

SECTION 16051

COMMUNICATIONS BACKBONE BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This specification section is supplemental and applicable to all Division 16 specification sections. In addition to the specific requirements defined in this Division 16 Section, the following project specifications apply, as appropriate, to the Communications Backbone Subcontract work:
 - 1. Section 07841, Through-Penetration Firestop System
 - 2. Section 16111, Conduit and Fittings
 - 3. Section 16131, Boxes
 - 4. Section 16140, Wiring Devices
 - 5. Section 16191, Support Devices

1.2 SUMMARY

- A. This section provides supplemental requirements for the backbone data/communications network to be installed on the CNMS site. The backbone network includes both copper and blown fiber elements located inside facilities and in the underground ductbank system.
- B. Scope
 - 1. The scope of this work is to procure, install and terminate the fiber optic and copper cabling as shown on drawingsCNMS.
 - 2. Where possible use the COM section of cable tray that is provided by others. Except where noted on the drawings, all conduit needed is to be procured and installed by the contractor.

1.3 REFERENCES

- A. National Fire Protection Association (NFPA):
 - 1. NFPA 70-99, National Electrical Code, (NEC).
- B. American National Standards Institute (ANSI):
 - 1. ANSI Z136.2-88, Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources.
- C. Electronic Industries Association/Telecommunications Industry Association (EIA/TIA):
 - 1. EIA/TIA 455-60-89 FOTP-60, Measurement of Fiber or Cable Length Using an OTDR.

2. EIA/TIA 455-61-89 FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR.
3. EIA/TIA 526-14-A90 OFSTP-14, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
4. EIA/TIA 492AAAA Detail Specification for 62.5 Micrometer Core Diameter/Micrometer Cladding Diameter Class 1a Graded Index Multimode Optical Fibers.
5. EIA/TIA 568-B Series A12.2 Commercial Building Telecommunication Cabling Standard.
6. EIA/TIA 492BA00 Blank Detail Specification for class IVa Dispersion-Unshifted Single Mode Optical Waveguide Fibers.
7. EIA/TIA 526-7, Optical Power Loss Measurements of Installed Single-Mode Fiber Cable Plant.
8. EIA/TIA 455-46A, 1990, FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers.
9. EIA-455-33A, 1988, FOTP-33, Fiber Optic Cable Tensile Loading and Bending Test
10. EIA/TIA-455-30B, FOTP-29, Refractive Index Profile, Transverse Interference Method.
11. EIA/TIA-455-51A, 1991, FOTP-51, Pulse Distortion Measurement of Multimode Glass Optical Fiber Information Transmission Capacity.
12. EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces

D. International Electrotechnical Commission (IEC):

1. IEC 825, Radiation Safety of Laser Products, Equipment Classification, Requirements and User's Guide.

E. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 812-84, Standard Definition of Terms Relating to Fiber Optics.

F. International Electrical Testing Association

1. NETA ATS-1995: Electrical Testing Specifications

G. Building Industry Consulting Service International. (BICSI)

Telecommunications Distribution Methods Manual. Issue 9. Tampa, FL: BICSI, . (10500 University Dr., Suite 100, Tampa, FL 33612-6415 ; 800-242-7405)

1.4 SUBMITTALS

- A. Prior to commencing work, the Communications Backbone Subcontractor is responsible for reviewing all contract documents to assure they comply with all project and local codes and immediately advising the CM of any changes required to comply with code regulations.
- B. For all products or materials, submittals of sufficient detail to determine compliance with the defined specifications are required for products or materials purchased as expressed or implied in this and other applicable Sections or in the provided design documents. Example submittals include shop drawings, manufacturer's data sheets, catalog information, etc.
- C. Deviations from the defined specifications are only allowed if approved by the CM in advance of purchase or use.

- D. For products or materials which the design documents do not provide a list of acceptable manufacturers, the proposed manufacturer and model number shall be submitted to the CM for approval in advance of purchase or use.
- E. The Communications Backbone Subcontractor is responsible for developing all design details not provided at the award of contract. Examples of this include, but are not limited to, raceway routing and connection details, cable and raceway pull schedules, and detailed inspection and test procedures. The wire and cable pull schedule must be approved by the CM prior to installation of any wires or cables.
- F. Field Test Reports: The Communications Backbone Subcontractor shall indicate and interpret test results for compliance with performance requirements.
 - 1. Upon completion of the Communications Backbone installation, verify compliance with wiring drawings, prove the integrity of the copper wiring insulation and perform electrical testing in compliance with Specification 16720. Document test results in a formal Test Results Report with signed checklists for each wiring termination.
 - 2. Test Fiber Optic cable per Specification 16129, Fiber Optic Cable and Accessories for Data Communications. Document test results in a formal Test Results Report with signed checklists for each fiber optic cable.
- G. An up to date "record set" of drawings shall be kept marked up with clearly legible indications of all changes made to the work. "As-built" fabrication drawings shall be delivered upon completion of the work.
- H. Periodic written project reports shall be submitted to the CM during regularly scheduled project status meetings at an interval agreed upon by the CM and the Communications Backbone Subcontractor but not less than a one-week interval.

1.5 QUALITY ASSURANCE

- A. The entire installation, with respect to both material and workmanship, shall be in accordance with the requirements of the design documents and the design specifications.
- B. The entire installation, with respect to both material and workmanship, shall be in accordance with the requirements of the Occupational Safety and Health Act, NFPA 70, the National Electrical Code, and any applicable local, state, or federal regulations.
- C. Material furnished by the Communications Backbone Subcontractor shall conform to the latest issues of the National Electrical Manufacturer's Association (NEMA), American National Standards Institute (ANSI), the Underwriters' Laboratories (UL), and the National Electrical Code (NEC). Where applicable, equipment and material shall bear the UL label or listed by UL.
- D. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Fiber Optic Cable, Devices and Accessories shall meet the requirements listed in Specification 16129 (Fiber Optic Cable and Accessories for Data Communications).
- F. The Subcontractor is responsible for identifying, coordinating the use thereof with the CM and complying with applicable standards that supercede the Standards specified herein, and that meet or exceed the needs of the Owner.
- G. Each and every item required for a complete installation may not be identified in the Drawings and Specifications. Such items shall be included by the Communications Backbone

Subcontractor if required to provide a complete and fail-safe system consistent with codes and acceptable standard practices. The Communications Backbone Subcontractor shall furnish all items (cable, wire, panels, connectors, support structures, etc.) as required for completion of the installation.

H. TPS and NFSS Cabling

- 1) Provide personnel training documentation to the CNMS QA staff.
- 2) The contractor shall generate, obtain CM approval, and follow a QA plan specifically for these cables. The purpose of this plan is to insure installation in accordance with drawings and requirements and that the installation is adequately documented.
- 3) Prior to installation the CNMS QA staff will brief the installers with a checklist of specification and drawing requirements to ensure proper installation.
- 4) The CM will perform pre-installation verification to ensure the installers have approved drawings and specifications, special work instructions, identification of materials and equipment.
- 5) The independent testing agency shall perform inspections and tests as defined in the QA plan to insure that installation is in accordance with approved drawings and specifications and manufacturers requirements and document the results of the inspections.

I. Fiber Optic Cabling

Planning

Prior to the start of any work (fiber or copper), the contractor shall submit a plan for CM approval addressing at least the following:

- 1) How personnel will be qualified for fiber cable pulling, fusion splicing, etc.
- 2) What independent testing agency will be engaged and how will this agency interact with the contractor and the CM.
- 3) How cable will be procured, received, stored and how OTDR testing will be performed and documented on reels prior to installation (See Section 3.3.H of Specification 16129).
- 4) How inspections of conduit, multi-duct cable, pull boxes, patch panels, etc will be conducted prior to pulling cabling (who will participate, when they will occur, what will be inspected, how will inspections be documented and signed off).
- 5) What fusion splicing equipment will be procured and in what quantity.
- 6) What tension analyses will be performed, what multi-duct cable and cable pulling equipment will be used and how they will be used to insure meeting manufacturers pulling requirements.
- 7) How manufacturer instructions will be obtained and implemented in the installation process.
- 8) How all inspections and test reports will be signed off (who will sign and when)

Execution

1. All personnel pulling and or terminating multi-duct cable and fiber cabling shall be qualified by having successfully performed work on the same types of cable and equipment that will be used at the CNMS site.
2. A test setup shall be maintained at the construction site for the duration of the work. The setup will be used by the independent testing agency to qualify personnel prior to their performing work.
3. The CM shall signoff on
 - a. Personnel qualifications
 - b. Confirmation that pull lists provide the proper cable path to building floor stub ups, meet requirements for separation of services, inner duct installation, etc., and document the as-built installation.
 - c. Inspection of inner duct cable pull box, pulling equipment, fusion splicing equipment etc. to be used prior to pulling a fiber run.
 - d. Inspection of configuration, labeling relation to drawings of imbedded conduit stub ups in building floors, imbedded conduit locations at the building 5 foot line, and conduit cross section arrangement of duct bank.
 - e. All deviations from design documents prior to pulling a fiber run
 - f. Inspections and test reports certifying installation and termination meets specifications

Testing

1. All fiber optic cabling shall be tested by a qualified independent testing agency engaged by the contractor.
2. The independent testing agency shall subject all fiber optic cabling to visual and mechanical inspection field tests per specification section 16129, including procedures stated in NETA ATS, Section 7.25 and certify that test parameters comply with manufacturers written instructions.
3. For cabling terminated in fusion spliced pigtails, the independent test agency shall perform the Optical Time Domain Reflectometer (OTDR) and other tests and inspections of Section 3.3 "Field Quality Control" of Specification 16129.
4. Copper cable to be tested per Specification 16720. Copper cable may be tested by the installing contractor.

1.6 COORDINATION

- A. The Communications Backbone Subcontractor, the GC, and the CM shall establish and agree upon a work schedule and sequence before any work begins.
- B. The Communications Backbone Subcontractor shall not begin any work until written authorization to do so has been received from the CM.
- C. The Communications Backbone Subcontractor shall sequence, coordinate, and integrate installing materials and equipment for efficient flow of the work.
- D. Where identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- E. Where identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

1.7 MATERIAL STORAGE AND HANDLING

- A. All equipment and materials that could be damaged or deteriorate from exposure to the elements shall be stored indoors, off the ground in suitable warehousing. Storage shall offer full protection from outside elements and shall be properly ventilated.
- B. The Communications Backbone Subcontractor shall touch-up, with paint acquired from the manufacturer, any equipment that has been scratched, cut or nicked during transportation, handling, or installation, and the Communications Backbone Subcontractor shall repair minor defects in the paint and these repairs are included in the work.
- C. Construction materials shall be protected against corrosion with a CM approved coating.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

- A. Approved Manufacturers
 1. Whenever applicable, the Communications Backbone Subcontractor shall purchase copper wire and cable (electrical) from the commodities supplier pre-selected by the CM and at the price negotiated by the CM.
 2. Manufacturer and model numbers for copper cabling are shown on drawings CNMS

3. Fiber Optic cabling shall be in accordance with specification Section 16129 (Fiber Optic Cable and Accessories for Data Communications).

B. All wire and cable (electrical and fiber optic) type must be identical to that identified in the design cable schedule. This includes number of conductors, number of strands, type of insulation, and insulation color coding. In all areas wire types shall be non-Teflon and non-nylon in construction, except in the /CNMS building.

C. Multi-Duct Tubing

Unless otherwise specified, multi-duct tubing shall provide at least ten percent spare tubes above the number of tubes needed to complete the initial fiber bundle installation requirements. All multi-duct tubing shall be composed of dielectric materials. The multi-duct tubing shall be suitable for installation in cable tray, plastic or metallic conduit, and conventional innerduct. During installation, multi-duct tubing ends are to be completely sealed to prevent ingress of contaminants, including water. The maximum bending radius shall be 20 times the cable diameter during installation and 10 times the cable diameter after installation. Upon completion of multi-duct tubing installation, all tubes shall pass the standard 150 psi pressure test and 5 mm ball bearing test per the cable manufacturer's recommended procedures. All unoccupied tubes shall be plugged on both ends

D. Outdoor Multi-duct tubing

E. Unless otherwise specified, multi-duct tubing shall provide at least ten percent spare tubes above the number of tubes needed to complete the initial fiber bundle installation requirements. Multi-duct tubing may be composed of dielectric and metallic materials. The multi-duct tubing shall be suitable for underground, buried, and aerial applications, as required. Multi-duct tubing for buried applications shall be steel armored for rodent protection, and conductive material(s) shall be bonded and grounded. During installation, multi-duct tubing ends are to be completely sealed to prevent ingress of contaminants, including water. The maximum bending radius shall be 20 times the cable diameter during installation and 10 times the cable diameter after installation. Upon completion of multi-duct cabling installation, all tubes shall pass the standard 150 psi pressure test and 5 mm ball bearing test per the cable manufacturer's recommended procedures. All unoccupied tubes shall be plugged on both ends. Fiber bundles

The contractor shall furnish and install optical fiber bundles as identified on the drawings and meeting the requirements of Section 16129, "Fiber Optic Data/Communications Systems"

The blown fiber configuration shall preserve the quantity of single mode and multimode fibers in each cable listed.

Fiber bundles shall not be spliced or patched at transition points from indoor to outdoor environments. Fiber bundles shall be installed end to end or home run from FOPs to FOPs to eliminate splicing and patching. Zero tensile stress shall be placed upon the fiber bundles during installation to eliminate micro-fractures within the glass fiber that result from pulling the optical fiber cable through inner duct systems.

F. Multi-duct tubing Patch Panels (MDP)

A NEMA-type enclosure, suitable for the site environmental conditions (i.e. NEMA 1 for indoor use) shall be provided for tube distribution, routing, and termination. MDPs shall be installed wherever several cables enter the same location or where cable type transitions take place. The contractor is responsible for selecting the MDP hardware to meet site conditions. Choose MDP size based on the number of tubes to enter the unit. MDPs shall be wall-, floor-, rack-, or ceiling-mounted to provide better protection and geometry for distribution. If rack-mount fiber termination hardware is required, wall-mount a MDP near the

rack and use individual tube cabling (provided with the fiber termination unit) to route and connect fiber bundle passing through the MDP to the fiber termination hardware.

G. Fiber Optic Patch Panels

A suitable enclosure shall be provided at all locations where fiber is to be terminated. FOP's shall provide for strain relief of incoming multi-duct cabling as well as providing connector panels and connector couplings adequate to accommodate the number of fibers to be terminated. All FOP's shall incorporate radius control mechanisms to limit bending of the fibers to the manufacturer's recommended minimums or 1.2", whichever is larger. All terminated fibers shall be mated to SC couplings mounted on patch panels. Couplers shall be mounted on a panel that, in turn, snaps into the housing assembly.

H. Connectors

Fiber Optic pigtail connector shall be type SC and meet the requirements of Section 16129, "Fiber Optic cable and accessories for Data Communications"

I. Data Communication System

Telephone (Type P) cable and termination accessories shall meet the requirements of Section 16720, "Copper/Data Communication Systems" and 16715 "Premises Telephone Wiring."

J. Copper Control and Signal Cabling

Copper cable shall meet the requirements of Section 16700, "Control/Signal Transmission Media".

2.2 IDENTIFICATION

- A. Each wire or cable (electrical and fiber optic) must be labeled at each end in coordination with the cable schedule and the design drawings. Labels shall be permanent in nature in that they will not deteriorate over the life of the facility when exposed to the environment of the facility. Wire and cable markers shall be pre-printed, durable, and capable of withstanding the environment.
- B. Raceway and Cable Labels: Comply with Section 16196, Electrical Identification, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.
- C. Cable labeling shall include the cable number and the source and designation equipment as stated on the wiring drawings.
- D. Marking products shall be approved by the CM prior to purchase or use. Use only CM approved labeling materials and methods in high radiation areas.
- E. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.
- F. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- G. Patch Panel Racks shall be marked with a barcode. The barcode label shall contain the rack nameplate identification name both as text and encoded as a Code 39 compliant barcode.

Where the label cannot be adhered to the item, it shall be on a tag adequately secured. The barcode label shall be adjacent to the rack nameplate.

- H. Fiber Optic cabling shall be in accordance with ANSI/TIA/EIA-606.

2.3 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.4 RADIATION COMPATIBLE EQUIPMENT AND MATERIALS

- A. Equipment or materials containing Teflon or nylon shall not be used, except in the CNMS building.

PART 3 - EXECUTION

3.1 GENERAL GUIDELINES

- A. The contractor shall be responsible for performing any needed pull tension analyses and generating final pull lists.
- B. All work shall be performed in accordance with the applicable CNMS Project Specifications.
- C. Materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer. The installation shall be accomplished by workmen skilled in their own particular crafts, and all work shall be conducted and finalized in a manner which is consistent with the job requirements.
- D. The plans are generally diagrammatic and the Communications Backbone Subcontractor shall coordinate all work with that of the various trades so that interference's between conduit, piping, equipment, and architectural work are avoided.
- E. The Communications Backbone Subcontractor shall provide field engineering design as required for the installation of conduit and cable tray.
- F. The Communications Backbone Subcontractor shall provide any additional schematics and/or wiring diagrams that may be required to facilitate erection or completion of installation.
- G. The Communications Backbone Subcontractor shall verify the exact locations of conduits, boxes, and supports, with reference to the drawings of other disciplines in order to avoid interference.
- H. The location of available floor openings (related to cabinet access egress for cabling) will be shown on structural or electrical drawings. Additional penetrations are the responsibility of the Communications Backbone Subcontractor and shall be coordinated with the GC and the CM.
- I. The Communications Backbone Subcontractor is responsible for protecting components during drilling and filing, brazing, welding, and soldering activities.
- J. Multi-duct Cable Installation
 - 1) Prior to pulling multi-duct cabling, thoroughly swab conduits to remove foreign material before pulling cables.

- 2) Label all conduit and verify that conduit stub ups are per the drawings.
- 3) Cable pulling shall be done in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and bending radii shall not be exceeded. Any multi-duct cabling bent or kinked to a radius less than recommended shall not be installed.
- 4) During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.
- 5) Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type which is non-injurious to the cable material used. Lubricant shall not harden or become adhesive with age.
- 6) Avoid abrasion and other damage to cables during installation.
- 7) Cable slack shall be provided in each cable. Follow recommended procedures from the manufacturer regarding length of slack cable ensuring a minimum of 5 meters (approximately 15 feet) of cable that shall be coiled and secured at each termination location. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage. The use of suitable enclosures designed for this purpose is encouraged.
- 8) All exposed multi-duct cabling shall be labeled at 35-foot (maximum) intervals with tags indicating ownership, cable type, and fiber type installed.
- 9) Multi-duct cabling shall be Tray rated if required by the installation environment.
- 10) Where not installed in a continuous length, multi-duct cabling segments shall be spliced using couplings designed for that purpose.
- 11) Pressure testing and obstruction testing shall be performed prior to fiber bundle installation.

K. Fiber Bundle Installation

- 1) Fiber bundles shall be installed according to manufacturer's recommendations.
- 2) Optical fiber cable bundles shall be continuously inserted and propelled or blown into the individual tubes or cells utilizing a compressed gas such as nitrogen as the propellant per the manufacturer's instructions. The blowing installation process and the fiber bundles must also be designed to allow removal, replacement, and reuse of the fiber bundles at any time in the future as deemed necessary by the owner.
- 3) Slack in each fiber bundle shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1 meter (39") of slack shall be retained at the work area, and a minimum of 3 meters (approximately 10') of slack shall be retained in equipment rooms and telecommunications closets.
- 4) All optical fiber terminations shall be completed by qualified personnel and shall comply with Section 16129.

3.2 EQUIPMENT INSTALLATION

- A. Materials and components shall be installed level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations. Clearance around equipment shall meet minimums established by NEC.
- C. If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom for future maintenance access.
- D. Give right of way to raceways and piping systems installed at a required slope.
- E. The Communications Backbone Subcontractor shall not cut, burn, or drill any structural member in order to mount equipment or facilitate installation under any circumstances without previously receiving written approval from the CM.
- F. Wires and cables shall be strain-relieved to avoid damage at box entry and exit points.

3.3 RACEWAY SUPPORT INSTALLATION

- A. Support IMC, rigid galvanized metal conduit, PVC conduit, and EMT, where exposed or concealed, in accordance with the applicable paragraphs of the National Electric Code.
- B. Raceway shall be supported at required intervals, to prevent excessive stressing and/or deflection of the trays. If raceway fittings are used, a support shall be provided immediately adjacent to each fitting. Supports shall be assembled with proper support fittings or welding, mounted plumb and level, and rigidly secured to the structure. All raceways shall be fastened to support members.
- C. Raceway covers shall be provided where mechanical damage may occur, or is warranted for personnel protection.
- D. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- E. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- F. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- G. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- H. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- I. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- J. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

- K. Simultaneously install vertical conductor supports with conductors.
- L. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.

3.4 WIRE AND CABLE INSTALLATION AND ROUTING

- A. Each cable or wire shall be pulled into the particular tray type designated for it on the design drawings.
- B. The size of cables and the type and voltage rating of insulation shall be as listed in the Contract Drawings and Cable Specification.
- C. General routing plans are provided in the design drawings. It is the responsibility of the Communications Backbone Subcontractor to develop wire and cable pull schedules based on the design drawings. The pull schedule must be approved by the CM prior to installation of any wires or cables.
- D. All cables shall be protected at all times by cable tray, conduit, liquid-tight or inside cabinetry. Exposed cable shall not be permitted. Care shall be exercised while installing wires and cables so as not to damage conductors, insulation, or shielding or to otherwise alter its mechanical or electrical properties. Cables shall be protected at all times from mechanical injury and from moisture at the unprotected ends.
- E. Cables installed in trays and cables running from trays to equipment shall be installed in an acceptable manner and shall present a neat appearance. Twisting of wires of cable shall not be permitted in conduits, trays, or ducts. All wire bundles shall be arranged in horizontal and vertical orientation. Install cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible. Sufficient lengths of cable shall be pulled into equipment, panels, boxes, etc., to permit a neat arrangement.
- F. Cables in trays shall be laid and not pulled into the trays. When pulling is necessary, adequate guides or rollers shall be used to minimize the pulling force and the possibility of cable damage. Manila or nylon rope or cord shall be used. The use of steel or other metallic cable, rope, or wire to pull wire or cable through cable trays shall not be permitted.
- G. Use manufacturer-approved pulling compound or lubricant where necessary. Compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- H. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- I. Cables in vertical tray runs of 6 feet or more shall be supported by lashing them to the tray or by tying with approved plastic cable ties at 3-foot intervals. Cable in horizontal trays shall be lashed at 6-foot intervals. The means of support shall be subject to the approval of the CM.
- J. Cabling located under a sub-floor or computer floor shall be routed in a cable tray system.
- K. All wires and cable shall be suitably grouped together and routed in suitably sized enclosed raceways.

- L. Instrumentation wires and cables shall be routed separately from power circuits to prevent electrical interferences.
- M. All wires and cables shall be continuous from origin to terminal strips without splices. Cable shields shall be continuous and neither grounded or interrupted along its path and shall be suitably insulated, except at points of termination. Splicing of cable is prohibited without prior written approval of the CM.
- N. Cables shall be clamped or secured in such a manner as to avoid tension on individual conductors or terminals. Cable forming shall be done in a manner that does not result in sharp bends over conduit bushings. The radii of bends in any cable shall not be less than the minimum bending radius recommended by the cable manufacturer. Damaged cables shall be removed and replaced at the expense of the Communications Backbone Subcontractor.
- O. Each cable shall be identified at each end and in exposed runs in pull boxes by attaching an approved plastic or fiber tag stamped with the cable identifying number as called for on drawings and in the Cable Schedule. When the Cable Schedule does not give this information, a suitable identification number shall be assigned and this information given to the CM. All cabling/conductors identified by the Communications Backbone Subcontractor shall be shown "as built" on the drawings. Jumper wires shorter than 12 inches long do not require labels.
- P. The Communications Backbone Subcontractor shall be responsible for the installation of flameproof type or weatherproof type cable glands as required.

3.5 FIBER OPTIC CABLE INSTALLATION AND ROUTING

- A. The installation and routing of Fiber Optic cables shall conform to applicable requirements listed in Specification Section 16129 "Fiber Optic Cable and Accessories for Data Communications".
- B. Duct banks shall be thoroughly cleaned prior to installation of cables or multi-duct tubing.
- C. All multi-duct tubing shall be installed before any cabling (copper or fiber) is pulled.
- D. Fiber bundles shall be installed only after a complete routing has been established and the multi-duct tubing has passed a pressure and an obstruction test.

3.6 FIBER OPTIC CABLE TERMINATION

- A. The termination of Fiber Optic cables shall be via fusion splicing that conforms to the requirements listed in Specification Section 16129 "Fiber Optic Data/ Communications Systems".
- B. Fusion splicing shall be performed using commercially available equipment (provided by the contractor) and by qualified personnel.

3.7 IDENTIFICATION

- A. The Communications Backbone Subcontractor shall provide installation of identification tags attached to the Patch Panel Racks (the tag shall include the tag number for ID with drawings, data sheets, requisitions, purchase orders, and correspondence). The format for these tags can be provided by the CM on request.
- B. Install markings at locations for most convenient viewing without interference with operation and maintenance of equipment.

- C. Coordinate names, abbreviations, colors, and other designations used for identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout the Site.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. All labeling shall be in accordance with ANSI/TIA/EIA-606 and Section 16196, "Electrical Identification" as applicable.

3.8 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Section 07841, Through Penetration Firestop System.

3.9 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.10 CLEANING AND PROTECTION

- A. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
- B. On completion of installation inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- C. All equipment, including the inside of terminal boxes, shall be cleaned after final connections are made and prior to securing covers in place.

3.11 PAINTING, REFINISHING AND TOUCHUP PAINTING

- A. The Communications Backbone Subcontractor shall prime and finish paint all ferrous material and equipment installed by him which is not galvanized or protectively painted by the manufacturer in accordance with the requirements contained in the applicable specifications and standards. Items to be painted shall include, but not be limited to, conduit and cable tray supports, and junction and pull boxes with their supports. Supports shall be painted prior to the installation of the equipment.
- B. Material and equipment to be painted shall be prepared and treated in accordance with the paint manufacturer's recommendation.
- C. The CM shall approve color and manufacturer of paint used by the Communications Backbone Subcontractor.
- D. Any unpainted structural steel or other ferrous surface which may be inaccessible after the equipment, material, or supports are installed, shall be called to the attention of the CM so that it may be painted prior to installation.

- E. Any galvanized finish damaged during construction shall be repaired using cold galvanizing compound.
- F. Refinish and touch up paint. Paint materials and application requirements are specified in Section 09900, Painting.
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.12 RADIATION COMPATIBLE EQUIPMENT AND MATERIALS

- A. Equipment or materials containing Teflon shall not be used, except in the /CNMS.

3.13 TESTING

- A. The Communications Backbone Subcontractor shall be responsible for performing inspections and tests to ensure proper installation of all patch panels, raceways, wire, cable, and associated connections and terminations. These inspections and tests include checks on equipment placement, quality of work, completeness of work, code compliance, wiring integrity, and conductor performance.
- B. All testing shall be performed by the independent testing agency per Specifications 16129 and 16720.
- C. The independent test agency shall verify that all codes and EIA/TIA standards have been followed, including, but not limited to, the requirements of the NEC.
- D. Any part of the installation that fails an inspection or test must be repaired or replaced by the Communications Backbone Subcontractor until it passes the associated test. The CM will accept the Test Documents only when all required inspections and tests are successful.
- E. Fiber Optic Cable shall be tested as required in Section 16129 "Fiber Optic Data/Communications Systems".
- F. The contractor shall perform a pressure test and obstruction test for each tube of multi-duct cable installed.
- G. Verify discontinuity between each conductor and all other conductors contained within a single cable. Also verify discontinuity between each conductor and ground. This discontinuity shall exceed one mega-ohm. Record an indication of success for each conductor in the Test Record Table.
- H. Electrical resistance tests shall not be performed on circuits containing electronic equipment with said equipment being connected to the conductors under test. When disconnection of electronic equipment from a circuit would create extensive work (e.g. 2 or more hours labor), the Communications Backbone Subcontractor shall notify the CM and request a waiver of the resistance test for that specific circuit. This waiver shall be so noted in the Test Record Table and shall require approval by the CM.

I.

I. TESTING DOCUMENTATION

1. The Communications Backbone Subcontractor shall generate a "Test Record Table" to capture the results of all performed tests. Each entry in the Table shall be initialed and dated by the test conductor. Once complete, the entire test record shall be signed by the test conductor, the associated supervising authority, or the Communications Backbone Subcontractor. Record the electrical nameplate data for any associated piece of equipment on the appropriate Test Record Table. Record the model number and serial number of each test instrument used in each test on the Test Record Table.
2. Testing documentation for fiber optic cabling shall be as specified in Section 16129 "Fiber Optic Data/Communications Systems".
3. "Yellow Line" design documents as tests are performed, to indicate successfully verified installations. Using a current set of field drawings, yellow out all wires, cables and fiber optic cable that pass inspection via the defined acceptance test procedures.
4. "Red line" any corrections/additions to design documentation for later use in production of as-built documentation. Any changes to wiring made in the field shall be noted on the as-built drawings. If a change is made to the field wiring, record it on the as-builts with a red pen or pencil. After recording the as-builts, sign and date the changes.

J. PHYSICAL INSPECTIONS

1. Design documentation will indicate the general location of equipment unless otherwise noted.
2. Site conditions and other factors may force installation of equipment in slightly different locations. If substantial relocation of equipment is found, inform the CM of the situation and gain approval before verifying the installation as satisfactory. Make a note of any location changes on the as-built drawings.
3. Verify proper physical locations of equipment per the design documentation.
4. Verify proper matching of components to design documents. This includes, but is not limited to, verifying model numbers for each component. Each of these verified parameters will be entered into the Test Record Table as appropriate.
5. Verify proper routing of raceways and adequacy of support for raceways and cables.
6. Verify quality workmanship and materials of communications backbone installations. Specifically verify that the supplied materials are as identified in the design documents, particularly noting the type and rating of each installed conductor.
7. Cable routing is to be neat and orderly (i.e. plumb, square, at right angles, appropriate bundling and support, etc.)
8. Verify that power-related conductors are adequately separated from communications backbone copper cables.
9. Wire insulation is to be intact with no visible flaws.

10. Conductors are to be labeled (including wire numbers and colors) in accordance to the signal and control wiring design documents and Section 16196, Electrical Identification.
11. Heat shrink is to be used where applicable.
12. All terminal strip terminations shall be "pull-tested" (no loose wires) to ensure all connections are snug and seated properly.
13. An "OK" will be entered in the Test Record Table for each inspection that is deemed acceptable.

END OF SECTION 16051