| Backbone | Multimode | Characterization/OTDR | OSP | Both | 850nm and 1300nm |
| Backbone | Singlemode | Characterization/OTDR | OSP | Both | 1310nm and 1550nm |
| Backbone | Multimode | Passive link ins. Loss | ISP/OSP | Both | 850nm and 1300nm |
| Backbone | Singlemode | Passive link ins. Loss | ISP/OSP | Both | 1310nm and 1550nm |
| Horizontal | Multimode | Passive link ins. Loss | ISP/OSP | Both | 850nm and 1300nm |
| Horizontal | Singlemode | Passive link ins. Loss | ISP/OSP | Both | 1310nm and 1550nm |

C. Multi-Pair/UTP cabling:

| Table 27.900.001.2: Tests For Multipair/UTP Cabling | | | | |
|--|-------------|-------------------|----------------------|-----------------------|
| Subsystem | Type | Test | Configuration | Notes |
| Backbone | Riser | Wire map & length | - | - |
| Horizontal | CAT 6 | Category 6 | Permanent Link | Per TIA/EIA-568-C.2-1 |

D. WLAN System Testing:

1. Use of test equipment, Motorola software and related accessories to complete WLAN system testing.
2. Identification of EMI and system tuning to mitigate effects of sources of EMI on the WLAN system.
3. Coordination of the WLAN system RF configuration, testing, tuning, verification and documentation as described in the contract documents.

1.7 SUBMITTALS

A. Refer to Submittals within Section 27100 for procedural, quantity, and format requirements.

B. Preconstruction Submittal Requirements:

1. Product Submittal, including cut sheets of testing equipment to be used (note all software/firmware versions as applicable) and certificate of last calibration.
2. Schedule Submittal, consisting of proposed schedule of work.

C. Submittal Requirements at Closeout:

1. Record Documents.

D. Submittal Description: Record Documents

1. Test Reports: Record documents submittal shall include test reports showing the following information:
 - a) A title page which includes:
 - 1) Client Name

- 2) Project Name
 - 3) Project Address
 - 4) General Contractor name / Telecommunications Installer name
 - 5) Date of Submittal
2. Individual tabs which break down the test results by building, and then by telecommunications room.
 3. All Fiber Optic "Post Installation" Passive Link Attenuation test results (utilize the forms provided by the owner for documentation of test results if the tester used does not have data storage capabilities) and Fiber Optic OTDR (for OSP only) test results.
 - a) First; Summary Report
 - b) Second; Individual Reports
 4. All Backbone UTP test results.
 5. All Horizontal cable test results, per cable
 - a) First; Summary Report
 - b) Second; Individual Reports
 6. All CATV distribution test reports
 7. All AV test reports
 8. Wireless site survey files that contain the field measurements from the required site survey after installation is complete.
 - a) Wireless system test results
 - 1) First; Summary Report
 - 2) Second; Individual Reports
 - b) Wireless system trouble spots.
 - c) Provide electronic file exported from the site survey software that is shall have the ability to be directly imported into Motorola LANPlanner software without conversion. The files shall contain the actual field measurement data from the wireless site surveys performed.
 - d) Contractor shall utilize Motorola SiteScanner Software to perform wireless site surveys.
 - e) Provide SiteScanner printed site survey report and electronic file showing signal strength, signal to noise, data rates, and channel information measured based on the final configuration, per the testing requirements in section 3
 - f) Provide a visual representation of the test results showing the pass/fail grid analysis on the overall floor plan for each floor within a building or on site plan per 27.900.001 section 3.11 B or C as applicable.
 9. Furnish all test results in hard copy format and on a CD-ROM.
 - a) Hard Copy;
 - 1) Provide (one (1) copy in a three ring binder.
 - 2) Binders shall be labeled with the project name, contractor name, and date of submission.
 - b) CD-ROM;
 - 1) Provide one (1) copy of all test results in their native data format, PDF and an exported Microsoft Excel compatible format (if applicable).
 - 2) Include all necessary software to allow viewing and printing of individual test results from their native format.
 - 3) On the CD provide a logical layout/folder system for all test reports.

- 4) CD shall be labeled with the project name, contractor name, and date of submission.
- 5) For each test, include either a schematic graphic or narrative accurately describing the test set up as a preface to the test reports. In other words, show the test cords with length/insertion loss, expected link insertion loss calculation, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.

1.8 QUALITY ASSURANCE

- A. Comply with the Quality Assurance requirements of Section 27100.

1.9 WARRANTY

- A. Warrant the validity of the test results. Under no circumstances shall any cable's test results be substituted for another's. If a single instance of falsification is confirmed, the Contractor shall be liable for a complete retest of the cabling system at no additional cost to the Owner. This includes the retaining the services of a neutral party to observe all retesting.

PART 2 PRODUCTS

2.1 GENERAL

- A. The manufacturer may change the product numbers listed in this Section at any time, as well as software and firmware versions. In the event this Section contains an invalid product number or conflicts with the written description, or specifies an out-of-date software and/or firmware version, notify the Owner in writing prior to issuing submittals or field testing or latest revision.
- B. All tests shall be performed with the latest revision of software.

2.2 SUBSTITUTIONS

- A. Comply with the Substitutions requirements of Section 27100.

2.3 FIBER OPTIC LIGHT SOURCE AND POWER METERS

- A. All connection interfaces shall be factory installed. No field-configurable adapters will be allowed at the light source.
- B. Wavelengths output shall be continuous.
- C. LED-based light source for multimode fiber testing shall have a:
 1. Center wavelength of $850\text{nm} \pm 30\text{nm}$ and $1300\text{nm} \pm 20\text{nm}$.
 2. Spectral width (FWHM) $30\text{nm} - 60\text{nm}$ at 850nm and $100\text{nm} - 140\text{nm}$ at 1300nm .
 3. Minimum output power level of $\geq 14\text{dBm}$.
- D. VCSEL-based light source for multimode fiber testing shall have a:
 1. Center wavelength of $850\text{nm} \pm 30\text{nm}$ and $1300\text{nm} \pm 20\text{nm}$.
 2. Spectral width (FWHM) $30\text{nm} - 60\text{nm}$ at 850nm and $100\text{nm} - 140\text{nm}$ at 1300nm .
 3. Minimum output power level of $\geq 14\text{dBm}$.
- E. LASER-based light source for singlemode fiber testing shall have a:
 1. Center wavelength of $1310\text{nm} \pm 20\text{nm}$ and $1550\text{nm} \pm 20\text{nm}$.
 2. Spectral width (FWHM) of $\leq 5\text{nm}$ at 1310nm and $\leq 5\text{nm}$ at 1550nm .
 3. Minimum output power level of $\geq 3\text{dBm}$.
- F. The light sources may contain internal lenses, pigtails, and modal conditioners, provided they meet the launch conditions as described in "Post-Installation" Passive Link Attenuation Testing Procedures (ref. PART 3 - EXECUTION).
- G. The power meter for both multimode and singlemode testing shall be capable of measuring relative or absolute power, and must be independent of modal distributions.

- H. All power meters used shall have the following performance:
 - 1. Dynamic range of 0dBm to -40dBm, minimum.
 - 2. Accuracy of ± 0.2 dB.
- I. Equipment shall be factory-calibrated within 12 months of testing date. All power meters and light sources used shall be calibrated and traceable to the National Bureau of Standards or NIST (National Institute of Standards and Technology) per the manufacturer.
- J. Tester shall have the ability to store test results and upload to a software package.
 - 1. The software shall not allow the manipulation of test data.
- K. Equipment shall be factory-calibrated within 12 months of testing date.
- L. Equipment: Corning Cable Systems or owner approved equal
 - 1. Corning Cable Systems,
 - a) OTS-600 Series
 - 1) #OS-403RD; Multimode Optical Source.
 - 2) #OS-404RXD; Singlemode Optical Source
 - 3) #OS-4RMDSD; Single and Multimode Optical source
 - 4) #OM-610; Optical Meter (single and multimode) w/10,000 test capacity
 - (i) #OA-LC; Power Meter LC Connector Adapter
 - 2. Fluke Networks,
 - a) #DTX-GFM2; DTX Series Gigabit Multimode Fiber Modules - Includes two modules each incorporating: 850 nm VSECL source and 1310 nm laser source combined into a single output port, 850-1550 nm power meter.
 - 1) # NFA-LC; Set of two LC Adapters for DTX-GFM2 power meter port for testing cable with LC connectors.
 - b) #DTX-MFM2; DTX Series Multimode Fiber Modules - Includes two modules (one for Main and one for Smart Remote). Each module contains 850nm and 1300nm LED light source combined into single output port, 850-1550 nm optical power meter.
 - 1) Note: requires the use of mandrels for proper testing.
 - c) #DTX-SFM2; DTX Series Singlemode Fiber Modules - Includes two modules each module contains 1310 nm and 1550 nm laser light source combined into single output port, 850-1550 nm power meter.

2.4 FIBER OPTIC MANDREL

- A. For jacketed (3.0 mm) fiber, mandrel diameter shall be 22 mm for 50/125 μ m fiber. For unjacketed buffered (0.9 mm) fiber, mandrel diameter shall be 25 mm for 50/125 μ m fiber.
 - 1. The fiber jumper used with a 22mm mandrel shall be 50/125 μ m non-bend improved (legacy) fiber.
- B. Equipment: Fluke Networks or equal
 - 1. Fluke Networks #NF-MANDREL-50; red mandrel for 50/125 μ m jacketed fiber
 - a) Note: Required for use with Fluke DTX-MFM2 when testing 50/125 μ m optical fiber.
 - 2. Corning Cable systems #OTS-COMBOMAN; Mandrel for testing 50/125 μ m jacketed fiber.

2.5 FIBER OPTIC OTDR

- A. Application: The fiber optic OTDR shall be used to characterize the OSP fiber optic backbone for excessive bends, length of cable, splices (although not permitted), connectors and overall integrity of the cable and fiber signal.

B. Multimode Source Module:

| Wavelength | Dynamic Range | Attenuation Deadzone | Reflective Deadzone | Loss Resolution | Distance Accuracy |
|------------|---------------|----------------------|---------------------|-----------------|-------------------|
| 850nm | 24dB | 6.5mt | 3.0 mt | 0.001 dB | 0.1 mt |
| 1300nm | 27 dB | 7.0 mt | 3.0 mt | 0.001 dB | 0.1 mt |

C. Singlemode Source Module:

| Wavelength | Dynamic Range | Attenuation Deadzone | Reflective Deadzone | Loss Resolution | Distance Accuracy |
|------------|---------------|----------------------|---------------------|-----------------|-------------------|
| 1310 nm | 24 dB | 6.5 mt | 3.5 mt | 0.001 dB | 0.1 mt |
| 1550 nm | 27 dB | 12.0 mt | 3.5 mt | 0.001 dB | 0.1 mt |

D. Equipment, including main unit and source modules, shall be factory-calibrated within 12 months of testing date. All OTDRs used shall be calibrated and traceable to the National Bureau of Standards or NIST (National Institute of Standards and Technology) per the manufacturer.

1. Note: submit OTDR information including calibration certification prior to construction and testing for owners review.

E. OTDR shall have the ability to store test results and upload to a software package.

F. Equipment:

1. Corning Cable Systems,
 - a) OV-1000 series, for multimode & singlemode systems
 - b) OV-Mini, for multimode & singlemode systems
 - c) OTS-View software latest version.
2. Fluke Networks,
 - a) OF500 series, for multimode & singlemode systems

2.6 FIBER OPTIC TEST CORDS

A. Multimode Fiber Optic Test Cord

1. The fiber of the multimode test cord(s) shall have the core diameter and numerical aperture nominally equal to that of the multimode fiber optic passive link.
 - a) The fiber jumper used with a 22mm mandrel shall be 50/125 μ m non-bend improved (legacy) fiber.
2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter.
4. The connector of the test cords shall be that which the light source accepts.
5. The connectors shall exhibit ≤ 0.5 dB loss per connection @ both 850nm and 1300nm, as measured per FOTP-171 D2.
 - a) Note: Fluke Networks requires ≤ 0.11 dB @ 850nm and 0.11 dB @ 0.10 dB per their calibration procedure.
6. Manufacturer: Corning Cable Systems or approved equal:
 - a) Corning Cable #030301S21RF002M LC to LC 6.6 Feet (2 meters) 0.1dB loss blue jacket.

B. Singlemode Fiber Optic Test Cord

1. The fiber of the singlemode test cord(s) shall have the mode field diameter nominally equal to that of the singlemode fiber optic passive link.

2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter.
4. The connector of the test cords shall be that which the light source accepts.
5. The connectors shall exhibit $\leq 0.5\text{dB}$ loss per connection @ both 1300nm and 1550nm, as measured per FOTP-171 D3.
 - a) Note: Fluke Networks requires $\leq 0.20\text{ dB}$ per their calibration procedure.
6. All singlemode connectors shall inhibit Fresnel reflections (i.e., have a "PC" finish).

C. Singlemode Fiber Optic OTDR Launch Cord

1. The fiber of the singlemode test cord(s) shall have the mode field diameter nominally equal to that of the singlemode fiber optic passive link.
2. The length of test cords used for OTDR loss testing shall be between 328 feet (100 meters) and 656 feet (200 meters) in length.
3. The connectors of the test cords shall be compatible with the connector types of the OTDR.
4. The connectors shall exhibit $\leq 0.5\text{dB}$ loss per connection @ both 1300nm and 1550nm, as measured per FOTP-171 D3.
5. All singlemode connectors shall match the mated fiber (PC or APC).
6. Manufacturer: Corning Cable Systems or approved equal:
 - a) Corning Cable # PTF-200M-SP5858 SC-PC to SC-PC 656 Feet (200 meters)
 - b) Corning Cable # PTF-200M-SP5865 SC-PC to SC-APC for video and DAS 656 Feet (200 meters)

D. Multimode Fiber Optic OTDR Launch Cord

1. The fiber of the multimode test cord(s) shall have the mode field diameter nominally equal to that of the multimode fiber optic passive link.
2. The length of test cords used for OTDR loss testing shall be 656 feet (200 meters) in length.
3. The connectors of the test cords shall be compatible with the connector types of the OTDR.
4. The connectors shall exhibit $\leq 0.5\text{dB}$ loss per connection @ both 850nm and 1310nm, as measured per FOTP-171 D2.
5. All multimode connectors shall match the mated fiber (UPC LOMMF).
6. Manufacturer: Corning Cable Systems or approved equal:
 - a) Corning Cable # PTF-100M-CP0258 SC to LC 328 Feet (100 meters)

2.7 CATEGORY 6 HORIZONTAL CABLE TESTER

- A. Equipment shall meet TIA/EIA-568C.2 requirements for Level III accuracy.
- B. Test Standards (minimum): TIA Category 6 (per TIA/EIA-568C.2); ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-T, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5
- C. Areas of Test Measurement (minimum): Wire Map; Length; Insertion Loss; Near End Crosstalk (NEXT) loss, at both master unit and remote unit; Power Sum NEXT (PSNEXT) loss, at both master unit and remote unit; Equal Level Far End Crosstalk (ELFEXT), at both master unit and remote unit; Power Sum ELFEXT, at both master unit and remote unit; Return Loss (RL), at both master unit and remote unit; Propagation Delay and Delay Skew; Attenuation-to-Crosstalk Ratio (ACR), at both master unit and remote unit; Power Sum ACR (PSACR), at both master unit and remote unit; Characteristic Impedance; DC Loop Resistance.

D. Equipment: Fluke Networks

1. #DTX-1200; "DTX CableAnalyzer" test kit (main unit, remote unit, CAT 6 permanent link adapters), loaded with latest version of firmware.
2. #DTX-1800; "DTX CableAnalyzer" test kit (main unit, remote unit, CAT 6 permanent link adapters), loaded with latest version of firmware.
3. "LinkWare" reporting and documentation software latest version.

E. Equipment: Ideal Industries

1. #LanTEK® II Series Cable Certifier; test kit (main unit, remote unit, CAT 6 permanent link adapters), loaded with latest version of firmware.
2. LANTEK® REPORTER reporting and documentation software latest version

F. Or approved equal by owner.

2.8 BACKBONE UTP CABLING TESTERS

A. Wire Map (continuity, opens, shorts, crossed pairs, up to 2,500 feet (762 meters) tester, or equal:

1. Siemon #MT-5000 test unit, with 25-pair adapter.
 - a) 25-Pair adapter to 110-block
 - 1) Independent Technologies or equal
 - (i) ITC-3012
 - b) 25-Pair to 8P8C pins 4-5 24 leg test cable
 - 1) Major Custom Cable or equal
 - (i) Z43162038-3FT

B. Length tester, or equal:

1. Fluke Networks #TS-90 test unit(up to 2,500 feet/762 meters)
2. Fluke Networks #TS-100 test unit(up to 3,000 feet/900 meters)

2.9 75 Ω COAX CABLE TESTERS

A. Application: The coax tester shall be used for the field verification of CATV and CCTV coax based cabling systems.

1. The tester shall test for continuity, opens and shorts between the center conductor and the shield.
2. Test results should be stored in the tester and downloaded with software if possible.
3. Tester should have test cords for "F" and "BNC" style connectors.
4. Equipment
 - a) FlukeNetworks #DTX-COAX; DTX Coax Cable Test Adapter for use with Fluke DTX-1200 or DTX-1800 series tester.
 - b) Greenlee; NC-100 NETcat® Micro Digital Voice Data and Video Wiring Tester
 - c) JDSU # CX200; Handheld Coax Mapper
 - d) Paladin Tools #Cable-Check Pro

2.10 AV CABLING (HD15/3.5MM STEREO/RCA)

A. Application: The AV cable tester should be used for the field verification of VGA and audio cables for AV systems.

1. The tester shall test for continuity, opens and shorts.
2. Test results should be stored in the tester and downloaded with software if possible

3. Equipment:
 - a) Ohm meter (Any brand)
 - b) Paladin Tools #Cable-Check Pro

2.11 RF TEST EQUIPMENT (CATV)

- A. Application: The tester shall measure signal strength between 5-860 MHz and perform leakage testing between 115-140 MHz
- B. Equipment: Sadelco or approved equal
 1. Sadelco #DisplayMaX 800CLI, RF levels tester 5-872 MHz with 108-140 MHz leakage test range.
 2. JDSU #CLI-1750 RF levels tester 5-890 MHz with 115-140 MHz leakage test range.

2.12 WIRELESS SURVEY TEST EQUIPMENT/SOFTWARE

- A. Equipment:
 1. Motorola SiteScanner site survey software and suitable laptop.
 2. Contractor shall utilize their own copy of Motorola SiteScanner software to perform all wireless site surveys. The cost of the software shall be considered a tool of the job which is to be included part of the bid response.
 3. AirPcap Nx Wireless Card, with external antenna port, capable of monitoring with a/b/g/n (2.4 GHz and 5GHz) WIFI standards.
 4. GPS receiver compatible with SiteScanner software.
 5. External antenna(s) for the appropriate WIFI bands as noted above.
 6. RF spectrum analyzer
 - a) Capable of capturing 2.4 GHz and 5GHz frequency bands.
 - b) Minimum receive sensitivity -90 dBm.
 - c) Ability to capture and save snapshots of each frequency band.
 - d) Ability to identify interference both in and around the Wi-Fi band from Wi-Fi devices, and other external sources of EMI.
 - e) Suitable antenna(s) for use in each band

PART 3 EXECUTION

3.1 SCHEDULING

- A. Prepare a schedule for testing activities based on the schedule developed and supplied in this bid package. Update testing schedule when changes in the cabling construction schedule occur.
- B. Schedule both the Owner and a representative of the test equipment manufacturer for a demonstration of testing methods. Execute a demonstration of testing methods with aforementioned parties prior to 'production' testing activities. Test reports and acceptance testing will not be accepted without proof of methods demonstration.
 1. At the demonstration the contractor shall provide the following information:
 - a) For each test include either a schematic graphic or narrative accurately describing the test set up as a preface to the test reports. In other words, show how the tester is to be set up with the cables or accessories, expected events or results with calculations, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.
 - b) Provide a copy of the approved submittal for the test equipment along with a copy of the certificate of calibration.
 - c) Provide a copy of a sample test report or the form to be completed.

- C. It may be necessary for the contractor to provide a signal generator at the input of the CATV distribution amplifier for commissioning and testing purposes.

3.2 FIELD QUALITY CONTROL

- A. Complete testing as delineated below prior to system acceptance.
- B. Permanently record all test results and presented in a format acceptable to the Owner before system acceptance.
- C. Remove and replace with new, at no cost to the Owner, any cables or conductors (copper or fiber) failing to meet the indicated standards. The Owner will not accept the installation until testing has indicated a 100% availability of all cables and conductors/strands or the Owner has approved any deviation from this requirement.
- D. Calibrate test sets and associated equipment per the manufacturers printed instructions at the beginning of each day's testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.

3.3 "PRE-INSTALLATION" TESTING PROCEDURES

- A. Ensure fiber continuity of all fiber strands of all cables prior to installation.
- B. Reports from "pre-installation" fiber continuity testing are not required to be submitted at project close out. *(Note: Factory test reports are still required for OSP fiber each reel)*
- C. Perform a wireless site survey prior to beginning any wireless installation to confirm baseline of design. Notify the construction representative or engineer of any discrepancies prior to installation.
 - 1. Measure the signal level coverage of the area and compare to the baseline coverage report of that area. Refer to 27.900.001.3.11 Testing, paragraph A, B, and C, for further testing requirements for each area to be tested.
- D. Perform pre-installation wireless testing prior to permanently mounting the antenna(s) based on the following criteria:
 - 1. Use the type of antenna as called out in the contract documents.
 - 2. Temporarily connect the antenna cable to the WAP.
 - 3. Place antenna(s) in location(s) at elevation(s) as shown on the plans.
 - 4. Measure the signal level coverage of the WAP and compare to the predictive coverage report of that area. Refer to 3.11 Testing, paragraph A, B, and C, for further testing requirements for each area to be tested.
 - 5. Adjust the antenna(s), elevation(s) and location(s), as needed to achieve the desired coverage in the predictive coverage report.
 - 6. Coordinate changes to RF configuration settings with Owner to achieve the desired coverage.
 - 7. Permanently mount the antenna(s) based on optimal location for RF coverage.

3.4 FIBER OPTIC BACKBONE CHARACTERIZATION TESTING (OTDR)

- A. Test fiber optic passive links per "Base Bid Requirements" in Part 1 of this Section.
- B. Precautions
 - 1. Adhere to the equipment manufacturer's instructions during testing activities.
 - 2. Prior to any testing activity or any measurements taken, complete the following activities:
 - a) Ensure the test equipment is at room temperature – approximately 70 degrees F (21 degrees C) (e.g., if necessary, bring the test equipment in from outdoors and let it set for however long it takes to bring the test equipment to reach room temp).

- b) Clean all launch cords and system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.
 3. Do not power off OTDR's light source during testing activity.
 4. Do not remove launch cord from the OTDR's light source at any time (unless the testing is complete or the equipment is being put away for the evening or during trouble shooting).
 5. Do not bend the launch cord smaller than 20 times the cord diameter during testing activities (this may induce loss into the cord reducing the accuracy of the measurement).
 6. Fully charge power source before each day's testing activity, if applicable.
- C. "Post-Installation" Characterization OTDR Testing Procedures

1. Equipment settings / measurement parameters:

- a) Index of Refraction: match cable-under-test fiber parameters; default settings as follows:

| Type of Fiber Cable | | Index of Refraction | |
|---------------------|--------------------|---------------------|-----------------|
| Multimode | Corning 50/125 OM3 | 1.480 @ 850nm | 1.479 @ 1300nm |
| Type of Fiber Cable | | Index of Refraction | |
| Singlemode | Corning SMF-28 | 1.4677 @ 1310nm | 1.4682 @ 1550nm |

- b) Pulse Width: multimode: 20ns; singlemode: 50 ns.

| | |
|------------------|--|
| Multimode 50/125 | 4 ns for cable lengths up to 1,640 feet (500 meters) 20 ns for cable lengths from 820 feet (250 meters) to 6,560 feet (2,000 meters) |
| Singlemode | 10 ns for cable lengths up to 6,560 feet (2,000 meters) 50 ns for cable lengths from 6,560 feet (2,000 meters) to 65,616 feet (20,000 meters) |

- c) Backscatter:
- 2) Multimode: -67dB @ 850nm, -74dB @ 1300nm;
 - 3) Singlemode: -74dB @ 1310nm and 1550nm
- d) Event Threshold: 0.05dB for both multimode and singlemode
- e) Reflection Threshold:
- 4) Multimode: -45dB
 - 5) Singlemode: -60dB
- f) Fiber Break/End-Of-Fiber: 3dB for both multimode and singlemode
2. Waveform: The waveform shall be real-time/normal density.
3. Obtain measurements using a 'launch' cord connected to the test instrument and the cable-under-test.
- a) The fiber of the launch cord shall match the fiber of the cable-under-test in physical and performance parameters (such as type, core/cladding size, index of refraction, refractive profile). The fiber of the launch cord should match the fiber of the cable-under-test in manufacturer and product.
 - b) The length of the launch cord shall be between 328 feet (100 meters) and 656 feet (200 meters).

4. Review the results of each test and bring to the attention of the Owner all fibers that do not meet the manufacturer's allowed loss for splices and connectors, or fibers that exceed the recommended length of the overall cable length.

D. Record Documents:

1. Test reports shall match the cable and fiber IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is associated with the electronic and printed test record.
2. The units for distance measurements (i.e., the “X” axis of the graph) shown on the print of the test measurements shall be feet.
3. For the traces, the x- and y-axis scales of a given cabling link shall be identical. Preferably, all reports shall be printed with identical scales on both x- and y-axis.
4. The launch cord must be shown in the trace of the printed test report.
5. Measurements shall carry a precision through one significant decimal place (minimum).
6. Each test report shall contain the following information (not necessarily in this order):
 - a) Project name,
 - b) General Contractor name / Telecommunications Installer name
 - c) Cable identifier, fiber number, and fiber type (e.g., “multimode”)
 - d) Measurement direction,
 - e) Date measurement was obtained,
 - f) Operator (name and company),
 - g) Test equipment model and serial number(s),
 - h) Set up parameters (minimum - pulse width, refractive index, and event threshold.)
 - i) Wavelength,
 - j) OTDR trace,
 - k) Length of fiber,
 - l) Overall link loss.
7. For each passive cabling link, include either a schematic graphic or narrative accurately describing the test set up as a preface to the test reports. In other words, show the launch cord with length, expected events with distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.

E. FIBER OPTIC BACKBONE/HORIZONTAL PASSIVE LINK INSERTION LOSS TESTING

F. Test fiber optic passive links per “Base Bid Requirements” in Part 1 of this Section.

G. Launch Conditions:

1. For passive link insertion loss testing for multimode fibers, the modal launch condition from the light source shall be characterized as Category 1 per OFSTP-14.
2. For passive link insertion loss testing of singlemode fibers:
 - a) Use the launch conditions, as described in FOTP-78.
 - b) Employ a method to remove high-order propagating modes, as described in FOTP-77.

H. Test Methods:

1. The passive link insertion loss testing of multimode fibers shall be performed according to “Test Method B: One Jumper Reference”, per OFSTP-14, for ‘permanent’ links, and shall be performed according to “Test Method C: Three Jumper Reference”, per OFSTP-14, for ‘channel’ links.

2. The passive link insertion loss testing of singlemode fibers shall be performed according to "Test Method A.1: One Jumper Measurement", per OFSTP-7.

I. Precautions

1. Adhere to the equipment manufacturer's instructions during testing activities.
2. Prior to any testing activity or any measurements taken:
 - a) Ensure the test equipment is at room temperature – approximately 70 degrees F (21 degrees C) (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
 - b) Power on the light source and power meter for at least 5 minutes.
 - c) Clean all test cords & system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.
3. Do not power off light source or the power meter during testing activity.
4. Do not remove Test Cord #1 from the light source at any time (unless the testing is complete or the equipment is being put away for the evening).
5. Do not bend the test cords smaller than 20 times the cord diameter (this may induce loss into the cord reducing the accuracy of the measurement).
6. Fully charge power sources before each day's testing activity.
7. Utilize standard 50/125µm (not reduced bend radius) fiber with mandrels for multimode testing.
 - a) Mandrels shall be placed on the light source side of the testing jumpers.

J. Passive Link Insertion Loss Testing Procedures

1. Test Equipment Set Up
 - a) Follow the test equipment manufacturer's initial adjustment and set up instructions.
 - b) If the power meter has a Relative Power Measurement Mode, select this mode.
 - c) If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
 - d) Set the light source and power meter to the same wavelength.
2. Test Cord Performance Verification
 - a) Connect Test Cord #1 between the light source and the power meter.
 - b) The value displayed on the power meter is the reference power (Pref) measurement. If the power meter has a relative power measurement mode, enter this reference power measurement (Pref) value into the meter. If it does not, hand-write Pref onto the record documents for future reference.
 - c) Disconnect Test Cord #1 from the power meter. Do not disconnect Test Cord #1 from the light source.
 - d) Connect the 'open' end of Test Cord #1 to an adapter (of matching connector type). Connect one end of Test Cord #2 to the adapter and the other end of Test Cord #2 to the power meter.
 - e) The value displayed on the power meter is the power measurement (Psum). If the power meter is in Relative Power Measurement Mode, the meter reading represents the test cord #2 connection attenuation. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the connection attenuation:

- 1) If Psum and Pref are in the same logarithmic units (dBm, dBu, etc):
Connection Attenuation (dB) = | Psum – Pref |
- 2) If Psum and Pref are in watts: Connection Attenuation (dB) = | 10 x log10 [Psum/Pref] |
 - (i) The measured connection attenuation must be less than or equal to the value found in Table 3 (below).

- f) Flip the ends of Test Cord #2 so that the end connected to the power meter is now connected to the adapter and the end connected to the adapter is now connected to the power meter.
- g) The meter reading is the reversed Power Measurement (Psum). Perform the proper calculations if not using Relative Power Measurement Mode.

Verify that both connection attenuation measurements are less than or equal to the value found in the following table:

| Test Cord | LC or SC Cord |
|--------------------|---------------|
| Multimode (50/125) | 0.50 dB Max |
| Singlemode | 0.55 dB Max |

- h) If both measurements are found to be less than or equal to the values found in Table 1, test cord #1 is acceptable for testing purposes. Unacceptable attenuation measurements may be attributable to test cord # or test cord #2. Examine each cord with a portable microscope and clean, polish, or replace if necessary.
 - i) Repeat this test procedure from the beginning reversing the test cords in order to verify the performance of test cord #2.
3. Determine the Launch Category of the Light Source
- a) The launch category of a light source can be determined by measuring its Coupled Power Ratio (CPR). The CPR is a measurement of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower Category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation to compensate for a light source's launch characteristics increases the accuracy of the test procedure.
 - b) Provide two test cords, one multimode (Test Cord #1) and one singlemode (Test Cord #2). Both cords shall be directly terminated on connectors that are compatible with the light source and power meter.
 - c) The fiber of the multimode test cord shall have the core diameter and numerical aperture nominally equal to those of the permanent link.
 - d) The fiber of the singlemode test cord shall contain Class IVa singlemode fiber, with a mode field diameter of $9.0\mu\text{m} \pm 1.0\mu\text{m}$ for 1310nm tests and $9.0\mu\text{m} \pm 1.0\mu\text{m}$ for 1550nm tests.
 - e) Connect test cord #1 between the light source and the power meter. Avoid placing bends in the cord that are less than 4 inches (101.6 mm) in diameter.
 - f) The meter reading is the Reference Power Measurement (Pref). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement (Pref) value into the meter. If it does not, hand-write Pref for future reference.
 - g) Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.

- h) Connect test cord #2 between the power meter and test cord #1, using an appropriate adapter between the test cords.
- 1) Test cord #2, the singlemode cord, shall include a high order mode filter. This can be accomplished by twice wrapping the cord around a 1.2" diameter (30 mm) mandrel.
- i) The meter reading is the Power Measurement (Psum). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the CPR:
- 1) If Psum and Pref are in the same logarithmic units (dBm, dBu, etc): $CPR (dB) = |Psum - Pref|$
 - 2) If Psum and Pref are in watts: $CPR (dB) = |10 \times \log_{10} [Psum/Pref]|$

| Coupled Power Ratio (CPR) in dB, for 50/125mm Fiber: | | | | | |
|--|---------------------|-----------|-----------|----------|----------------------|
| | Cat-1 Overfilled | Cat-2 | Cat-3 | Cat-4 | Cat-5 Underfilled |
| 850nm source | 20 – 24 | 16 – 19.9 | 11 – 15.9 | 7 – 10.9 | 0 – 5.9 |
| 1300nm source | 16 – 21 | 12 – 15.9 | 8 – 11.9 | 4 – 7.9 | 0 – 3.9 |

4. Multimode and Singlemode Insertion Loss Measurement

- a) Prior to testing calculate loss budget for proper pass/fail criteria and record in documentation.
- b) After setting up the test equipment, verifying the performance of the test cords, and determining the light source's CPR, the insertion loss of the passive link segments can be measured.
- c) The meter reading is the Reference Power Measurement (Pref). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement (Pref) value into the meter.
 - 1) Prior approval is required if the tester does not electronically record the Pref. If it does not, hand-write Pref for future reference and to be included in the Record Documents.
- d) Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
- e) Connect test cord #1 to the passive link segment 'input'.
- f) At the opposite end of the passive link segment, connect test cord #2 to the link segment 'input' and the power meter.
- g) The meter reading is the Power Measurement (Psum). If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the insertion loss:
 - 1) If Psum and Pref are in the same logarithmic units (dBm, dBu, etc): $Link\ Segment\ Attenuation (dB) = |Psum - Pref|$
 - 2) If Psum and Pref are in watts: $Link\ Segment\ Attenuation (dB) = |10 \times \log_{10} [Psum/Pref]|$
- h) Record Psum for inclusion into the Record Documents. Refer to Records (ref. PART 3: EXECUTION) for all of the information to record.

5. Acceptable Measurement Values

- a) Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
- b) The general insertion loss equation for any link segment is as follows:
 - 1) Insertion loss = <cable loss> + <connection loss> <splice loss> + <CPR adjustment>.
 - (i) Note: A connection is defined as the joint made by two mating fibers terminated with remateable connectors (e.g., LC, SC, etc).
- c) 50/125µm Multimode Insertion Loss Coefficients
 - 1) ISP FREEDM ONE or MIC Cable Loss = Cable Length (km) x (2.8 dB/km @ 850-nm or 1.0B/km @ 1300-nm).
 - 2) OSP ALTOS or FREEDM Series Cable Loss = Cable Length (km) x (3.0 dB/km @ 850-nm or 1.0B/km @ 1300-nm).
 - 3) Connection Loss (LC Connectors) = Connections (mated pairs or adapters) x 0.40 dB.
 - 4) Splice Loss = Splices x (0.05 dB for fusion or 0.10 dB for mechanical).
 - (i) Note: Splice Loss is for connector pig tail fusion splices only.
 - 5) CPR Adjustment = See following table:

| | Cat-1 | Cat-2 | Cat-3 | Cat-4 | Cat-5 |
|---------------|-------|-------|-------|-------|-------|
| 850nm source | +0.50 | 0.00 | -0.25 | -0.50 | -0.75 |
| 1300nm source | +0.25 | 0.00 | -0.10 | -0.20 | -0.30 |

d) Single mode Insertion Loss Certificates

- 1) ISP FREEDM One or MIC Cable Loss = Cable Length (km) x (0.4 dB/km @ 1310-nm or 0.3B/km @ 1550-nm).
- 2) OSP ALTOS or FREEDM Series Cable Loss = Cable Length (km) x (0.4 dB/km @ 1310-nm or 0.3B/km @ 1550-nm).
- 3) Connection Loss (SC Connectors) = Connections (mated pairs or adapters) x 0.40 dB
- 4) Splice Loss = Splices x (0.07 dB for fusion or 0.15 dB for mechanical).
- (ii) Note: Splice Loss is for connector pig tail fusion splices only.
- 5) CPR Adjustment = Not applicable for singlemode.

6. Record Documents:

- a) All cable and fiber IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is entered into the stored test result in the power meter.
- b) Measurements shall carry a precision through one significant decimal place (minimum).
- c) Each test report shall contain the following information (not necessarily in this order):
 - 1) Project name and address,
 - 2) General Contractor name / Telecommunications Installer name.
 - 3) Operator's name(s),
 - 4) Date of measurement,
 - 5) Test equipment - manufacturer, model, and serial number,
 - 6) Cable identifier, fiber and fiber type,
 - 7) Measurement direction,
 - 8) Wavelength,
 - 9) Measured loss values.

3.5 BACKBONE TWISTED PAIR CABLING TESTING REQUIREMENTS AND PROCEDURES

A. Testing Requirements

1. Test backbone multi-pair cabling per “Base Bid Requirements” in Part 1 of this Section.
2. The installation will be accepted when testing has indicated a 100% availability of all terminated pairs or the Owner has approved any deviation from this requirement.

B. Testing Procedures

1. Test wire map and continuity for all pairs.
 - a) Do not test through cross-connects. Test each segment independently.
2. ISP Cabling: Test cable from BEP/110-block to patch panel.
 - a) Note: When using the MT-5000 the use of a hydra cable is recommended
 - b) Note: Testing may also be done with an approved category 6 tester and the appropriate adapters.
3. OSP Cabling: Test cables from the protected side (through the fuses) of the BEP at each end prior to cross-connect or ISP cabling being installed.
4. Test length for 4% of pairs of each cable. Test at least 1-pair from each binder group. None of the pairs tested for length shall be of the same 25-pair binder group.

C. Record Documents:

1. All cable and pair IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/termination label shall be the same as what appears on the test reports.
2. Measurements shall carry a precision through no significant decimal place.
3. Each test report shall contain the following information (not necessarily in this order):
 - a) Project name and address,
 - b) General Contractor name / Telecommunications Installer name,
 - c) Operator's name(s),
 - d) Date of measurement,
 - e) Test equipment - manufacturer, model, and serial number,
 - f) Cable identifier and pair numbers,
 - g) Overall test result, and
 - h) Measured values of minimum requirements.

3.6 HORIZONTAL CATEGORY 6 TESTING PROCEDURES

A. Precautions

1. Adhere to the equipment manufacturer's instructions during all testing.
2. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature – approximately 70 degrees F (21 degrees C) (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
3. Fully charge power sources before each day's testing activity

B. Test Equipment Set Up

1. Set up the tester to perform a full Category 6 test, as a Permanent Link configuration.
2. If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6.

- a) If setting to generic Category 6 measure and set NVP for the cable type in the presence of a HSC construction representative.
3. Set the tester to save the full test results (all test points, graphs, etc.).
4. Save the test results with the associated cable link identifier to match that as specified in 27.150.001.
5. Calibrate the test set per the manufacturer's instructions.

C. Acceptable Test Result Measurements

1. Links which report a Fail, Fail* or Pass* for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
 - a) The Fail* and Pass* selection within the tester shall be selected. Note: Any results with an "*" are considered a Fail.
2. Any reconfiguration of link components required as a result of a test Fail, must be re-tested for conformance.
3. Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
4. Minimum measurement requirements:

| | |
|---|--|
| Wire Map | All pairs of the cabling link shall be continuous and terminated correctly at both ends. No exceptions shall be accepted |
| Length | The maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration shall be 308 feet (94 m), including test cords. |
| Insertion Loss | The acceptable insertion loss measurements for any Category 6 cabling link shall be no greater than that as listed in TIA/EIA-568C.2. |
| Worst Pair-to-Pair Near End CrossTalk (NEXT) Loss | The acceptable worst pair-to-pair NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568C.2 table 35. |
| Power Sum NEXT Loss | The acceptable worst pair-to-pair NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568C.2 table 37. |
| Worst Pair-to-Pair ELFEXT and FEXT Loss | The acceptable power sum PS-NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568C.2. |
| Power Sum ELFEXT and FEXT Loss | The acceptable worst pair-to-pair ELFEXT and loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568C.2. |
| Return Loss | The acceptable return loss measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568C.2 table 30. |
| Propagation Delay and Delay Skew | The acceptable propagation delay and delay skew measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568C.2. |
| DC Loop Resistance | The DC loop resistance for category 3, 5e, 6, and 6A permanent links shall not exceed 21 Ω per TIA/EIA-568C.2. |
| Shield Continuity | For ScTP or shielded cables the shield connectivity shall be verified at each end point/connector and be continuous. Not required for UTP cabling. |

D. Record Documents

1. For each Horizontal Category 6 test measurement, record the following information:

- a) Project name and address,
- b) General Contractor name / Telecommunications Installer name,
- c) Operator's name(s),
- d) Date of measurement,
- e) Test equipment - manufacturer, model, and serial number,
- f) Cable identifier,
- g) Overall test result,
- h) Measured values of minimum requirements.

3.7 75 Ω COAXIAL CABLE TESTING

- A. Calibration: When using a Fluke DTX series the tester shall be calibrated every 30 days at a minimum. For all others follow manufacturer's recommendations.
- B. Test each segment of the cable separately. Do not test through splitters, taps etc.
- C. Cable shall be verified for continuity, open, shorts, overall length. Additionally test for insertion loss and length if possible.
- D. Record Documents
 - 1. For each Horizontal Coaxial cable test measurement, record the following information:
 - a) Project name and address,
 - b) General Contractor name / Telecommunications Installer name,
 - c) Operator's name(s),
 - d) Date of measurement,
 - e) Test equipment - manufacturer, model, and serial number,
 - f) Cable identifier,
 - g) Overall test result
 - h) Measured values of minimum requirements.

3.8 AV CABLING (HD15/3.5MM STEREO/RCA)

- A. Cable shall be verified for continuity, open, shorts, overall length.
 - 1. Utilize either an automated tester or ohm meter for continuity tests
- B. Connect computer or AV device and verify functionality of installed cables.
- C. Record Documents
 - 1. For each AV cable test measurement, record the following information:
 - a) Project name and address,
 - b) General Contractor name / Telecommunications Installer name,
 - c) Operator's name(s),
 - d) Date of measurement,
 - e) Test equipment - manufacturer, model, and serial number,
 - f) Cable identifier,
 - g) Overall test result
 - h) Measured values of minimum requirements.

3.9 AV CABLING (HD15/3.5MM STEREO/RCA)

- A. Cable shall be verified for continuity, open, shorts, overall length.
 - 1. Utilize either an automated tester or ohm meter for continuity tests
- B. Connect computer or AV device and verify functionality of installed cables.
- C. Record Documents
 - 1. For each AV cable test measurement, record the following information:
 - a) Project name and address,
 - b) General Contractor name / Telecommunications Installer name,
 - c) Operator's name(s),
 - d) Date of measurement,
 - e) Test equipment - manufacturer, model, and serial number,
 - f) Cable identifier,
 - g) Overall test result
 - h) Measured values of minimum requirements.

3.10 CATV ACTIVE TESTING

- A. Once the system has been installed and tuned/balanced the completed system shall be tested for RF signal strength, signal tilt and RF leakage.
 - 1. It may be necessary for the contractor to provide a signal generator at the input of the CATV distribution amplifier for commissioning and testing purposes.
- B. Systems Level at Un-Populated (no horizontal cable present) Tap Ports: Provide signal at all frequencies (channels) per the design.
 - 1. Either obtain from the drawings or calculate anticipated signal strength at each un-populated tap ports within the distribution cabinet.
 - 2. Test each un-populated tap port at 55.25 MHz (channel 2) and at 859.25 MHz (channel 135) at the user outlet for RF signal strength.
 - 3. Calculate and measure tilt between lower and upper channel (frequency) measurements.
 - a) System Tilt: 3.5dB maximum between high and low frequencies
 - 4. Record Documents:
 - a) Project name and building identifier
 - b) General Contractor name / Telecommunications Installer name
 - c) Operator's name(s)
 - d) Date of RF signal measurement
 - e) Test equipment - manufacturer, model, and serial number
 - f) Cover letter indicating the overall pass/fail for the CATV system
 - g) Identify building, tap value and tap value for un-populated ports
 - h) Reading/measurement (RF and Tilt)
 - 1) Cause/effect/solution for any readings outside of tolerance
 - 2) New reading measurement
- C. Systems Level at Work Area Outlet: Provide signal at all frequencies (channels) between 2.5dB and 6.0dB.
 - 1. Test each outlet at 55.25 MHz (channel 2) and at 859.25 MHz (channel 135) at the user outlet (faceplate).

2. Calculate and measure tilt between lower and upper channel (frequency) measurements.
 - a) System Tilt: 3.5dB maximum between high and low frequencies
3. Record Documents:
 - a) Project name and building identifier
 - b) General Contractor name / Telecommunications Installer name
 - c) Operator's name(s)
 - d) Date of RF signal measurement
 - e) Test equipment - manufacturer, model, and serial number
 - f) Cover letter indicating the overall pass/fail for the CATV system
 - g) Cable identifier
 - h) Reading/measurement (RF and Tilt)
- D. RF Leakage: Measure at a distance not to exceed 10 ft (3 m) from each connection point or device at a frequency of 133.250MHz (Channel 16 or C). RF leakage shall not exceed 20 $\mu\text{V}/\text{M}$ or -42.92dBmv.

Tech note: The test shall be conducted no closer than 10 ft (3 m) to/from an earth ground or bonding conductors.

1. Antenna may be a mono-pole (rubber duck), a dipole or yagi style.
2. Record Documents:
 - a) Project name and building identifier
 - b) General Contractor name / Telecommunications Installer name
 - c) Operator's name(s)
 - d) Date of leakage measurement
 - e) Test equipment - manufacturer, model, and serial number
 - f) Cover letter indicating the overall pass/fail for the leakage tests
 - g) Location of test
 - h) Reading/measurement

3.11 WIRELESS TESTING/SURVEY

- A. General testing requirements, applicable to all wireless work, as follows:
 1. Motorola SiteScanner software with compatible wireless network card installed on laptop shall be used.
 2. The WLAN Contractor shall divide the area being tested into grids, sized as called for in each section below.
 3. Test each grid for a minimum of -75 dBm signal strength and data rate as called for below:
 - a) A minimum of one data sample must be obtained from each grid for the area under test, as close as possible to the center of the grid.
 - b) The SiteScanner "track run" method as defined by the Motorola SiteScanner software shall be used where possible and single point measurements used only in difficult to access areas.
 - c) Based on the test criteria, each grid shall be assigned a pass or fail value and visually represented on a plan view of the tested area.
 - d) Grids that fail test requirements shall be investigated and the reason for failure determined (e.g., interference, low signal or other) and documented.

4. Testing Failures

- a) The WLAN Contractor shall tune the antenna locations to correct all failed areas. If failures are unable to be resolved by antenna relocation or configuration adjustments, the WLAN Contractor shall provide to the Owners representative and Design Engineer the following:
 - 1) A summary of areas that failed, with reasons identified as to why the failure occurred.
 - 2) Proposed solutions to correct any areas that failed that were not able to be corrected by adjusting the antenna mounting location.
 - 3) Details of the proposed solution and options available to provide complete coverage to the Owner.
- b) Use the RF Spectrum Analyzer as needed to determine the source of interference or EMI to troubleshoot the system.
 - 1) All sources of EMI found during testing shall be quantified as to their effect on the performance of the WLAN system.
 - 2) Identify and locate the sources of EMI within the test results.
 - 3) Delineate the area affected by the EMI graphically within the test report.

B. Outdoor site wireless testing:

- 1. Use a GPS receiver and external antenna.
- 2. Grid size shall be 20 X 20 ft (6.1 X 6.1m).
- 3. "Pass" criteria is a minimum connection speed of 6 Mbps, for 802.11n 2.4GHz and 5 GHz bands.

C. Indoor Site wireless testing:

- 1. Grid size shall be 6 X 6 ft (1.83 X 1.83m).
- 2. Test each grid based on the following area requirements:
 - a) For high occupancy areas (office space areas, etc.), "Pass" criteria is a minimum connection speed of 24 Mbps, for 802.11 a/g/n 2.4 GHz, 5GHz, and 11Mbps for 802.11 b.
 - b) For low occupancy areas (process, exterior, warehouse, etc.) "Pass" criteria is a minimum connection speed of 6 Mbps, for 802.11a/b/g/n 2.4GHz and 5 GHz bands.

3.12 AV AUDIO SYSTEM PERFORMANCE TESTING

- A. Test Plan: Provide a written test plan for all installed devices detailing the test equipment, testing method, acceptance criteria and a sample of the test report documentation to the construction representative prior to scheduling the performance testing. The testing plan shall include:
 - 1. Testing of all inputs, outputs and tie-lines.
 - 2. Testing of all display/control devices, equipment configurations, speakers and connections.
 - 3. Testing of any other cabling or components.
 - 4. Testing of all audio for compliance with Performance Standards.
 - 5. Testing of all control function from all control points to all controlled devices for specified operation of the system.
- B. Testing personnel: The Contractor shall have a minimum of two people knowledgeable of the system as installed available for testing and adjustment for the Acceptance Test.
 - 1. All Contractor costs associated with personnel and equipment for Acceptance Testing shall be included with the bid.
 - 2. The Contractor should allow for complete on-site testing and adjustment of the system.

- C. Noise and RF Pickup:
 - 1. Set up system for each mode of operation.
 - 2. Check to ensure that system is free from noise, hum, and RF interference.
- D. Buzzes, rattles and distortion:
 - 1. Apply high-quality program source signal to the system. Adjust the system for frequency peaks and its specified maximum sound pressure level.
 - a) Ensure that audio is clear and that the audio level is consistent for the designed coverage area.
 - 2. In both cases, monitor system for buzzes, rattles and distortion.
 - 3. Correct all cases of defects within the system, and notify Owner of problems external to the system.
- E. The Contractor shall demonstrate the operation of each major component and system operation and performance using microphones and loud speakers provide with the system.
- F. Project Close-out Submittals:
 - 1. All tuning and adjustments shall have hard copy data turned over to the Owner and Engineer. Submit record drawings and documentation of tests and adjustments made during final testing to building owner.

3.13 VIDEO SYSTEM PERFORMANCE ACCEPTANCE TESTING

- A. Test Plan: Provide a written test plan for all installed devices detailing the test equipment, testing method, acceptance criteria and a sample of the test report documentation to the construction representative prior to scheduling the performance testing. The testing plan shall include:
 - 1. Testing of all inputs, outputs and tie-lines.
 - 2. Testing of all display/control devices, equipment configurations, projectors/monitors and connections.
 - 3. Testing of any other cabling or components.
 - 4. Testing of all video for compliance with performance standards.
 - 5. Testing of all control function from all control points to all controlled devices for specified operation of the system.
- B. Testing personnel: The Contractor shall have a minimum of two people knowledgeable of the system as installed available for testing and adjustment for the Acceptance Test.
 - 1. All Contractor costs associated with personnel and equipment for Acceptance Testing shall be included with the bid.
 - 2. The Contractor should allow for complete on-site testing and adjustment of the system.
- C. Picture Quality:
 - 1. The picture shall be distortion free and focused for the optimum viewing angles.

3.14 SOUND MASKING SYSTEM ACCEPTANCE TESTING

- A. Test Plan: Provide a written test plan for all installed devices detailing the test equipment, testing method, acceptance criteria and a sample of the test report documentation to the construction representative prior to scheduling the performance testing. The testing plan shall include:
 - 1. Testing of all inputs, outputs and tie-lines.
 - 2. Testing of all display/control devices, equipment configurations, speakers and connections.
 - 3. Testing of any other cabling or components.
 - 4. Testing of all audio for compliance with sound masking performance standards.

- a) Ensure proper equalization to provide minimum privacy index requirements as defined in 27.519.001 and the CWP.
- 5. Testing of all control function from all control points to all controlled devices for specified operation of the system.
- B. Testing personnel: The Contractor shall have a minimum of two people knowledgeable of the system as installed available for testing and adjustment for the Acceptance Test.
 - 1. All Contractor costs associated with personnel and equipment for Acceptance Testing shall be included with the bid.
 - 2. The Contractor should allow for complete on-site testing and adjustment of the system.
- C. Noise and RF Pickup:
 - 1. Set up system for each mode of operation.
 - 2. Check to ensure that system is free from noise, hum, and RF interference.
- D. Buzzes, rattles and distortion:
 - 1. Apply noise generator (source signal) to the system. Adjust the system for frequency peaks and its specified maximum sound pressure level.
 - 2. Apply sine-wave sweep from 50 to 5,000 Hz at 10db below full amplifier power.
 - 3. Monitor system for buzzes, rattles and distortion.
 - 4. Ensure that sound masking audio level is consistent for the designed coverage area.
 - 5. Correct all cases of defects within the system, and notify Owner of problems external to the system.
- E. Project Close-out Submittals:
 - 1. All tuning and adjustments shall have hard copy data turned over to the Owner and Engineer. Submit record drawings and documentation of tests and adjustments made during final testing to building owner.

3.15 GROUNDING AND BONDING TESTING

- A. General Requirements
 - 1. Upon completion of the installation of the system, the contractor shall perform a standard ground-resistance test with an Owner approved ground resistances test with a Ground Impedance Tester unit and associated procedures.
 - 2. Only on contractor installed equipment, where test show resistance to ground is greater than 1/2 ohm, the contractor shall take appropriate action to reduce the ground resistance to 1/2 ohm or less.
 - a) Test from TMGB/TGB to cabinet bus bar.
 - b) Test from BEP bus bar (not bond conductor) to TMGB.
 - c) Testing from lug to lug is NOT acceptable.
 - d) Records results electronically and submit to owner for approval.
- B. Project Close-out Submittals:
 - 1. All grounding and bonding tests shall be recorded on form QCM-N-1681 and the hard copy data shall be turned over to the Owner and Engineer.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers the design requirements for SimplexGrinnell 4100ES version Fire/Life Safety Alarm system devices and wiring. It is intended to supplement the Fire Alarm information.

1.2 REFERENCES

A. SSG documents:

1. 28.320.001.001 Simplex Fire/Life Safety System Typical Panel Elevations
2. 28.320.001.002 Simplex Fire/Life Safety System Device Tagging Details
3. 28.320.001.003 Simplex Fire/Life Safety System Tagging Details
4. 28.320.001.004 Simplex Fire/Life Safety System Initiating Device Installation Details
5. 28.320.001.005 Simplex Fire/Life Safety System Notification Device Installation Details
6. 28.320.001.006 Simplex Fire/Life Safety System RIAM and SIAM Installation Details
7. 28.320.001.007 Simplex Fire/Life Safety System Remote Duct detector wiring Diagram
8. 28.320.001.008 Simplex Fire/Life Safety System Duct Smoke Detector Installation Details
9. 28.320.001.009 Simplex Fire/Life Safety System Duct Smoke Detector Details
10. 28.320.001.010 Simplex Fire/Life Safety System Flame Detector Installation Details
11. 28.320.001.011 Simplex Fire/Life Safety System Flame Detector Terminal Strip Details
12. 28.320.001.012 Simplex Fire/Life Safety System Surge Suppression Field end
13. 28.320.001.013 Simplex Fire/Life Safety System Device Mounting Details
14. 28.320.001.014 Simplex Fire/Life Safety System Cable Installation Details
15. 28.320.001.016 Simplex Fire/Life Safety System VESDA Installation Details
16. 28.320.001.017 Simplex Fire/Life Safety System VESDA Application Details

PART 2 PRODUCTS**2.1 CONTRACTOR FURNISHED MATERIALS**

- A. Including but not limited to the products, materials, cable and wire listed in section 2.01.
- B. Junction Boxes and Enclosures.
1. Junction Boxes:
 - a) Wall mounted, steel or fiberglass, enclosed and gasketed (NEMA 12 indoors and NEMA 4X outdoors, NEMA 4X is to be used indoors in wet or moist environments), with removable mounting plate in back of box (ensure plate is bonded to junction box/enclosure).
 - b) Screw or clamp type latch.
 - c) Acceptable manufacturers: Hoffman, SCE and Wiegmann.

C. Approved wire and cable:

| j | | | | | | | |
|---|-----------|--------|-----------|---------------|----------------|------------|----------|
| Description | Conductor | Rating | West Penn | General Cable | Belden | Paige | Tappan |
| (1) pair #16AWG shielded with red jacket P16 | Stranded | FPLP | 60990Bs | - | 6200FL 0021000 | 454907ARE* | G50163.1 |
| | | FPLR | 991s | - | 5200FM 0021000 | 454627ARE* | F50141.1 |
| Description (1) pair #14AWG shielded with red jacket P14 | Stranded | FPLP | 60992Bs | - | 83752 0021000 | 454908ARE* | G60121.1 |
| | | FPLR | 995s | - | 5100FM 0021000 | 454648ARE* | F60167.1 |
| (1) pair #12AWG shielded with red jacket P12 | Stranded | FPLP | 60994Bs | - | 83802 0021000 | 454943ARE* | G70093.1 |
| | | FPLR | 999s | - | 5000FM 0021000 | 454687ARE* | F70095.1 |
| (4) pair #16AWG shielded with gray or black jacket O16 | Stranded | AERIAL | - | 232560 | 1039A 0107500 | 70232560 | - |
| (1) pair #14AWG shielded with gray or black jacket O14 | Stranded | AERIAL | AQ295 | C0458A.41.10 | 9314 0601000 | 70C0458A | - |
| (1) pair #12AWG shielded with gray or black jacket O12 | Stranded | AERIAL | AQ296 | C0460.38.10 | 9312 0601000 | 70C0460 | - |

* Note: All Paige stranded cables are special order.

- Electrical Contractor is responsible for verifying with the above listed cable manufacturers that the part numbers above are valid and match all of the listed requirements.

- Type P16, P14 and P12 cables shall have a red jacket.
- Type O16, O14 and O12 cables can have a black jacket.

- Refer to SSG document 28.320.001.014 for cable installation details.

D. Electrical Contractor provided wiring devices:

- Terminal blocks:

- Minimum rating: 10 amperes at 24VDC.
- Din Rail mounted.
- Two terminals, clamp type (open screw type not acceptable); accept up to #12 AWG wire.
- Acceptable manufacturers: Weidmuller SAK4, Phoenix, Allen Bradley and Square-D.
- Number and tag terminals consecutively.
 - Machine printed tags shall be used; hand written tags are prohibited.
- Assemble terminal strips and mount on back plate of termination cabinet.

E. Electrical Contractor provided field devices:

- Safety shower/eye-wash limit switches:

- Provide and install the following switches for safety shower/eye-wash stations:
 - TOPWORX GO Switch Cat. #11-11523-A4
 - TOPWORX GO Switch Target Magnet Cat. #4-V13060-S51
- Portable safety shower/eye-wash stations or eye-wash stations:

- a) Provide and install the following push/pull button for portable safety shower/eye-wash stations:
 - 2) Allen-Bradley jumbo mushroom head, 1 NO - 1 NC contact, red, model 800T-FXJ6A with model 800T-N310J guard. For classified (Class I, Div 2) areas substitute model 800T-FXJ6AR. Install EOL resistor as required.
 - 1) Surface mount enclosure for portable SS/EW push/pull buttons, single position: NEMA 4/13, Allen-Bradley model 800T-1TZ.
- 2. Walktest switches:
 - a) Allen-Bradley two position selector switch, model 800T-H2A with no legend plate. Install EOL resistor as required.
 - b) Surface mount enclosure for single walktest switch: NEMA 4/13, Allen-Bradley model 800T-1TZ.
- 3. Muster button:
 - a) Allen-Bradley jumbo mushroom head, 1 NO - 1 NC contact, green, model 800T-FXJ1A with model 800T-N310J guard. For classified (Class I, Div 2) areas substitute model 800T-FXJ1AR. Install EOL resistor as required.
 - b) Surface mount enclosure for muster buttons, single position: NEMA 4/13, Allen-Bradley model 800T-1TZ.
- 4. Emergency Ventilation Shutdown (EVS) button:
 - a) Allen-Bradley jumbo mushroom head, 1 NO - 1 NC contact, red, model 800T-FXJ6A with model 800T-N310J guard. For classified (Class I, Div 2) areas substitute model 800T-FXJ6AR. Install EOL resistor as required.
 - b) Surface mount enclosure for EVS buttons, single position: NEMA 4/13, Allen-Bradley model 800T-1TZ.
- 5. Temperature sensor:
 - a) Johnson Controls (A19BBC-2).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install system in accordance with manufacturer's specifications and instructions. All devices shall be installed in locations shown on drawings. Any conflicts with structure or equipment shall be addressed with the Owner's Representative prior to installation.
 - 1. All fire alarm cable shall be in fire alarm dedicated conduit. This includes any and all devices connected to the fire alarm system. Additional acceptable raceway includes Cable Tray & open wire method with J-hooks with Owner Approval.
 - 2. All pull boxes and conduit fitting covers shall be painted Red.
 - 3. The contractor shall mount and provide raceways between all fire alarm back-boxes as shown on the drawings. The contractor shall leave 10'-0" of wire for termination with the wire label marked within 1'-0" of entry into the panel. The Owner will mount interior fire alarm boards and provide final termination. The Electrical Contractor shall notify the Owner when the back-boxes are mounted, raceways installed, cable pulled, tagged, free of ground faults, short circuits and open circuits so that the panel commissioning may be scheduled.
- B. Terminations:
 - 1. Electrical Contractor shall verify that all shields are continuous and bonded together at each field device termination. Electrical Contractor shall verify that all shields are free from grounds with the exception of the single ground point in the 4100ES fire alarm panel. All shields shall be spliced using Dolphin Connectors. Exposed shield wiring shall not be

permitted. All wires and cables shall be labeled per the drawings without exception. Machine printed tags shall be used; hand written tags are prohibited.

2. Electrical Contractor shall insure that there are no splices outside of fire alarm panels, complete “unspliced” home runs from the fire alarm panel to the field devices are required.

C. Tagging:

1. Provide and install device and wire tags as noted on 28.320.001.002, 28.320.001.003 and 28.320.001.014.

D. Control and Termination Panels:

1. Assemble cabinets, mount devices, rail kits, panel tamper switch, and terminal strips.
2. Mount panels at location shown on drawings. Refer to SSG document 28.320.001.001 for mounting and conduit details.
3. Panel and box internal wiring is to be organized. Wires are to be grouped and secured to back panel at regular intervals.
4. Mount fire alarm panels and equipment as directed by Owner.
5. Double stick tape shall not be used to secure devices.

E. Mounting of EOL resistor on last device in circuit.

1. Prior to turning on any class B circuits, the Electrical Contractor shall verify that the EOL resistor is the correct value and that the loop is wired correctly.
2. Analog devices such as smoke detectors and duct smoke detectors do not require EOL resistors.
3. SIAM device circuits shall be monitored by a 6.8k ohm end-of-line resistor.
4. NAC circuits shall be monitored by a 10k ohm end-of-line resistor.
 - a) Exception: NAC circuits powered by the Altronix AL1042ULADA power supplies will require a 2.2k ohm end-of-line resistor.
5. The IdNET circuits may be “T-tapped” to facilitate installation. Only perform “T-taps” at device terminals, indicate T-taps on as-built drawings.
 - a) When wiring the IdNET circuit devices, care must be taken to limit the number of “T-taps.”
6. Indicating circuits (speaker and strobe circuits) may not be “T-tapped.”

F. All addressable devices shall be assigned an address by the Electrical Contractor by use of the dip-switches on the device. Refer to SSG document 28.320.001.004 - Detail F00 and Building Fire Alarm Points List for addressing. Install and terminate the device with the assigned addresses at the location shown on the drawings.

G. Automatic detector installation:

1. Thermal detectors, refer to SSG document 28.320.001.004 - Details F01 and F02:
 - a) Install only detector bases or housings to avoid contamination and loss during construction. Detectors should be installed just prior to system commissioning and left with the protective covering installed. In cases where the devices are above 10’-0”, pull strings shall be attached to the protective covers for easy removal.
2. Combination smoke/thermal detectors, refer to SSG document 28.320.001.004 - Details F01 and F02:
 - a) Install only detector bases or housings to avoid contamination and loss during construction. Detectors should be installed just prior to system commissioning and left with the protective covering installed. In cases where the devices are above 10’-0”, pull strings shall be attached to the protective covers for easy removal.

3. Linear thermal detecting cable, refer to SSG document 28.320.001.004 - Detail F05 and manufactures installation instructions.
4. VESDA systems, refer to SSG documents 28.320.001.016 and 28.320.001.017:
 - a) The Electrical Contractor is responsible for mounting and providing power to the VESDA panel and their power supplies.
 - b) Provide and install the required conduit and cabling for monitoring of the VESDA system as shown on the drawings in the Construction Work Package (CWP).
 - c) When using the VESDA Laser Plus, a dedicated VESDANET circuit shall be supplied. Install the Owner provided power supplies to power the VESDA panels.
 - d) When using the VESDA Laser Compact, a connection to the IdNET and 24VDC is required at the VESDA panel.
 - e) The entire sampling path shall consist of 3/4" diameter VESDA approved piping and fittings. The use of capillary tubes for drops to equipment is not acceptable.
 - f) When sampling tubes are run for ceiling protection ensure sampling point holes are located in the bottom side of pipe. Pipe shall be run as close to the ceiling level as possible.
 - g) When sampling tubes are run for sub-floor protection ensure sampling point holes are located in the bottom side of pipe. Pipe shall be run as close to the bottom of the raised floor tiles as possible.
 - h) When sampling points are required within an equipment enclosure coordinate closely with the equipment supplier for penetration locations and allowable penetration depth. Keep the sampling points as high in the cabinet as allowable.
 - i) When sampling points are required at the venting ports of a communication cabinet coordinate with the Communications Contractor for acceptable locations for pipe anchors and VESDA pipe. Ensure that the sampling points are at the exhaust vent for the enclosure. The exact sampling port size and locations shall be determined by the Aspire calculation for the system.
 - j) When a VESDA system is used as a duct smoke detector, care must be taken to ensure proper air flow through the piping. Coordinate sampling point size, locations, orientation, and spacing closely with the Aspire calculations and the manufacturer's requirements. It is the installing Contractor's responsibility to ensure proper operation of the detector.
 - k) Each sample point shall have an adhesive decal indicating the location of the sampling point. Decals shall be the type produced by VESDA specifically for sample point identification.
 - l) Pipe installation shall be conform to all manufacturers' guidelines. Ensure pipe joints are seated fully and bonded properly. Remove dust and shavings from all pipes before connection to the VESDA panel.
 - m) Bending of VESDA piping should be avoided. Use the appropriate, precast, pipe fittings to achieve the desired pipe configuration.
5. Duct smoke detectors, refer to SSG document 28.320.001.008 - Details F24, F25, F26 and 28.320.001.009 - Details F27, F28 (A or B) and F29. For Remote Duct Smoke Detectors refer to SSG documents 28.320.001.007.
 - a) Refer to IMC for placement.
 - b) Wire the RIAM shut-down relay to shut down respective unit only upon the detection of smoke in the duct smoke detector.
 - c) Secure both ends of the sampling tube. Always install tube in widest width of duct.

- d) Supply duct smoke detectors shall not be installed until after the insulation is installed on the ducts by the Mechanical Contractors. The insulation shall serve as a barrier between the side wall of the duct and the duct smoke detector housing. This will help to eliminate the build-up of condensation in the sealed housing of the duct smoke detector.
- 6. Flame Detector, refer to SSG document 28.320.001.010 - Details F30 and F31 and 28.320.001.011 - Detail F32:
 - a) Flame detector alarm contacts shall be individually monitored by an individual SIAM and supervised with a 6.8k ohm, 5 watt, 5% tolerance. 5 watt resistors are required to provide for heat dissipation.
 - b) Flame detector trouble contacts within a given area shall be NC and wired in series on one side of the loop. This loop will be monitored by a SIAM and terminated with a 6.8k ohm, ½ watt, 5% tolerance resistor for supervision.
 - c) Wall mount device in an accessible location as shown on the drawings in the CWP. Install the device at a location where it can best monitor the area for flames.
 - d) Flame detector is to be installed on the supplied swivel mount.

H. Initiating device installation:

- 1. Manual pull station installation, refer to SSG document 28.320.001.004 - Details F03 and F04:
 - a) Mount at 48" above finished floor and within 5'-0" of every exit doorway.
 - b) Manual pull stations shall be covered neatly with clear plastic bags and left with the reset key in the device. These bags and keys are to be removed after successful system commissioning.
 - c) Pull stations installed outdoors shall be protected with a weatherproof cover or shall be rated for installation in an outdoor environment.
- 2. Sprinkler system monitoring, refer to SSG document 28.320.001.006 - Details F13 and F22:
 - a) If sprinkler riser room has a junction box, mount the SIAM modules as shown on drawing.
 - b) Use normally open alarm contacts.
 - c) Mount EOL resistor across alarm contacts of the monitored device.
- 3. Safety shower/eye-wash (SS/EW) units, refer to SSG document 28.320.001.006 - Detail F17:
 - a) Combination safety shower and eye-wash units can share the same SIAM device for monitoring.
 - b) Mount EOL resistor across alarm contacts of the eye wash limit switch.
- 4. Walktest switches, refer to SSG document 28.320.001.006 - Detail F16:
 - a) All walktest switches and back-boxes shall be supplied by the Electrical Contractor.
 - 1) Sprinkler walktest switch: wall mount in an accessible location within the associated sprinkler riser room, mount at 54" above finished floor unless otherwise noted.
 - 2) SS/EW walktest switch: wall mount at location shown on the drawings in the CWP, mount at 54" above finished floor unless otherwise noted.
- 5. Muster buttons, refer to SSG document 28.320.001.006 - Detail F15:
 - a) Muster buttons and back-boxes shall be supplied by the Electrical Contractor.

- 1) Wall mount device in an accessible location as shown on the drawings in the CWP. Mount enclosure in horizontal orientation, 48" above finished floor unless otherwise noted.
6. EVS buttons, refer to SSG document 28.320.001.006 - Detail F18:
 - a) All EVS buttons and back-boxes shall be supplied by the Electrical Contractor.
 - 1) Wall mount device in an accessible location as shown on the drawings in the CWP. Mount enclosure in horizontal orientation, 54" above finished floor unless otherwise noted.
7. Temperature sensor, refer to SSG document 28.320.001.006 - Detail F14:
 - a) Wall mount device in an accessible location as shown on the drawings in the CWP, at 66" above finished floor unless otherwise noted.
 - b) Set temperature sensor to trip at 40 degrees Fahrenheit.
8. Oxygen monitors, refer to SSG document 28.320.001.006 - Detail F19:
9. HCL monitors, refer to SSG document 28.320.001.006 - Detail F19:
10. Emergency lighting UPS monitoring, refer to SSG document 28.320.001.006 - Detail F19:
 - a) The connection to the emergency lighting UPS is made inside of the network enclosure, which is typically located at the distribution end of the emergency lighting UPS.
11. High water level sensor, refer to SSG document 28.320.001.006 - Detail F19:
 - a) High water level detector panels are to be wall mounted at 66" above finished floor unless otherwise noted.
 - b) The high water level sensors are to be placed on the floor or subfloor dependent upon the application.
12. Heat trace monitoring, refer to SSG document 28.320.001.006 - Detail F19:
 - a) Heat tracing systems are to be monitored by the fire/life safety system for failure.
 - b) Refer to heat trace manufacturer's drawings for connection details.
13. Ancillary alarm panels, refer to SSG document 28.320.001.006 - Detail F19:
 - a) Specialized Suppression Systems:
 - 1) Suppression system control panels shall be monitored for alarm and trouble.
14. Fire pump controller, refer to SSG document 28.320.001.006 - Detail F19:
 - a) Equipment to be monitored will be per drawing in CWP.
15. Other devices, refer to SSG document 28.320.001.006 - Detail F19:
 - a) Other devices such as low fuel level, high fuel level, water tank level, etc. shall be provided and installed by the Electrical Contractor as shown on the drawings in the CWP.
- I. Notification appliance installation:
 1. Speakers, refer to SSG document 28.320.001.005 - Detail F11:
 - a) Wall mount, 80" to bottom of device above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - b) All speakers are to be set to 70V when installed.
 - c) Set speaker tap at the settings noted on the drawings in the CWP.
 2. Strobes, refer to SSG document 28.320.001.005 - Detail F11:

- a) Wall mount, 80" above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the lens.
- b) Set candela at the settings noted on the drawings in the CWP.
- 3. Speaker strobe combination device, refer to SSG document 28.320.001.005 - Detail F11:
 - a) Wall mount, 80" above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the lens.
 - b) Set candela at the settings noted on the drawings in the CWP.
 - c) All speakers are to be set to 70V when installed.
 - d) Set speaker tap at the settings noted on the drawings in the CWP.
- 4. Loud speaker with strobe, refer to SSG document 28.320.001.005 - Detail F09:
 - a) Wall mount, 80" above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the lens.
 - b) Set candela at the settings noted on the drawings in the CWP.
 - c) All speakers are to be set to 70V when installed.
 - d) Set speaker tap at the settings noted on the drawings in the CWP.
- 5. Dual strobe, refer to SSG document 28.320.001.005 - Detail F08:
 - a) Wall mount, 80" above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the amber lens.
 - a) Set candela at the settings noted on the drawings in the CWP.
- 6. Sprinkler bell, refer to SSG document 28.320.001.005 - Detail F10:
 - a) Wall mount, 96" above finished floor.
 - b) The sprinkler bell and back box must be installed in a weather proof manner.
 - c) Install the Owner supplied wire guard around each sprinkler bell.
- 7. CID2 rated speakers, refer to SSG document 28.320.001.005 - Details F06 and F12:
 - a) Wall mount, 80" to bottom of device above finished floor, or up 12" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - b) Install the 70V audio card in the C1D2 speakers.
 - c) When installed next to a C1D2 strobe, mount 12" above C1D2 rated strobe, or up to 12" below the ceiling to top of the device, whichever is lower.
 - d) Set speaker volume to the setting noted on the drawings in the CWP.
- 8. CID2 rated strobes, refer to SSG document 28.320.001.005 - Details F06 and F07:
 - a) Wall mount, 80" above finished floor or 6" below the ceiling, whichever is lower. Devices shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the lens.
 - b) Orient strobe vertically.
 - c) Set candela at the settings noted on the drawings in the CWP.
- J. Surge suppression, refer to SSG document 28.320.001.012 - F36:

1. Surge protection shall be installed on all exterior cable runs. Use surge protection panels, complete with a qualified earth ground in the enclosure for grounding of each of the surge suppressors.
 - K. Relay Individual Addressable Modules (RIAM), refer to SSG document 28.320.001.006 - Detail F20:
 1. RIAM's are to be used to interface with ancillary systems so that the ancillary systems function properly during an alarm condition within the fire/life safety system.
- 3.2 Testing and Commissioning:
- A. Test in accordance with NFPA, Local, State and Federal codes, standards and guidelines.
 - B. The Electrical Contractor is responsible for contacting the HSC Owners Representative to sign-out the SimplexGrinnell IdNET loop tester. Prior to contacting the equipment vendor for assembling the panel components, the Electrical Contractor shall provide documentation that the IdNET circuit passed inspection.
 - C. Testing and turnover.
 1. After the panel is fully assembled, programmed and checked out by the equipment vendor's technician, the turnover shall be scheduled.
 2. The Electrical Contractor who installed the cabling shall be responsible to troubleshoot and repair any problems with the wiring.
 3. An acceptance test shall be performed on the completed system (panel) per NFPA 72. This test shall be performed by the equipment vendor's technician and witnessed by the Owner's Loss Prevention team member. The results of this test shall be documented on "Fire Alarm System Inspection and Test Report" forms.
 - D. Final system check, board installation, programming, initial acceptance test, and energization shall be performed by the equipment vendor's technician.
 1. The Electrical Contractor is not required to be present during final system check, but shall correct any errors found within three (3) working days.
 2. Commissioning shall occur after device installation is complete, panels shall be programmed and stabilized, then final turnover will be scheduled.
- 3.3 As-Built Drawings:
- A. Prior to system testing the Electrical Contractor shall provide the Owner's Representative detailed as-built drawings showing routes of cabling and any pre-approved relocation of devices and/or equipment. The as-built drawings shall include the following information;
 1. All wire and cable routes.
 2. End-of-Line device locations.
 3. Locations of all T-taps
 4. Any deviation from original drawings, including relocation of devices.
 5. Complete equipment list detailing parts used and quantities.
 6. Any splice points not within a device enclosure that were pre-approved by the Owner's Representative. Splice points exterior to the fire alarm system are not allowed unless approved in writing by Owner.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers requirements for Siemens XLS version Fire/Life Safety Alarm system devices and wiring. It is intended to supplement the Fire Alarm information.

1.2 REFERENCES

- A. SSG documents:

1. 28.321.001.001 Siemens XLS Fire/Life Safety System Installation Details
2. 28.321.001.002 Siemens XLS Fire/Life Safety System Installation Details
3. 28.321.001.003 Siemens XLS Fire/Life Safety System Installation Details
4. 28.321.001.004 Siemens XLS Fire/Life Safety System Tagging Details
5. 28.321.001.005 Siemens XLS Fire/Life Safety System Tagging Details

PART 2 PRODUCTS**2.1 CONTRACTOR FURNISHED MATERIALS**

- A. Including but not limited to the products, materials, cable and wire listed in section 2.01.

- B. Junction Boxes and Enclosures

1. Junction Boxes:

- a) Wall mounted, steel, enclosed and gasketed (NEMA 12 indoors and NEMA 4X outdoors, NEMA 4X is to be used indoors in wet or moist environments), with removable mounting plate in back of box (ensure plate is bonded to junction box/enclosure).
- b) Screw or clamp type latch.
- c) Acceptable manufacturers: Hoffman, SCE and Weigemann.

- C. Wire and Cable

| Description | Conductor | Rating | West Penn | General Cable | Belden | Paige | Tappan |
|--|-----------|--------|-----------|---------------|----------------|------------|----------|
| (1) pair #16AWG shielded with red jacket P16 | Stranded | FPLP | 60990Bs | - | 6200FL 0021000 | 454907ARE* | G50163.1 |
| | | FPLR | 991s | - | 5200FM 0021000 | 454627ARE* | F50141.1 |
| Description (1) pair #14AWG shielded with red jacket P14 | Stranded | FPLP | 60992Bs | - | 83752 0021000 | 454908ARE* | G60121.1 |
| | | FPLR | 995s | - | 5100FM 0021000 | 454648ARE* | F60167.1 |
| (1) pair #12AWG shielded with red jacket P12 | Stranded | FPLP | 60994Bs | - | 83802 0021000 | 454943ARE* | G70093.1 |
| | | FPLR | 999s | - | 5000FM 0021000 | 454687ARE* | F70095.1 |
| (4) pair #16AWG shielded with gray or black jacket O16 | Stranded | AERIAL | - | 232560 | 1039A 0107500 | 70232560 | - |
| (1) pair #14AWG shielded with gray or black jacket O14 | Stranded | AERIAL | AQ295 | C0458A.41.10 | 9314 0601000 | 70C0458A | - |
| (1) pair #12AWG shielded with gray or black jacket O12 | Stranded | AERIAL | AQ296 | C0460.38.10 | 9312 0601000 | 70C0460 | - |

* Note: All Paige stranded cables are special order.

1. Electrical Contractor is responsible for verifying with the above listed cable manufacturers that the part numbers above are valid and match all of the listed requirements.
 - a) Type P16, P14 and P12 cables shall have a red jacket.
 - b) Type O16, O14 and O12 cables can have a black jacket.
2. Refer to SSG document 28.320.001.014 for cable installation details.

D. Electrical Contractor provided wiring devices:

1. Terminal blocks:
 - a) Minimum rating: 10 amperes at 24VDC.
 - b) Din Rail mounted.
 - c) Two terminals, clamp type (open screw type not acceptable); accept up to #12 AWG wire.
 - d) Acceptable manufacturers: Weidmuller SAK4, Phoenix, Allen Bradley and Square-D.
 - e) Number and tag terminals consecutively.
 - 1) Machine printed tags shall be used; hand written tags are prohibited.
 - f) Assemble terminal strips and mount on back plate of termination cabinet.

E. Electrical Contractor provided field devices:

1. Safety shower/eye-wash limit switches:
 - a) Provide and install the following switches for safety shower/eye-wash stations:
 - 1) TOPWORX GO Switch Cat. #11-11523-A4
 - 2) TOPWORX GO Switch Target Magnet Cat. #4-V13060-S51
2. Portable safety shower/eye-wash stations or eye-wash stations:
 - b) Provide and install the following push/pull button for portable safety shower/eye-wash stations:
 - 1) Allen-Bradley jumbo mushroom head, 1 NO - 1 NC contact, red, model 800T-FXJ6A with model 800T-N310J guard. For classified (Class I, Div 2) areas substitute model 800T-FXJ6AR. Install EOL resistor as required.
 - 2) Surface mount enclosure for portable SS/EW push/pull buttons, single position: NEMA 4/13, Allen-Bradley model 800T-1TZ.
3. Walktest switches:
 - a) Allen-Bradley two position selector switch, model 800T-H2A with no legend plate. Install EOL resistor as required.
 - b) Surface mount enclosure for single walktest switch: NEMA 4/13, Allen-Bradley model 800T-1TZ.
4. Muster button:
 - a) Allen-Bradley jumbo mushroom head, 1 NO - 1 NC contact, green, model 800T-FXJ1A with model 800T-N310J guard. For classified (Class I, Div 2) areas substitute model 800T-FXJ1AR. Install EOL resistor as required.
 - b) Surface mount enclosure for muster buttons, single position: NEMA 4/13, Allen-Bradley model 800T-1TZ.
5. Emergency Ventilation Shutdown (EVS) button:
 - a) Allen-Bradley jumbo mushroom head, 1 NO - 1 NC contact, red, model 800T-FXJ6A with model 800T-N310J guard. For classified (Class I, Div 2) areas substitute model 800T-FXJ6AR. Install EOL resistor as required.

- b) Surface mount enclosure for EVS buttons, single position: NEMA 4/13, Allen-Bradley model 800T-1TZ.
- 6. Temperature sensor:
 - a) Johnson Controls (A19BBC-2)
- 7. Water sensor:
 - a) Provide and install the following water sensor:
 - 1) Winland (WB-800)

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install system in accordance with manufacturer's specifications and instructions. All devices shall be installed in locations shown on drawings. Any conflicts with structure or equipment shall be addressed with the Owner's Representative prior to installation.
 - 1. All fire alarm cable shall be in fire alarm dedicated conduit. This includes any and all devices connected to the fire alarm system. Additional acceptable raceway includes Cable Tray & open wire method with J-hooks with Owner Approval.
 - 2. All pull boxes and conduit fitting covers shall be painted Red.
 - 3. The contractor shall mount and provide raceways between all fire alarm back-boxes as shown on the drawings. The contractor shall leave 10'-0" of wire for termination with the wire label marked within 1'-0" of entry into the panel. The Owner will mount interior fire alarm boards and provide final termination. The Electrical Contractor shall notify the Owner when the back-boxes are mounted, raceways installed, cable pulled, tagged, free of ground faults, short circuits and open circuits so that the panel commissioning may be scheduled.
- B. Terminations:
 - 1. Contractor will verify that all shields are continuous and bonded together at each device tie in point. Contractor will verify that all shields are free from grounds with the exception of the single ground point in the head-end fire alarm panel. All shields shall be spliced using splice caps and insulated by the use of electrical tape or heat shrink tubing. Exposed shield wiring shall not be permitted. All wires and cables shall be labeled per drawings without exception. Machine printed tags shall be used; hand written tags shall not be used.
 - 2. Contractor shall insure that there are no splices outside of fire alarm panels, complete "unspliced" home runs from the fire alarm panel to the field devices are required
- C. Tagging:
 - 1. Provide and install device and wire tags as noted on 28.321.001.004.
- D. Control and Termination Panels:
 - 1. Assemble cabinets, mount devices, rail kits, panel tamper switch, and terminal strips.
 - 2. Mount panels at location shown on drawings. Refer to SSG document 28.321.001.003 for mounting and conduit details.
 - 3. Panel and box internal wiring is to be organized. Wires are to be grouped and secured to back panel at regular intervals.
 - 4. Mount and terminate fire alarm panels and equipment as directed by Owner.
 - 5. Double stick tape shall not be used to secure devices.
- E. Mounting of EOL resistor on last device in circuit.
 - 1. Prior to turning over meter on all class B circuits, Contractor shall verify that the EOL resistor is the correct value and that the loop is wired correctly.

2. Device circuits (Analog only) may be "T-tapped" to facilitate installation. Only perform "T-taps" at device terminals or within Termination Boxes, indicate T-taps on as built drawings. Indicating circuits (Speaker/ Strobe) may not be "T-tapped". Analog devices such as smoke detectors and duct detectors do not require EOL resistors. When wiring analog devices, care must be taken to limit the number of T-taps.
- F. Analog Initiating devices shall be programmed by the Owner. Gather, install and terminate correct device in location as shown in drawings.
- G. Automatic Detector Installation:
1. Heat Detectors: Refer to SSG document 28.321.002.006 detail F11.
 2. Smoke and Combination Detectors: Refer to SSG document 28.321.001.001 detail F11.
 3. Duct Detectors. Refer to SSG documents 28.321.001.001 and 28.321.001.003 details F09, F21, F22 and F23.
 - a) Refer to NFPA 90A for placement.
 - b) Wire HVAC shut-down relay to shut down respective unit only.
 - c) Secure both ends of the sampling tube. Always install tube in widest width of duct.
 - d) Where in duct smoke detectors are installed in concealed locations more than 10' AFF or in locations where the devices indicators are not clearly visible, the duct detector shall be provided with a remote indication devices at a location as stipulated by owner.
 4. Install only detector bases or housings to avoid contamination and loss during construction. Detectors should be installed just prior to system commissioning and left with the protective covering installed. In cases where the devices are above 10' pull strings shall be attached to the protective covers for easy removal.
 5. Supply duct smoke detectors shall not be installed until after the insulation is installed on the ducts by the Mechanical Contractors. The insulation shall serve as a barrier between the side wall of the duct and the duct smoke detector housing. This will help to eliminate the build-up of condensation in the sealed housing of the duct smoke detector.
 6. VESDA systems, refer to SSG documents 28.320.001.016 and 28.320.001.017:
 - a) The Electrical Contractor is responsible for mounting and providing power to the VESDA panel and their power supplies.
 - b) Provide and install the required conduit and cabling for monitoring of the VESDA system as shown on the drawings in the Construction Work Package (CWP).
 - c) When using the VESDA Laser Plus, a dedicated VESDANET circuit shall be supplied. Install the Owner provided power supplies to power the VESDA panels.
 - d) When using the VESDA Laser Compact, a connection to the IdNET and 24VDC is required at the VESDA panel.
 - e) The entire sampling path shall consist of 3/4" diameter VESDA approved piping and fittings. The use of capillary tubes for drops to equipment is not acceptable.
 - f) When sampling tubes are run for ceiling protection ensure sampling point holes are located in the bottom side of pipe. Pipe shall be run as close to the ceiling level as possible.
 - g) When sampling tubes are run for sub-floor protection ensure sampling point holes are located in the bottom side of pipe. Pipe shall be run as close to the bottom of the raised floor tiles as possible.
 - h) When sampling points are required within an equipment enclosure coordinate closely with the equipment supplier for penetration locations and allowable penetration depth. Keep the sampling points as high in the cabinet as allowable.

- i) When sampling points are required at the venting ports of a communication cabinet coordinate with the Communications Contractor for acceptable locations for pipe anchors and VESDA pipe. Ensure that the sampling points are at the exhaust vent for the enclosure. The exact sampling port size and locations shall be determined by the Aspire calculation for the system.
 - j) When a VESDA system is used as a duct smoke detector, care must be taken to ensure proper air flow through the piping. Coordinate sampling point size, locations, orientation, and spacing closely with the Aspire calculations and the manufacturer's requirements. It is the installing Contractor's responsibility to ensure proper operation of the detector.
 - k) Each sample point shall have an adhesive decal indicating the location of the sampling point. Decals shall be the type produced by VESDA specifically for sample point identification.
 - l) Pipe installation shall conform to all manufacturers' guidelines. Ensure pipe joints are seated fully and bonded properly. Remove dust and shavings from all pipes before connection to the VESDA panel.
 - m) Bending of VESDA piping should be avoided. Use the appropriate, precast, pipe fittings to achieve the desired pipe configuration.
- H. Manual Pull Station Installation: Refer to SSG document 28.321.001.001 detail F06.
- 1. Mount at 48" above finished floor and within 5ft of the exit doorway.
 - 2. Cover stations neatly with clear plastic bags after installation. These bags are to be removed after successful system commissioning.
 - 3. Manual pull stations in C1D1 or C1D2 areas shall be explosion proof non-analog devices monitored by a SIM module.
 - 4. Pull stations exposed to outside weather will be protected with a weatherproof cover.
- I. Sprinkler System Monitoring: Refer to SSG document 28.321.001.001 details F03 and F04.
- 1. When used, mount transponder module per drawing.
 - 2. Use Normally Open alarm contacts.
 - 3. Mount resistor across alarm contacts of monitored device.
 - 4. The sprinkler waterflow detection device must be field adjusted so that an alarm is initiated no more than 90 seconds after a sustained flow of at least 40 L/min (10 gpm)
- J. Safety Shower and Eye Wash (SS/EW) Units: Refer to SSG document 28.321.001.001 details F01 and F08.
- K. Flame Detector; Refer to SSG document 28.321.001.002 Details F19 and F20:
- 1. Flame detector alarm contacts shall be individually monitored by an individual SIAM and supervised with a 6.8k ohm, 5 watt, 5% tolerance. 5 watt resistors are required to provide for heat dissipation.
 - 2. Flame detector trouble contacts within a given area shall be NC and wired in series on one side of the loop. This loop will be monitored by a SIAM and terminated with a 6.8k ohm, ½ watt, 5% tolerance resistor for supervision.
 - 3. Wall mount device in an accessible location as shown on the drawings. Place device at a location where the device can best monitor the area for flames.
 - 4. Flame detector is to be installed on the swivel mount.
- L. Walktest switches, refer to SSG document 28.321.001.001 - Detail F04:
- 1. All walk test switches and back-boxes shall be supplied by the Electrical Contractor.

- a) Sprinkler walk test switch: wall mount in an accessible location within the associated sprinkler booth, mount at 54" above finished floor unless otherwise noted.
 - b) SS/EW walk test switch: wall mount at location shown on the drawings, mount at 54" above finished floor unless otherwise noted.
- M. Muster buttons, refer to SSG document 28.321.001.001 - Detail F07:
- 1. The muster button and back-box shall be supplied by the Electrical Contractor.
 - a) Wall mount device in an accessible location as shown on the drawings. Mount enclosure in horizontal orientation, 48" above finished floor unless otherwise noted.
- N. Remote Control Points (ICP's):
- 1. Used to remotely control strobe and speaker circuits, and monitor remote power supplies.
 - 2. Install adjacent to first controlled device. ICP's must be configured using the supplied programmer.
 - 3. ICP's require connection to the SLC (ALD loop) and either 24VDC power or a power (70.7V) audio riser.
- O. Indicating Appliances; Refer to SSG document 28.321.001.001 and 28.321.001.002 details F02, F10, F14 and F15.
- 1. Speakers:
 - a) Wall mount, 80" above finished floor, or 6 inches below the ceiling, whichever is lower.
 - b) Set speaker tap at the settings noted on the drawings.
 - 2. Strobes:
 - a) Wall mount, 80" above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the lens.
 - b) Set candela tap at the settings noted on the drawings.
 - 3. Speaker strobe combinations:
 - a) Wall mount, 80" above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the lens.
 - b) Set candela tap at the settings noted on the drawings.
 - c) All speakers are to be set to 70V when installed.
 - d) Set speaker tap at the settings noted on the drawings.
 - 4. C1D2 rated Speakers
 - a) Wall mount, 80" to bottom of device above finished floor, or 6" below the ceiling, whichever is lower. Device shall not be mounted higher than 96" above finished floor.
 - b) Install the 70V audio card in the C1D2 speakers.
 - c) Set speaker tap at the settings noted on the drawings.
 - d) When installed next to a C1D2 strobe, mount 12" above C1D2 rated strobe, or 6" below the ceiling to top of the device, whichever is lower.
 - 5. C1D2 rated strobes:
 - a) Wall mount, 80" above finished floor or 6" below the ceiling, whichever is lower. Devices shall not be mounted higher than 96" above finished floor.
 - 1) Measurement shall be from the bottom of the lens.

- b) Orient strobe vertically.
 - c) Set candela tap at the settings noted on the drawings.
 - P. Temperature Switches: Refer to SSG document 28.321.001.002 detail F13
 - 1. Mount switches at 66" above finished floor.
 - 2. Set to trip at 40 degrees Fahrenheit, falling.
 - 3. Install EOL during initial installation for this device.
 - Q. Tamper Switch: Refer to SSG document 28.321.001.002 detail F17.
 - 1. Install on Panels when shown on the Riser diagrams.
 - 2. Tamper switches at minimum will be installed on all fire alarm fiber cabinets.
 - R. Alarm Panels:
 - 1. CO2 discharge panels:
 - a) Existing suppression system control panels shall be monitored for alarm and trouble.
 - b) Additional points may include pre-alarm, pre-release, and additional alarm and trouble "points".
 - c) Install transponder modules adjacent to existing panels and connect to contact outputs on alarm panel.
 - d) Alarm contact shall be programmed as "alarm" inputs.
 - S. Conventional Zone Modules (CZM's):
 - 1. Used to monitor remote (>200') devices or a "zone" of devices, such as heat detectors.
 - 2. Connect SLC and 24VDC to unit.
 - 3. Provide EOL resistor at last device.
 - T. Other Sensors:
 - 1. Other sensors such as high water, low fuel shall be provided and installed by the electrical contractor as shown on the prints.
 - U. Surge Suppression: Refer to SSG document 28.321.001.002 detail F16.
 - 1. Specified transector surge protection shall be installed on all exterior building cable runs. The transector surge protectors shall be din rail mounted and complete with a qualified earth ground in the enclosure for grounding of each of the surge suppressors.
 - V. Fire Pump Controller:
 - 1. Points to be monitored will be per drawing in CWP.
- 3.2 TESTING AND COMMISSIONING:
- A. Testing and turnover.
 - 1. After the panel is fully assembled, programmed and checked out by the equipment vendor's technician, the switch-over shall be scheduled.
 - 2. The contractor who installed the cabling shall be responsible to troubleshoot and repair any problems with the wiring.
 - 3. An acceptance test shall be performed on the completed system (panel) per NFPA 72. This test shall be performed by the equipment vendor's technician and witnessed by Loss Prevention. The results of this test shall be documented on "Fire Alarm System Inspection and Test Report" forms.
 - 4. The Contractor shall be present at the acceptance test and they must be accessible for any deficiencies that must be addressed. Deficiencies shall be communicated to the Contractor by the Owner's Representative and logged in the inspection and test log. If problems are

found, during the acceptance test, with the Contractors installation the Contractor shall remedy the situation within three working days.

- B. Final system check, board installation, programming, initial acceptance test, and energization shall be performed by the equipment vendor's technician.
1. Contractor is not required to be present during final system check, but will correct any errors found within three working days.
 2. Commissioning shall occur after device installation is complete, panel shall be programmed and stabilized, then final switch over will be scheduled.

3.3 AS-BUILT DRAWINGS:

- A. Prior to system testing the Contractor shall provide the Owner's Representative with detailed as-built drawings showing routes of cabling and any pre-approved relocation of devices and/or equipment. The as-built drawings will include the following information;
1. All wire and cable routes
 2. End-of-Line devices
 3. Locations drawings showing T-Taps
 4. Any derivation from original drawings, including relocation of devices.
 5. Complete equipment list detailing parts used and counts
 6. Any splice points not within a device enclosure that were pre-approved by the Owner's Representative. All splice points exterior to the fire alarm system are not allowed unless approved in writing by HSC loss prevention group.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This Section includes general administrative and procedural requirements for sections under Division 16, and is intended to supplement, not supersede, Division 1 requirements.

1.2 REFERENCES**A. SSG:**

1. 28.140.001.001: Security - Access Control System Type 1-5 Door Details
2. 28.140.001.002: Security - Access Control System Type 6-10 Door Details
3. 28.140.001.003: Security - Access Control System Type 11-12 Door Details
4. 28.140.001.004: Security - Access Control System Type 14-16 Door Details
5. 28.140.001.005: Security - Access Control System Type 20, 21 & 22 Door Types
6. 28.140.001.006: Security - Access Control System Type 23-24 Door Types
7. 28.140.001.009: Security - Muster Accountability System Type 35-39 Door Details
8. 28.140.001.010: Security - Muster Accountability System Type 40-44 Door Details
9. 28.140.001.011: Security - Access Control System Type 1 Door Wiring Diagram
10. 28.140.001.012: Security - Access Control System Type 2 Door Wiring Diagram
11. 28.140.001.013: Security - Access Control System Type 3 Door Wiring Diagram
12. 28.140.001.014: Security - Access Control System Type 4 Door Wiring Diagram
13. 28.140.001.015: Security - Access Control System Type 5 Door Wiring Diagram
14. 28.140.001.016: Security - Access Control System Type 6 Door Wiring Diagram
15. 28.140.001.018: Security - Access Control System Type 7 & 8 Door Wiring Diagram
16. 28.140.001.019: Security - Access Control System Type 9 Door Wiring Diagram
17. 28.140.001.023: Security - Access Control System Type 13 Door Wiring Diagram
18. 28.140.001.024: Security - Access Control System Type 14 Door Wiring Diagram
19. 28.140.001.025: Security - Access Control System Type 15 Door Wiring Diagram
20. 28.140.001.030: Security - Access Control System Type 20 Door Wiring Diagram
21. 28.140.001.031: Security - Access Control System Type 21 Door Wiring Diagram
22. 28.140.001.032: Security - Access Control System Type 22 Door Wiring Diagram
23. 28.140.001.033: Security - Access Control System Type 23 Door Wiring Diagram
24. 28.140.001.034: Security - Access Control System Type 24 Door Wiring Diagram
25. 28.140.001.036: Security - Access Control System Type 24 Door Wiring Diagram
26. 28.140.001.035: Security - Intrusion Detection System Wiring Details
27. 28.140.001.036: Security - Intrusion Detection System Installation Details
28. 28.140.001.037: Security - Muster Accountability System Installation Details
29. 28.140.001.038: Security - Access Control System Door Frame Back Box Details
30. 28.140.001.039: Security - Access Control System Surge Suppression Details
31. 28.140.001.040: Electronic Security System HSC Cable Labels
32. 28.140.001.041: Security – Access Control System Card Reader Installation Details
33. 28.140.001.042: Security – Access Control System Electrified Lockset Details

- 34. 28.140.001.043: Security – Access Control System Electromagnetic Lock Details
- 35. 28.140.001.044: Electronic Security System Panel Installation Details
- 36. 28.140.001.045: Security – Access Control System Riser Diagram
- 37. 28.140.001.046: Security – Muster Accountability System Riser Diagram
- 38. 28.140.001.047: Electronic Security System Legend Sheet
- 39. 28.140.001.050: Security – Access Control System Single I-Star Panel Cabinet Details
- 40. 28.140.001.052: Security – Access Control System Power Controller Wiring Details
- 41. 28.140.001.053: Security – Access Control System AL1012ULXB to GCM Wiring Details
- 42. 28.140.001.054: Security – Access Control System AL1024ULXB to PCM Wiring Details
- 43. 28.140.001.056: Security - Access Control System Device Tagging Details
- 44. 28.140.001.057: Security - Access Control System Device Tagging Details
- 45. 28.140.001.059: Security – Muster Accountability System Tagging Details

PART 2 PRODUCTS

2.1 CONTRACTOR FURNISHED MATERIALS

- A. Electrical Contractor Furnished Materials

PART 3 EXECUTION

3.1 EXAMINATION

- A. Conditions: Under other sections, verify conditions are acceptable for product installation in accordance with manufacturer's instructions.
- B. Pathways: Under other sections, verify that pathways and supporting devices are properly and permanently installed; and the temporary supports, devices, etc., have been removed.
- C. Field Measurements: Verify dimensions of pathways, including length of pathways.

3.2 INSTALLATION

- A. Install system in accordance with manufacturer's instructions. All devices shall be installed in locations shown on drawings. Any conflicts with structure or equipment shall be addressed with the Owner's Representative prior to installation.
 - 1. All vertical cable below the ceiling shall be in conduit. This includes any and all devices connected to the electronic security system.
 - a) Exceptions:
 - 1) Where cables route into Access Control Cabinet, wire mesh may be used if
 - 2) applicable. This raceway will be determined by the drawings.
 - 3) When a new system is installed in an existing building, wire mold may be used.

This raceway will be determined by the drawings.
 - 2. Horizontal cable shall be ran in communications cable tray where a divider has been installed for security cables.
 - a) Exception:
 - 1) J-hooks may be used where cable tray is not available.
- B. TBS Cabinets:
 - 1. Mount where shown on drawings.
 - 2. Assembly: Install panels, expansion modules, din rails, terminal strips, relays, Panduit, and tamper switches.

3. Fasten the devices to back plate of enclosure using #10-32 or #14-20 threaded fasteners in drilled and tapped holes. Use metal ¾" spacers when mounting expansion modules.
4. Internal cabinet wiring is to be organized. Wires are to be grouped and secured to the back panel at regular intervals. Install Panduit wire management where needed.
5. Install screw on wire management clips where needed. Double stick tape shall not be used to secure devices.

C. Terminations

1. Splices outside of electronic security system panels are not permitted. Complete "unspliced" home runs from the electronic security system panel to the field devices are required.
2. For all wire-to-wire terminations use Dolphin connectors, part number DC-100-P.
3. All wires and cables shall be labeled per drawings without exception. Machine printed tags shall be used; hand written tags shall not be used.
4. The Contractor shall leave 10' of wire for termination with the wire label marked within 1' of entry into the Access Control Cabinet.
5. All terminations inside of the access control cabinet shall be terminated by security contractor under another contract.

D. End-of-Line Resistors (EOL)

1. An EOL shall be installed on all inputs circuits.
2. The EOL shall be installed inside of the device being monitored.
 - a) Where the EOL cannot be installed inside of the device, it shall be installed as close to the device as possible without disabling the function of the device.
3. Refer to SSG 28.140.001.011 thru 28.140.001.035 for EOL wiring details.

E. Tamper Switches

1. Install on TBS Cabinets and Panels as shown on drawings.

F. Access Control System (ACS) Equipment

1. Card Reader Installation

a) R10

- 1) Mullion Mount
- 2) Shall be mounted at 48" A.F.F.

b) R40

- 1) Shall be mounted at 48" A.F.F.
- 2) Should be mounted on wall at latching side of the door.
 - (i) Shall be mounted within 12" of door opening.
 - (ii) Exception: When used for egress through a double leaf door opening.
 - Shall be mounted within 12" from the edge of the opened door leaf.
 - When possible do not place card readers in location behind an open door.

c) R90

- 1) Shall be mounted on contractor provided stanchion, part number S3S31284/50-
- 2) WPC-SPECIAL manufactured by PMP.
- 3) Shall be powered by a dedicated 24VDC circuit.
- 4) Shall not be a triggered output in a fire alarm event.
- 5) Shall be protected by lightning protection.

d) Combine all card reader cable shields and bond to access control cabinet.

- 1) In applications where an access control cabinet is not used, bond card reader cable drain wires to I-Star panel.
 2. Door Hardware Installation
 - a) General Contractor is responsible for installation of all electronic door hardware.
 - 1) Exceptions:
 - (i) Surface mounted door contacts.
 - (ii) PT-3V power transfer loop.
 - b) Refer to SSG document 28.140.001.001 through 28.140.001.010 for device locations.
 - c) Refer to SSG document 28.140.001.011 through 28.140.001.035 for wiring details.
 3. Gate Controls Installation
 - a) All wiring from gate controller to respective building access control equipment shall be protected by lightning protection.
 - b) Electrical contractor to pull gate controller cabling to gate controller and leave 5' of cable coiled inside of gate controller enclosure. All wire terminations inside of the gate controller shall be terminated by gate controller manufacturer's technician.
- G. Intrusion Detection System (IDS) Equipment
1. Door Position Switch Installation
 - a) General Contractor is responsible for installation of all electronic door hardware.
 - 1) Exceptions:
 - (i) Surface mounted door contacts.
 - (ii) PT-3V power transfer loop.
 - b) Door position switches should be mounted with tamper resistance in mind. For maximum sensitivity, the unit should be mounted opposite hinged side of door.
 - c) Refer to SSG document 28.140.001.001 through 28.140.001.010 for device locations.
 2. Gate Position Switch Installation
 - a) Gate position switch shall be mounted at the center height of the gate on the latch side of opening.
 - 1) All gate monitoring should be via balance magnetic switches. The status switch contacts shall be closed when the gate is closed.
 - b) Refer to SSG document 28.140.001.047 for installation details.
 - c) Refer to SSG document 28.140.001.046 for wiring details.
 3. Glass Break Sensor Installation
 - a) Sensors should be mounted on an adjacent wall or the ceiling of a room, mounted at a minimum distance of 3.3' and a maximum distance of 25' from the window(s) being protected.
 - 1) Exception: Where the ceiling is higher than 12' or is sloped away from the window(s) being protected, they may be mounted on a wall or column within 25' from the window(s) being protected.
 4. Motion Sensor Installation
 - a) Sensors should be mounted on the ceiling of a room and within 25' from the area being protected.
 - 1) Exception: Where the ceiling is higher than 12' or is sloped away from the area being protected, they may be mounted on a wall or column within 20' from the area being protected.

5. Hold Up Button Installation

- a) Hold up devices are mechanical switches permanently mounted in an inconspicuous location, such as under a counter or desk. They should be simple push-button switches, activated by the touch of a finger or hand.

H. Muster Accountability System (MAS) Equipment

1. Accountability Card Reader Installation

- a) Refer to Section 3.02-F-1.

2. Muster Card Reader Installation

- a) Muster card reader should be mounted at 48" AFF within 12" of the muster button.
- b) Refer to SSG document 28.140.001.009 and 28.140.001.011 for installation details.

3. Green Muster Light Installation

- a) Muster light should be mounted at the top of the door or 80" AFG when not next to a door. In the case where another device is existing in that location. It may be relocated near the desired location with 6" space between the muster light and any other device. Owner shall approve the location before the muster light is installed.
- b) Refer to SSG document 28.140.001.049 for installation details.

4. Request-to-Print Button Installation

- a) Shall be mounted at 48" AFF within 12" of the muster card reader.

5. Muster Display Installation

- a) Install power and Communications per drawings in CWP.

I. Grounding

1. Contractor shall verify that all devices and components are grounded according to SSG document 16020.

J. Tagging

1. Contractor shall verify that all equipment is tagged properly.
2. Refer to SSG document 28.140.001.056, 28.140.001.057 and 28.140.001.059 for tagging details.
 - a) If device is not a part of the SSG documents, contact construction representative for tag location.

3.3 TESTING AND COMMISSIONING

- A. Test in accordance with NFPA, Local, State and Federal codes, standards and manufacturer's guidelines.

B. As-Built Drawings Submittal Requirements

1. Quantity: Submit quantity of as-built drawings as described in Division 1. In the absence of requirements, submit (1) set of as-built drawings.
2. Format:
 - a) Prepare as-built drawings by "Red Marking" Owner provided engineering drawings.
 - b) Use the same sheet size as the Contractor Documents, and use the project title block.
 - c) Text: Minimum of 3/32" high and legible penmanship.
 - d) Use symbols identical to the symbols shown on the drawings.
 - e) Mark up system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.

3. Content:
 - a) As-built drawings shall fully represent actual installed conditions and shall incorporate revisions made during the course of construction.
 - b) All wire and cable routes.
 - c) End-of-Line devices
 - d) Relocation of devices
 - e) Complete equipment list detailing parts used and counts.
- C. Testing and Turnover:
 1. After the system is fully assembled, programmed and checked out by the equipment vendor's technician, the switch-over shall be scheduled.
 2. The contractor who installed the cabling and field devices shall be responsible to troubleshoot and repair any problems with the cabling and field devices.
 3. An acceptance test shall be performed on the completed system. This test shall be performed by the equipment vendor's technician and witnessed by Loss Prevention. The results of this test shall be documented on the "Electronic Security System Inspection and Test Report" forms.
 4. The Contractor shall be present at the acceptance test and they must be accessible for any deficiencies that must be addressed. Deficiencies shall be communicated to the Contractor by the Owner's Representative and logged in the inspection and test log. If problems are found, during the acceptance test, with the Contractor's installation, the Contractor shall remedy the situation within three working days.
- D. Final system check, board installation, programming, initial acceptance test and energization shall be performed by the equipment vendor's technician.
 1. The Contractor is not required to be present during the final system check, but will be responsible to correct any errors found, within three working days.
 2. Commissioning shall occur after device installation is complete, panel shall be programmed stabilized, and then final switch-over will be scheduled.

END OF SECTION

PART 1 GENERAL**1.1 SCOPE**

- A. This section covers requirements for the installation of CCTV systems:

1.2 REFERENCES

A. SSG Document

1. 28.240.002 Hemlock Semiconduction CCTV system Installation Guide.
 - a) 28.240.002.001 Beam and Pole Mount CCTV Detail
 - b) 28.240.002.002 Thermal Imaging and Esprit Mounting CCTV Detail
 - c) 28.240.002.003 Class 1 Division 2 Camera Mounting Detail
 - d) 28.240.002.004 Reactor Wall CCTV Mounting Detail
 - e) 28.240.002.005 CCTV Camera Perimeter Fence Line Mounting Elevation Details
 - f) 28.240.002.006 Interior Analog CCTV Mounting Details
 - g) 28.240.002.007 Interior IP CCTV Mounting Detail
 - h) 28.240.002.008 CCTV Camera Mounting Detail
 - i) 28.240.002.009 Metal CCTV Pole Electrical Details
 - j) 28.240.002.010 CCTV Column Mounted Electrical Details
 - k) 28.240.002.011 CCTV Wood Pole Mounted Electrical Details
 - l) 28.240.002.012 Enlarged Metal CCTV Pole Electrical Details
 - m) 28.240.002.013 CCTV TBS Cabinet High Line Bent/Vertical Beam & Pole Mounting Details
 - n) 28.240.002.014 CCTV Class I Div II Enclosure Network Connection Detail
 - o) 28.240.002.015 CCTV Media Conversions Enclosure Network Connection Detail
 - p) 28.240.002.016 CCTV Perimeter Fence Line Control 1 PTZ Camera
 - q) 28.240.002.017 CCTV Perimeter Fence Line Control 2 Fixed Cameras
 - r) 28.240.002.018 CCTV Perimeter Fence Line Control 2 Fixed and 1 PTZ Cameras

PART 2 PRODUCTS**2.1 Manufacturers**

- A. Manufactures will be listed on the drawings in the CCTV Schedule.

2.2 MATERIALS

- A. See details for contractor furnished material

PART 3 EXECUTION**3.1 INSTALLATION**

- A. Install box and conduit per installation details.
- B. Install power as identified on drawings.

3.2 TESTING

- A. Refer to CWP Specification for testing requirements.

END OF SECTION

ATTACHMENT 'A'

LIST OF REFERENCED SSG DOCUMENTS

| <u>DOCUMENT NO.</u> | <u>TITLE</u> |
|---------------------|---|
| 13.412.022 | Instrument Cable Specification (Non-Armored Twisted Pair/Triad/Quad) |
| 13.413.002 | Medium Fiberglass Field Junction Box Assembly |
| 13.413.003 | Large Fiberglass Field Junction Box Assembly |
| 13.413.005 | Small Fiberglass Field Junction Box Assembly |
| 13.416.001 | Mounting Stands for Field Junction Boxes and Field Instruments |
| 13.417.002 | Electrical Terminations & Wiring for Field Instruments |
| 13.417.008 | Instrument Wiring for ABB Systems |
| 13.417.009 | Instrument Wiring for SIS Systems |
| 13.433.006.004 | Magnetic Flowmeter Flanged (Standard) with Grounding Straps |
| 13.433.006.005 | Magnetic Flowmeter Flanged with Grounding Rings (Conductive Lined Pipe) |
| 16.020.004 | Grounding of Dry Type Transformers, Panelboards and Associated Circuitry |
| 16.020.007 | 600V Class Variable Frequency Drive Shield Termination and Parts Listing |
| 16.020.021 | Ground Resistance Test and Results Submittal Form |
| 16.021.000 | Grounding Materials and Details |
| 16.022.020 | Equipment Static Grounding Test Method |
| 16.022.101 | Static Grounding for Drums and Scale Stations |
| 16.022.102 | Static Grounding for Dip Pipes |
| 16.022.110 | Static Grounding of Tanks and Distillation Columns |
| 16.022.120 | Static Grounding for Loading Stations Tank Car and Truck |
| 16.022.130 | Static Grounding for Dempster Tanks and Dempster Tank Stations |
| 16.023.003 | Lightning Protection - Construction Specifications |
| 16.025.000 | Building Steel Grounding |
| 16.030.001 | Installation Test and Inspection Record for Motors and Motor Wiring (Motors Less Than 150hp) |
| 16.111.002 | Conduit Floor Penetrations (Non-Fire Rated) |
| 16.111.004 | Conduit Floor Penetrations (Fire Rated) |
| 16.112.007 | Closing of Cable Tray Openings 3M® Fire Barrier 2001 Silicone RTV Foam |

ATTACHMENT 'A'

| | |
|------------|---|
| 16.112.008 | Cable Tray Installation Details |
| 16.112.009 | Cable Tray Floor Penetrations (Non-Fire Related) |
| 16.120.010 | 600 Volt, 500 Kcmil Cable Splicing Detail (2 Conductors per Phase to 4 Conductors per Phase) |
| 16.140.002 | Typical Allen-Bradley Pushbutton Stations |
| 16.195.004 | Tagging and Identification Construction Requirements |
| 16.195.006 | Cable Tray Tagging |
| 16.370.004 | High Potential Cable Testing |
| 16.410.010 | Installation Test and Inspection Record 480V Non-Motor Circuits Test Form |
| 16.461.003 | Installation Test and Inspection Record for Dry-Type Transformers |
| 16.481.001 | Electrical Conduit Installation Details for Motors |
| 16.481.002 | Installation Test and Inspection Record for Motor Control Centers |
| 16.510.001 | Installation Details for Interior Chain Suspended Lighting Fixtures |
| 16.520.000 | Installation Details for Pendant and Stanchion Mounted Lighting Fixtures |
| 16.535.003 | Wall Mounted Emergency Lighting Units |
| 16.601.001 | Installation Test and Inspection Record Uninterruptible Power Supply (UPS) System Circuits |
| 16.855.001 | Installation Test and Inspection Record for Electrical Heat Tracing |
| 27.052.002 | Interior Communications Building Pathways |
| 27.100.002 | Low Voltage Communications Cabling Installation Practices |
| 27.110.002 | Communication Equipment Rooms |
| 27.130.002 | Communications Backbone Cabling |
| 27.150.002 | Communications Horizontal Cabling |
| 27.800.002 | Grounding and Bonding of Communication Systems |
| 28.140.001 | Electronic Security System Installation Details |
| 28.240.001 | CCTV System Installation Details |
| 28.320.001 | SimplexGrinnell 4100ES Fire/Life Safety System Installation Details |
| 28.321.001 | Siemens XLS Fire/Life Safety System Installation Details |

END OF ATTACHMENTS