SECTION 27 0300 - COMMUNICATIONS FIBER OPTIC CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all fiber optic cable as specified herein and as required for proper distribution of all wire, cable, and electrical conductors throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. Division 27 of the Specifications requires the furnishing and installing of all items, including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, equipment, transportation, rigging, storage, tools, scaffolding, machinery, appliances, utilities, testing, commissioning, and all required permits and licenses.

C. Before submittal of bid, examine all drawings, specifications, addenda, alternates, special conditions, and all other Contract Documents of all Division and Sections of this project, verify all governing conditions at the site, and become fully informed as to the extent and character of the work required, as well as its relation to other work in the building. Submittal of a bid is an agreement to all requirements of the Contract Documents, and no consideration will be granted for any claimed misunderstanding thereof.

D. Submittal of a bid is deemed a representation by the bidder that it is qualified in all respects properly to perform the work for which it is bidding and has experience with similar work. Bidders are deemed to be aware, on the basis of their background and experience, of materials which may be required in the discharge of their responsibilities, even though unspecified. For example, claims for extras for unspecified shoring or supporting materials will not be considered if the need for such materials would have been reasonably obvious to bidders skilled and experienced in the work to be done and the submittal of a bid shall be deemed a waiver of any such claims.

E. All statements, requirements, and contractual obligations imposed upon the Contractor awarded this Division of the Contract Documents shall also be applicable to his Subcontractors, Agents acting on behalf of the Contractor, servants and/or employees. All correspondence, agreements, and final responsibility for completion of work shall rest solely with this Contractor.

F. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0400 - Communications Ladder Rack.
2. Section 27 0500 - Common Work Results for Communications.
3. Section 27 0506 - Grounding and Bonding for Communications Systems.
4. Section 27 1000 - Communications Conduit.
5. Section 27 1100 - Communications Equipment Room Fittings.
6. Section 27 1300 - Communications Backbone Cabling.
7. Section 27 1500 - Telecommunications UTP Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCES

A. The entire installation and all equipment, materials and methods shall comply with the currently enforced versions of all applicable laws, rules, regulations, standards, legislation, codes and ordinances of New York City, Underwriters Laboratory and New York City Electrical Code, Telecommunications Industries Association/Electronic Industries Association/(TIA/EIA) and Building Industry Consulting Service International (BICSI) Standards where they do not conflict with any applicable requirements of laws, codes, ordinances, legislation, etc., of all federal, state and local authorities whether indicated on the Contract Documents or not. All equipment shall be MEA and/or BS&A approved or have an OTCR approval and approved for use in New York City. Modifications required by the above said authorities having jurisdiction shall be made without additional cost to the Owner.

1. Except as modified herein, the requirements and recommendations of the latest editions of the following documents are made part of these Specifications:

a. ANSI/TIA/EIA - 568 C “Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements”.
b. ANSI/TIA/EIA - 568B.3 “Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard”.
c. ANSI/TIA/EIA - 569 “Commercial Building Standard for Telecommunications Pathways and Spaces”.
d. ANSI/TIA/EIA – 606-A “Administration Standards for the Telecommunications Pathways and Spaces”.
e. ANSI/TIA/EIA - 607 “Commercial Buildings Grounding and Bonding Requirements for Telecommunications”.
f. ANSI/NFPA-70 - “National Electrical Code”.
g. ANSI/NFPA-780 - “Lightning Protection Code”.
h. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards – A Background Report.”
i. BICSI “Telecommunications Distribution Methods Manual”.
j. IEEE Std 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
k. ANSI R211.
l. BOCA National Building Code, 1996; Seismic exposure Group II — Performance Category “C”.

B. Where Contract Document requirements are in excess of rules, regulations and Code requirements, and are permitted under the Code, the Contract Documents shall govern. In the event of a conflict between the Contract Documents and the applicable laws, rules, regulations, codes and ordinances of federal, state and local authorities having jurisdiction, the latter shall govern.

C. Where alterations to and/or deviations from the Contract Documents are required by the Authorities listed above, report the requirements to the Architect and Engineer and secure his written approval before starting the required modifications.

D. Pay royalties or fees required in connection with the use of patented devices, or systems, and save the Owner, the Architect, the Engineer and the Construction Manager harmless from any claims or lawsuits arising from such use and indemnify each thereof against attorneys in connection therewith.

E. Secure and pay for necessary approvals, permits, inspections carting, legal dumping, etc., and deliver the official records of the granting of permits to the Owner without additional cost to the Owner.

F. All equipment, materials, and methods to be furnished and/or installed by this Division shall comply with all applicable requirements of laws, codes, ordinances, legislation, standards, etc., of all federal, state and local authorities, whether indicated on the Contract Documents or not.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to Substantial completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB's), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC's), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a "Materials Safety Data Sheet", as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to Section 27 0300 and shall include but not be limited to:

1. Single Mode and Multimode fiber optic cable, including samples, complete with fittings, materials, connector details, etc.

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and Section 27 0300.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyl's (PCB) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. If it complies with these Specifications, Fiber and fittings manufactured by one of the following manufacturers will be acceptable:

1. Corning Cable Systems.
2. Systimax.

2.3 MULTI-MODE FIBER-OPTIC CABLE:

A. Provide plenum and/or riser rated fiber, ~~multi-mode~~***LOMMF***, fiber cable with integral strength member and individually jacketed ***OM4/***50/125 µm strands.

B. Cabling shall be rated, and installed in a manner consistent with the requirements of the National Electrical Code (NEC).

C. All fibers in the cable must be usable and meet required specifications.

D. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

E. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

F. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m^2).

G. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

H. The attenuation specification shall be a maximum value for each cabled fiber at 23 $\pm$ 5°C on the original shipping reel.

I. The fiber shall meet the requirements of TIA/EIA-492AAAC, "Detail Specification for ~~850-nm~~***OM4*** Laser-Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers."

J. Core Diameter: 50.0 ± 3.0 µm.

K. Core Non-Circularity: $\leq$ 5 %.

L. Defined as: $\left(1-\frac{\text{Minimum Core Diameter}}{\text{Maximum Core Diameter}}\right)\times 100$

M. Cladding Diameter: 125.0 ± 2.0 µm.

N. Cladding Non-Circularity: < 2.0 %.

O. Defined as: $\left(1-\frac{\text{Minimum Cladding Diameter}}{\text{Maximum Cladding Diameter}}\right)\times 100$

P. Core-to-Cladding Concentricity: ≤ 3.0 μm.

Q. Coating Diameter: 245 ± 5 μm.

R. Refractive Index Profile: Graded index.

S. Numerical Aperture: 0.200 ± 0.015.

T. Attenuation: < 3.5/1.5 dB/km at 850/1300 nm.

U. IEEE 802.3 Performance: The fiber shall support laser-based Gigabit Ethernet (GbE) operation in the 1000BASE-SX (850 nm) and 1000BASE-LX (1300 nm) operating windows at 600 meters.

V. Minimum cabled Effective Modal Bandwidth (EMB) determined by Restricted Mode Launch (RML) measurement method (FOTP-204): 2000 MHz•km at 850 nm.

W. Minimum OFL Bandwidth: 1500/500 MHz•km at 850/1300 nm.

X. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.

Y. Attenuation at the Water Peak: The attenuation coefficient at 1380 nm shall not exceed the attenuation coefficient at 1300 nm by more than 3.0 dB/km.

Z. Macrobend Attenuation: The attenuation due to 100 turns of fiber around a 75 ± 2 mm diameter mandrel shall not exceed 0.5 dB at 850 nm or 1300 nm

2.1 SINGLE MODE OPTICAL FIBER (DISPERSION UNSHIFTED):

AA. The single-mode fiber utilized in the optical fiber cable shall meet TIA/EIA-492CAAA, "Detail Specification for Class IVa Dispersion-Unshifted ***(OS2)*** Single-Mode Optical Fibers," and ITU recommendation G.652, “Characteristics of Single-Mode Optical Fibre Cable”.

BB. Cladding Diameter: 125.0 ± 1.0 μm

CC. Core-to-Cladding Concentricity: ≤ 0.5 μm

DD. Cladding Non-Circularity: ≤ 1.0 %

EE. Defined as: $\left(1-\frac{\text{Minimum Cladding Diameter}}{\text{Maximum Cladding Diameter}}\right)\times 100$

FF. Coating Diameter: 245 ± 5 μm.

GG. Attenuation: ≤ 1.0 dB/km at 1310 nm and ≤ 0.75 dB/km at 1550 nm.

HH. Attenuation Uniformity: No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.

II. Attenuation at the Water Peak: ≤ 2.1 dB/km at 1383 ± 3 nm.

JJ. Cutoff Wavelength (λ_{ccf}): < 1260 nm.

KK. IEEE 802.3z Performance: The fiber shall support laser-based Gigabit Ethernet (GbE) operation in the 1000BASE-LX (1300 nm) operating window at 5000 m.

LL. Mode Field Diameter: 9.2 ± 0.4 μm at 1310 nm /10.4 ± 0.8 μm at 1550 nm.

MM. Macrobend Attenuation: The attenuation due to 1 turn of fiber around a 32 ± 2 mm diameter mandrel shall not exceed 0.50 dB at 1550 nm.

NN. The attenuation due to 100 turns of fiber around a 75 ± 2 mm diameter mandrel shall not exceed 0.05 dB at 1310 nm and 0.10 dB at 1550 nm.

OO. Zero Dispersion Wavelength (λo): 1302 nm ≤ λo ≤ 1322 nm.

PP. Zero Dispersion Slope (So): ≤ 0.092 ps/(nm²/km).

QQ. Dispersion: ≤ 3.55 ps/(nm/km) from 1285 - 1330 nm ≤ 18 ps/(nm/km) at 1550 nm.

RR. Fiber Curl: > 4.0 m. radius of curvature.

SS. Cabled Fiber Polarization Mode Dispersion (PMD): ≤ 0.5 $ps/\sqrt{km}$

2.4 FIBER OPTIC PATCH CORDS

A. LC connector to LC connector, as required.

B. LC connector to SC connector, as required.

C. MTRJ connector to LC connector, as required.

D. Laser Optimized, 50 micron, MultiMode, as required. Patch cords must meet the same performance specifications as outlined above for 50 micron, laser-optimized optical fiber cable.

E. Single mode, as required.

F. Provide factory terminated and tested patch cords in quantities as indicated on the drawings and in lengths as required.

PART 3 - EXECUTION

3.1 GENERAL CABLE INSTALLATION:

A. The wiring system, including both copper and fiber optic applications, shall be configured as documented on the Contract/Bid Documents.

B. Furnish and install the telecommunications cables/wires in accordance with the drawings and instructions provided by the Engineer and manufacturer's recommendations.

C. All cables shall be installed in an electrically or optically continuous fashion between the designated origin and destination points. That is, all cables must be "homerun" with no unspecified splices, couplers, or intermediate connection points along the specified channel.

D. All cables shall be securely held in place by an industry-acceptable practice, which also meets applicable Codes.

E. Each reel of cable shall be provided with a manufacturer's report certifying performance.

3.2 CABLE LABLING

A. Labels for the individual cables will be furnished by the Owner and installed by the IT Contractor.

B. Color coding shall be in accordance with the ANSI/TIA/EIA-606A standards.

C. Labels shall be placed on both ends of every cable at least 4 inches from the point at which the cable jacket is opened to expose individual copper pairs or fiber strands, or from the connector or terminal block.

D. All labels shall be visually and physically accessible at work locations, and when cables are mounted to frames, blocks, racks, etc., where the proper mounting procedure allows ready access to individual cables. When cables are mounted to punch-down wiring blocks with integrated labeling capacity, the wiring labels shall be affixed on cables as above, and the blocks shall be labeled using machine-generated black uppercase lettering on a permanent adhesive stock, duplicating the information on the cable identification label.

E. Provide all cable tags. Label each tag with the appropriate cable number as shown on the drawings, and as indicated on the cable schedules provided by the Engineer.

F. Cable identification numbers shown on the plans are presented in an abbreviated format. All cable ID's shall be formatted at the direction of the Owner.

G. After pulling and terminating cables, place the appropriate cable tag as noted above. Temporary tags are acceptable for use during construction. All temporary tags must be removed and replaced with permanent machine-generated tags prior to acceptance.

H. If at any time during the job, the permanent cable tag becomes illegible or is defaced or removed, immediately replace it with a duplicate preprinted cable tag.

I. Labeling for patch panels, faceplates and jacks shall be installed as shown on drawings detail.

J. Provide a nameplate on each patch panel, cross-connect field, equipment rack, cabinet, etc. Unless otherwise noted, use a permanent adhesive label stock, covered with a permanent water-resistant sealer.

3.3 TESTING

A. Contractor shall provide sufficient skilled labor to complete testing within the agreed-upon test period.

B. Contractor must fulfill all Owner, Engineer, and Manufacturer's Warranty/Test requirements.

C. Contractor must be qualified to provide system certification for the cabling solution provided. At the completion of the installation, Contractor must supply said system certification along with copies of all applications and correspondence pertaining to the system certification.

D. Contractor's company shall have a minimum of 3 years experience installing and testing fiber optic cabling systems. All installers assigned by the Contractor to the installation shall have factory certification that they are qualified to install and test the provided products.

E. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.

F. Contractor is responsible for submitting acceptance documentation as defined below.

G. Owner reserves the right to be present during any or all of testing.

H. Testing shall be of the permanent link. A link is defined as the passive cabling network between two cross-connects (patch panels or outlets). This includes cable, connectors and splices but does not include active components. The link test contains the representative connector loss at the patch panel associated with the mating of patch cords but does not include the performance of the connector at the equipment interface.

I. Prior to testing, submit for review and approval copies of test report forms proposed for use.

1. Each test report form shall contain the following general information: Date of preparation, date of test, project name, Contractor's name, media type, make, model, software revision, and serial number of test equipment used, date of last calibration and names of test crew.

J. All cabling not tested strictly in accordance with these procedures shall be retested at no additional cost to the Owner.

K. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation as described below.

L. Either the test equipment shall be fully charged prior to each day's testing or a fresh set of batteries shall be brought to the job site.

M. Remove all defective cables from the cable pathways. Do not abandon cables in place.

N. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.

O. The Engineer further reserves the right to conduct, using the Contractor's equipment and labor, a random retest of up to five (5) percent of the cable plant to confirm documented test results.

P. All test results and corrective procedures are to be documented and submitted to the Engineer within ten (10) working days of test completion.

Q. In addition to the specified test, be prepared to be present while the Owner or Owner's designated representatives install and conduct performance tests of the transport electronics connected to the cabling system. Be prepared to conduct on-the-spot cable tests and effect cable plant repairs, as necessary. Successful equipment performance tests do not relieve the Contractor of the specified testing, repair, and documentation requirements.

R. All cables shall be factory tested for continuity before shipment. Submit documentation to the Engineer that the cable has been tested by the manufacturer to industry standards.

S. The Contractor shall provide a thorough testing program for the communications cabling plant, and final acceptance testing. The testing program being proposed shall be submitted to the Engineer for approval before testing begins. Provide all required test equipment. The Owner's representatives may choose to observe any or all testing. Final acceptance testing shall be performed jointly by the Contractor and the Owner's representative. The Contractor shall provide procedures, a list of test equipment and operating instructions before the tests.

T. Subsystems shall be tested individually before testing for end-to-end connectivity. All faults shall be corrected and retested. All test results shall be completely documented.

U. All cable that fails manufacturer's or specified testing criteria shall be replaced at no additional expense to Owner.

V. Owner reserves the right to independently test any or all of the cable plant. If more than 3% of the tested cable plant within a floor, system or area fails, the Contractor will be required to take the following actions at no additional cost to Owner:

1. Reimburse Owner for all costs incurred for independent testing.
2. Work overtime to remedy defects and retest entire floor, system or area as defined by Owner. This corrective work shall not impact the planned occupancy dates.
3. Reimburse Owner for supervision representation by their duly appointed representative during action taken in b. above.
4. Contractor shall provide all test results to Owner at periods of 20% of scheduled test completion time.

W. Fiber Tester

1. Corning Tester

a. Fiber Continuity Test: The Contractor shall utilize the Corning UniCam continuity test system during the termination of all fiber connectors. The Contractor shall be responsible for obtaining all equipment that is necessary to perform the continuity test, including, but not limited to, the following:

1) Enhanced UniCam installation tool.
2) MT-RJ UniCam tool coupler.
3) Fault finder test box assembly.
4) UniCam length gauge.

b. MT-RJ/Dual Fiber Field Test: The Contractor shall be responsible for performing a dual-fiber test. This test will return results of the actual loss that will be realized during day-to-day transmissions over the fiber. The Contractor shall be responsible for obtaining the proper training on this procedure from Corning, as well as obtaining all the testers and adapters that are required.

c. Test equipment shall be capable of measuring relative or absolute optical power in accordance with ANSI/TIA/EIA-526-14A, “Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant”, and ANSI/TIA/EIA-526-7 Method A, “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Insertion Loss Using An Optical Power Meter”.

d. Test equipment shall incorporate 850 nm and 1300 nm LED sources in same unit with output power of ≥ -20 dBm at each wavelength. Detectors shall have a dynamic range of at least +3 dB to –55 dB.

e. Sources and meters shall automatically synchronize wavelengths to prevent calibration-related errors.

f. The time-of-flight methodology shall be employed when measuring the fiber length optically.

g. Type of fiber test equipment must be approved by the Engineer prior to use on the job.

X. Fiber-optic Tests

1. After installation of connectors, visually inspect each fiber end-face at 10X magnification. Refinish any fibers showing visible defects and/or striations in the core area.

2. Unless otherwise specified, 50 micron enhanced multimode fiber cabling must meet the performance specifications of ANSI/TIA/EIA-568-C. Attenuation and length shall be tested.
3. All optical fibers shall be individually tested with connectors attached. Each cable span shall be tested individually. Tests shall be conducted selectively after cross-connection of the cable spans.
4. An optical loss set (OLS) which combines the optical power meter (OPM) and optical source with adjustable output power level shall be used. The OLS/OPM shall display measured transmission loss directly in dB by comparing the optical power received after transmission through the fiber path to its own optical source power. Once this difference is adjusted to "zero" for a cable under test, all fibers in the cable are then measured relative to the "zeroed" source power and displayed in dB.
5. Link attenuation shall be tested in accordance with ANSI/TIA/EIA-526-14A. Reference measurements shall be made in accordance with Reference Method A, Two Jumper Reference. Optical loss shall be measured on each fiber at both 850 nm and 1300 nm. Loss shall be measured on each fiber in both directions.
6. Strands whose measured attenuation fall outside the acceptable range by power meter testing shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, an OTDR shall be used to determine a loss factor for each connector pair, the exact length of the fiber and to identify the presence of any core damage.
7. Faults related to connectorization shall be corrected, and the fiber retested as stated above, until acceptable attenuation measurements are received.
8. Where defects cannot be corrected, replace any cable having fewer that the manufacturer's guaranteed number of serviceable fibers.
9. Link length shall be optically measured and shall not be calculated using cable sheath length markings.
10. Cabling shall meet the ANSI/TIA/EIA-568-A loss and length criteria for all links. It includes the cross-connect connectors and splices (if any). Calculate the total expected link loss based on the number of mated connector pairs, the connector's published loss per mated pair and the cable's published loss based on distance. Demonstrate that measured link loss does not exceed the calculated link loss by more than 5%.

Link Criteria

Attenuation @ 850 nm ≤ fiber length (km) x 3.5 dB/km
+ number of connector pairs x 0.75 dB
+ number of splices x 0.3 dB

Attenuation @ 1300 nm ≤ fiber length (km) x 1.5 dB/km
+ number of connector pairs x 0.75 dB
+ number of splices x 0.3 dB

Length: ≤ 2000 m. (6560 ft.)

Y. Testing of Installed Single-Mode Fiber Cable

1. Link attenuation shall be tested in accordance with ANSI/TIA/EIA-526-7 Method A. Reference measurements shall be made in accordance with Method A.1 or equivalent. Optical loss shall be measured on each fiber at 1310 nm. Loss shall be measured on each fiber from each direction (bi-directionally).
2. Link length shall be optically measured and shall not be calculated using cable sheath length markings.
3. Cabling shall meet the following loss and length criteria. It includes the cross-connect connectors and splices (if any).

4. Link Criteria

Length	< = 90 m (295 ft)	91-1000 m (3281 ft)	1001-2000 m (6562 ft)	2001-5000 m (16404 ft)
Attenuation 1310 nm	< = 2.0 dB	< = 3.0 dB	< = 3.3 dB	< = 4.7 dB

5. Contractor must warrant in writing that 100% of the installation meets the requirements specified above.
6. Random retesting, if performed, shall be at the expense of the Owner, using standard labor rates. Any failing cabling shall be retested and restored to a passing condition.

Z. Documentation

1. Upon completion of all tests, six (6) copies of the test results shall be submitted for review. Prior to cutover, the Contractor shall perform a random sampling test, jointly with the Owner or Owner's representative, of one in six optical fibers selected by the representative, to verify conformance to the Specifications.
2. Test reports shall be submitted in electronic format. Hand-written or Hard copy test reports are not acceptable.
3. Electronic reports are to be submitted on 3.5 inch diskettes or CD format. If proprietary software is used, disk or CD shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., then software to read these files is not provided. Electronic reports must be accompanied by a certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
4. Fiber test reports shall include the following information for each cabling element tested:

    a. Actual measured attenuation (loss) at 850 nm and 1300 nm, expected attenuation at 850 nm and 1300 nm per Part 2 Section 3, and the margin. An individual test that fails the link attenuation criteria shall be marked as FAIL.
    b. Reference method.
    c. Number of mated connectors and number of splices (if any).
    d. Actual length and expected length. Any individual test that fails the link length criteria shall be marked as FAIL.
    e. Group refractive index (GRI) at 850 nm and 1300 nm.
    f. Tester manufacturer, model, serial number and software version.
    g. Circuit ID number and project/job name.
    h. Auto-test specification used.
    i. Overall pass/fail indication.
    j. Date and time of test.
    k. As a minimum, also provide cable number, fiber count, individual fiber numbers, connector types, number of connectors/patches; calculated maximum link loss, length of run, measured link loss for each fiber.

5. Test reports shall be submitted at 20% intervals of testing schedule, within seven (7) business days of completion of testing.

AA. Acceptance: Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with the Contract Documents, the Owner shall notify the Contractor in writing of the formal acceptance of the system.

3.4 “AS-BUILTS”

A. Provide “as-built” drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction.

END OF SECTION 27 0300

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SECTION 27 0400 - COMMUNICATIONS LADDER RACK

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all ladder rack/cable tray as specified herein and as required for proper distribution of all wire, cable, and electrical conductors throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0500 - Common Work Results for Communications.
3. Section 27 0506 - Grounding and Bonding for Communications Systems.
4. Section 27 1000 - Communications Conduit.
5. Section 27 1100 - Communications Equipment Room Fittings.
6. Section 27 1300 - Communications Backbone Cabling.
7. Section 27 1500 - Telecommunications UTP Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCE STANDARDS

A. All conduit and all components shall be designed, manufactured, and tested in accordance with the latest applicable industry standards and codes including the following:

1. ANSI/TIA/EIA - 568 C "Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements".
2. ANSI/TIA/EIA - 568B.3 "Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard".
3. ANSI/TIA/EIA - 569 "Commercial Building Standard for Telecommunications Pathways and Spaces".
4. ANSI/TIA/EIA - 606-A "Administration Standards for the Telecommunications Pathways and Spaces".

5. ANSI/TIA/EIA - 607 “Commercial Buildings Grounding and Bonding Requirements for Telecommunications”.
6. ANSI/NFPA-70 - “National Electrical Code”.
7. ANSI/NFPA-780 - “Lightning Protection Code”.
8. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards – A Background Report.”
9. BICSI “Telecommunications Distribution Methods Manual”.
10. IEEE Std 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
11. ANSI R211.
12. BOCA National Building Code, 1996; Seismic exposure Group II — Performance Category “C”.
13. NEMA PB-VE-1 - Cable Tray.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to Substantial Completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB’s), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC’s), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a “Materials Safety Data Sheet”, as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to Division 27 and shall include but not be limited to:

1. Ladder Rack, including samples, complete with fittings, materials, connector details, etc.

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and Division 27.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyl’s (PCB) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. If it complies with these Specifications, ladder rack, cable tray and fittings manufactured by one of the following manufacturers shall be acceptable:

1. Chatsworth Products Inc.
2. Legrand/Cablofil.
3. ***Cooper B-Line.***

2.3 LADDER RACK

A. All cable trays and fittings shall be supported in accordance with the latest NEMA standards as recommended in Publication No. VE-2 (maximum 12 ft. 0 in. span).

B. Cable tray shall be installed such that side rails are anchored to vertical wall using rated anchor bolts as per manufacturer's instructions, and each side rail's ends are bolted or welded to respective steel members in slab.

C. All ladder rack and cable tray shall be installed with seismic restraints and vibration isolation devices at all locations as described on the drawings.

D. Ladder rack system shall be made of straight sections, fittings, including brackets, rods, clamps, jumpers, fasteners, concrete inserts, etc., and accessories as defined in the latest NEMA standards publication VE-1. Ladder rack shall be UL classified as equipment grounding conductors.

E. Ladder rack shall consist of two (2) longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 9 inches on center for straight sections. Rung spacing in radiused fittings shall be 2 inches on center and measured at the center of the tray's width. Rungs shall have a minimum cable bearing surface of 7/8 in. with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

F. Straight sections side rails shall be I-beam and shall be supplied in standard lengths of 12 feet.

G. Side rails of straight sections and fittings shall be compatible so that standard splice plates can be used to join straight sections and fittings. Fittings shall have 3 inch tangents beyond the curved section to accommodate the standard splice plates.

H. Splice plates shall be the bolted type, using either square neck or ribbed-neck carriage bolts and serrated flange locknuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed .00033 ohm. The cable tray shall be designed so that a splice plate located anywhere along the span shall not decrease the strength of the cable tray system.

I. Splice plates shall be furnished with straight sections and fittings.

J. All accessories shall be furnished as required to protect, support and install the ladder rack system.

K. Ladder rack shall be capable of carrying a uniformly distributed load of 132 lbs./ft. with safety factor of 2.0 when supported as simple span and tested per NEMA VE1-4.01. In addition to the uniformly distributed load, the cable tray shall support 200 lbs. concentrated load at midpoint (middle of span) without permanent distortion to cable tray. Load and safety factors specified are applicable to both the side rails and rung capacities.

L. Ladder rack shall be made to manufacturing tolerances as specified by NEMA (see NEMA VE1-2.03 and VE1-2.04).

M. Provide bend sections with a minimum 24 inch radius.

N. Coordinate installation of ladder rack with all other Trades.

O. 6 in. outboard rungs shall be installed as indicated on drawings.

P. Submit proposed supporting criteria, including loading characteristics, to the Structural Engineer for review.

Q. Ladder runway shall be installed in wiring closets for dressing of inter-runway cabling and patching where necessary.

R. Ladder runway system shall be made of straight sections, fittings, including brackets, rods, clamps, jumpers, fasteners, concrete inserts, etc., and accessories as defined in the latest NEMA standards publication VE-1. Ladder runway shall be UL classified as equipment grounding conductors.

S. Ladder runway shall consist of two (2) longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 9 inches on center for straight sections. Rung spacing in radiused fittings shall be 2 inches on center and measured at the center of the tray's width. Rungs shall have a minimum cable bearing surface of 7/8 in. with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

T. Ladder runway shall have an overall nominal depth of 1-1/2 in. unless otherwise noted on plans. Load width shall be as indicated on the drawings.

U. Straight sections and side rails shall be tubular construction.

V. Side rails of straight sections and fittings shall be compatible so that standard splice plates can be used to join straight sections and fittings. Fittings shall have 3 inch tangents beyond the curved section to accommodate the standard splice plates.

W. Splice plates shall be the bolted type, using either square neck or ribbed-neck carriage bolts and serrated flange locknuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed .00033 ohm. The cable tray shall be designed so that a splice plate located anywhere along the span shall not decrease the strength of the cable tray system.

X. Splice plates shall be furnished with straight sections and fittings.

Y. All accessories shall be furnished as required to protect, support and install the ladder runway system.

Z. Ladder runway shall be capable of carrying a uniformly distributed load of 132 lbs./ft. with safety factor of 2.0 when supported as simple span and tested per NEMA VE1-4.01. In addition to the uniformly distributed load, the cable tray shall support 200 lbs. concentrated load at midpoint (middle of span) without permanent distortion to cable tray. Load and safety factors specified are applicable to both the side rails and rung capacities.

AA. Ladder runway shall be made to manufacturing tolerances as specified by NEMA (see NEMA VE1-2.03 and VE1-2.04).

BB. Coordinate installation of ladder runway with all other trades.

CC. Where runways come together, use adjustable, junction splice kits, and appropriate radial junction kits in order to maintain proper cable turning radii.

DD. Submit proposed supporting criteria including loading characteristics to the Structural Engineer for review.

EE. Submit shop drawings indicating routing and proposed method of installation complete with dimensions BEFORE commencing work.

2.4 FLEXIBLE CABLE TRAY

A. Provide flexible cable tray raceway with basic equipment as shown on Drawings and as required, including, but not limited to, splice plates, bracket mounts and hardware.

B. Straight 10 ft. standard tray sections constructed of welded wire mesh, coated with electroplated zinc galvanizing.

C. Steel fittings with hot-dipped mill-galvanized commercial coating. Steel, zinc electroplated nuts, bolts and washers.

D. Dimensions – 4 in. loading depth unless otherwise noted on plan. Load width shall be as indicated on the drawings.

E. Submit shop drawings indicating routing and proposed method of installation complete with dimensions BEFORE commencing work.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine and compare the telecommunications pathway drawings and specifications with the drawings and specifications of other Trades; report any discrepancies between them to the Engineer and obtain from him written instructions for changes necessary in the work.

B. Install and coordinate the telecommunications pathways work in cooperation with other Trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner accepted by the General Contractor. All repairs or changes required in the work of the Contractor caused by his neglect shall be made by him at his own expense.

C. The locations of ladder racks, conduits, outlets and other equipment indicated on the drawings are approximately correct and are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed.

D. Telecommunications pathways running parallel to electrical cables/conduits shall be separated by a minimum of 12 in. When crossing, maintain a 3 in. minimum separation. Maintain a minimum 12 in. separation from all fluorescent lighting fixtures.

E. Telecommunications pathways shall cross electrical cables/conduits at 90 degree angles only.

F. The Contractor shall maintain a current copy of this bid specification at the job site at all times.

G. The Contractor shall maintain a complete file of shop drawings and other submissions at the job site at all times. These shop drawings and submissions shall be made available to the General Contractor, Owner, Engineer or Architect at his request.

H. Keep all items protected before and after installation, with dust- and moisture-proof barrier materials. It shall be the Contractor's responsibility to ensure the integrity of these protective measures throughout the life of the project.

I. Clean up all debris generated by installation activities.

J. At all times during the construction, the Contractor shall protect all equipment from damage and theft.

K. Upon project completion, provide “as-built” drawings and documentation as defined herein.

L. All telecommunications pathways provided as part of this work shall provide smooth surfaces wherever contact could be made with correctly installed telecommunications cabling. All burrs, threaded sections, or other sharp or abrasive edges or surfaces in cable bearing sections shall be finished smooth or with rounder edging provided.

M. Provide expansion joints in the cable trays/runways wherever trays/runways span a building expansion joint.

N. Cables shall follow conduit routes and trunk patterns or main pathways reflected on drawings. Tributary pathways shall be established for cable distribution from the main cable pathway to the telecommunications outlet. Where specific routes are not indicated, cables shall follow room boundaries under raised floor or above hung ceiling for distribution into walls, outlets, channels, or conduits. Cabling below raised floors shall follow specified routes and shall always be routed parallel or perpendicular to building construction (no diagonals).

3.2 “J” HOOKS

A. No more than twenty-four (24) 4-pair cables shall be suspended in each 2 in. “J” hook support. If smaller cable supports are used, do not fill support more than 40% full.

B. All cable distribution from the cable trays/conduits to points of vertical transition to work areas shall be supported by means of 2 inch “J” hooks on 5 foot centers (max). Ceiling support grids and service hangers shall not be used for support of telecommunications cabling.

C. Main cabling pathways consist of the pathways out from the Equipment Rooms on cable tray or other means of cable support as detailed below. Tributary cable paths consist of the pathways from the main cable pathway to the telecommunications outlet.

D. “J” hooks shall be directly attached to the ceiling deck or hung from the deck by a threaded rod. (Length of the threaded rod shall not exceed 3 feet and the distance between rings shall not exceed 5 feet.)

E. Using removable hook and loop type (Velcro®) cable fasteners, cables must be neatly tie-wrapped in bundles at the midpoint between “J” hooks.

3.3 LADDER RACK

A. A ladder rack system shall be made of straight sections, fittings, including brackets, rods, clamps, jumpers, fasteners, concrete inserts, etc., and accessories as defined in the latest NEMA standards publication VE-1. Ladder rack shall be UL classified as equipment grounding conductors.

B. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 9 inches on center for straight sections. Rung spacing in radiused fittings shall be 2 inches on center and measured at the center of the tray's width. Rungs shall have a minimum cable bearing surface of 7/8 in. with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

C. Straight section side rails shall be I-beam.

D. Ladder racks shall be supported by trapeze hangers. Supports shall be located where practicable so that connections between the sections of the ladder rack fall between the support point and the

quarter section of the span. The support centers shall be in accordance with the load and span requirements as outlined by the manufacturer. A support shall be placed within 2 feet on each side of any connection to a fitting.

E. Side rails of straight sections and fittings shall be compatible so that standard splice plates can be used to join straight sections and fittings. Fittings shall have 3 inch tangents beyond the curved section to accommodate the standard splice plates.

F. Splice plates shall be the bolted type, using either square-neck or ribbed-neck carriage bolts and serrated flange locknuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed .00033 ohm. The cable tray shall be designed so that a splice plate located anywhere along the span shall not decrease the strength of the cable tray system.

G. Splice plates shall be furnished with straight sections and fittings.

H. All accessories shall be furnished as required to protect, support and install a ladder rack system.

I. Ladder rack shall be capable of carrying a uniformly distributed load of 132 lbs./ft. with safety factor of 2.0 when supported as simple span and tested per NEMA VE1-4.01. In addition to the uniformly distributed load, the cable tray shall support 200 lbs. concentrated load at midpoint (middle of span) without permanent distortion to cable tray. Load and safety factors specified are applicable to both the side rails and rung capacities.

J. Ladder rack shall be made to manufacturing tolerances as specified by NEMA (see NEMA VE1-2.03 and VE1-2.04).

K. Where runways come together, use adjustable, junction splice kits, and appropriate radial junction kits in order to maintain proper cable turning radius.

L. Where cables spill over the side of the runway, or through the runway, provide cable runway radius drops.

M. Provide all required appurtenances required for installation of runway ladder rack system.

N. Submit shop drawings indicating proposed method of installation complete with dimensions before commencing work.

O. Have an overall nominal depth and width as shown on plans.

P. Coordinate with all other Trades.

Q. Posed supporting criteria, including loading characteristics, to the Structural Engineer for review.

R. Cable runways and trays shall be routed to maintain the minimum EMI spacing as defined under the EMI/RFI Avoidance section.

S. Cable tray shall not be routed directly above fluorescent light fixtures.

T. Cable runways shall be supported in the Telecom Rooms using wall mounting brackets and/or ceiling supports as indicated in accordance with manufacturer's recommendations. Support all cable runways which do not run adjacent to walls with ceiling-hung threaded rod for all spans in excess of five (5) feet. Use manufacturer's original fittings at all bends, joints, offsets, etc.

U. Cable trays penetrating through walls shall be interrupted, and secured to the walls. A metallic liner of equivalent size to the carrying capacity of the cable tray shall be provided through the wall, framed on both sides. The bottom of the liner shall be mounted to match the loading level of the

cable tray. Firestopping shall be provided when penetrations are made through fire-rated structures (if required).

1. Software revision, and serial number of test equipment used, date of last calibration and names of test crew.

3.4 "AS-BUILTS"

A. Provide "as-built" drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction

END OF SECTION 27 0400

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SECTION 27 0500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Division 27 of the Specifications requires the furnishing and installing of all items, including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, equipment, transportation, rigging, storage, tools, scaffolding, machinery, appliances, utilities, testing, commissioning, and all required permits and licenses.

B. Before submittal of bid, examine all drawings, specifications, addenda, alternates, special conditions, and all other Contract Documents of all Division and Sections of this project, verify all governing conditions at the site, and become fully informed as to the extent and character of the work required, as well as its relation to other work in the building. Submittal of a bid is an agreement to all requirements of the Contract Documents, and no consideration will be granted for any claimed misunderstanding thereof.

C. Submittal of a bid is deemed a representation by the bidder that it is qualified in all respects properly to perform the work for which it is bidding and has experience with similar work. Bidders are deemed to be aware, on the basis of their background and experience, of materials which may be required in the discharge of their responsibilities, even though unspecified. For example, claims for extras for unspecified shoring or supporting materials will not be considered if the need for such materials would have been reasonably obvious to bidders skilled and experienced in the work to be done and the submittal of a bid shall be deemed a waiver of any such claims.

D. All statements, requirements, and contractual obligations imposed upon the Contractor awarded this Division of the Contract Documents shall also be applicable to his Subcontractors, Agents acting on behalf of the Contractor, servants and/or employees. All correspondence, agreements, and final responsibility for completion of work shall rest solely with this Contractor.

E. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0400 - Communications Ladder Rack.
3. Section 27 0506 - Grounding and Bonding for Communications Systems.
4. Section 27 1000 - Communications Conduit.
5. Section 27 1100 - Communications Equipment Room Fittings.
6. Section 27 1300 - Communications Backbone Cabling.
7. Section 27 1500 - Telecommunications UTP Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCES

A. The entire installation and all equipment, materials and methods shall comply with the currently enforced versions of all applicable laws, rules, regulations, standards, legislation, codes and ordinances of New York City, Underwriters Laboratory and New York City Electrical Code, Telecommunications Industries Association/Electronic Industries Association/(TIA/EIA) and Building Industry Consulting Service International (BICSI) Standards where they do not conflict with any applicable requirements of laws, codes, ordinances, legislation, etc., of all federal, state and local authorities whether indicated on the Contract Documents or not. All equipment shall be MEA and/or BS&A approved or have an OTCR approval and approved for use in New York City. Modifications required by the above said authorities having jurisdiction shall be made without additional cost to the Owner.

1. Except as modified herein, the requirements and recommendations of the latest editions of the following documents are made part of these Specifications:

a. ANSI/TIA/EIA - 568 C “Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements”.
b. ANSI/TIA/EIA - 568B.3 “Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard”.
c. ANSI/TIA/EIA - 569 “Commercial Building Standard for Telecommunications Pathways and Spaces”.
d. ANSI/TIA/EIA – 606-A “Administration Standards for the Telecommunications Pathways and Spaces”.
e. ANSI/J-STD-607-A - “Commercial Buildings Grounding and Bonding Requirements for Telecommunications”.
f. ANSI/NFPA-70 - “National Electrical Code”.
g. ANSI/NFPA-780 - “Lightning Protection Code”.
h. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards – A Background Report.”
i. BICSI “Telecommunications Distribution Methods Manual”.
j. IEEE Std 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
k. ANSI R211.
l. BOCA National Building Code, 1996; Seismic exposure Group II — Performance Category “C”.

B. Where Contract Document requirements are in excess of rules, regulations and Code requirements, and are permitted under the Code, the Contract Documents shall govern. In the event of a conflict between the Contract Documents and the applicable laws, rules, regulations, codes and ordinances of federal, state and local authorities having jurisdiction, the latter shall govern.

C. Where alterations to and/or deviations from the Contract Documents are required by the Authorities listed above, report the requirements to the Architect and Engineer and secure his written approval before starting the required modifications.

D. Pay royalties or fees required in connection with the use of patented devices, or systems, and save the Owner, the Architect, the Engineer and the Construction Manager harmless from any

claims or lawsuits arising from such use and indemnify each thereof against attorneys in connection therewith.

E. Secure and pay for necessary approvals, permits, inspections carting, legal dumping, etc., and deliver the official records of the granting of permits to the Owner without additional cost to the Owner.

F. All equipment, materials, and methods to be furnished and/or installed by this Division shall comply with all applicable requirements of laws, codes, ordinances, legislation, standards, etc., of all federal, state and local authorities, whether indicated on the Contract Documents or not.

1.5 ABBREVIATIONS AND ACRONYMS

AC	Alternating Current.
ACEG	Alternating Current Equipment Ground.
AWG	American Wire Gauge.
ADA	Americans with Disabilities Act.
AISC	American Institute of Steel Construction.
ANSI	American National Standards Institute.
ASA	Acoustical Society of America.
ASTM	American Society for Testing and Materials.
BICSI	Building Industry Consulting Services International.
BSA	Board of Standards and Appeals.
CBC	Coupled Bonding Conductor.
CISPR	International Special Committee on Radio Interference.
CSA	Canadian Standards Association.
DC	Direct Current.
EF	Entrance Facility.
EIA	Electronic Industries Association.
EMT	Electrical Metallic Tubing.
EPA	Environmental Protection Agency.
ER	Equipment Room.
ETL	Electric Testing Laboratory.
FM	Factory Mutual.
PWD	Premise Wiring Distribution
IEEE	Institute of Electrical and Electronic Engineers.
IRI	Industrial Risk Insurers.
MBR	Main Business Room.
MEA	Material Equipment Approval.
MSDS	Materials Safety Data Sheet
MSS	Manufacturers' Standardization Society Standards.
MTA	Metropolitan Transportation Authority.
NCC	Network Communication Center
NCS	National Communications System.
NEC	National Electrical Code (NFPA 70).
NEMA	National Electrical Manufacturers Association.
NFPA	National Fire Protection Association.
NUSIG	National Uniform Seismic Installation Guidelines.
OSHA	Occupational Safety Health Administration.
POE	Point of Entry
PWD	Premise Wiring Distribution
SER	Service Entry Room.
TBB	Telecommunications Bonding Backbone.
TBBIBC	Telecommunications Bonding Backbone Interconnecting Bonding Conductor.
TER	Telecommunications Equipment Room.
TGB	Telecommunications Grounding Busbar.
TIA	Telecommunications Industry Association.
TIB	Technical Information Bulletin.

TMGB	Telecommunications Main Grounding Busbar.
TSB	Technical Service Bulletin.
UL	Underwriters Laboratories.

1.6 DEFINITIONS

A. For purposes of these Specifications the following definitions apply:

1.	"ARCHITECT":	the Architect of record.
2.	"ENGINEER":	the Engineer of record.
3.	"CONTRACTOR":	the individual, partnership or corporation to whom has been awarded the contract for providing the work associated with this Division.
4.	"CONSTRUCTION MANAGER"	an individual or group that contracts with another organization or individual (owner) for the scheduling and coordination of all design and construction processes including the selection, hiring and oversight of specialty trade contractors for a building or other structure.
5.	"LIGHTING DESIGNER":	the primary project Lighting Designer.
6.	"PROVIDE":	to "furnish" and "install"
7.	"INSTALL":	to join; unite; fasten; link; attach; set up or otherwise connect together; complete, tested and ready for normal satisfactory operation.
8.	"FURNISH":	to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application.
9.	"AS DIRECTED":	as directed by the Architect or the Engineer.
10.	"CONCEALED":	embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings or accessible raised floor cavities.
11.	"SUBMIT":	submit to the Architect and/or the Engineer for review.
12.	"FINISHED SPACES":	spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
13.	"EXPOSED":	exposed to view.
14.	"SUPPLY":	to purchase, procure acquire, and deliver complete with related accessories.
15.	"WORK":	includes labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.
16.	"PIPING":	includes pipe, tube, fittings, flanges, valves, controls, strainer, hangers, supports, unions, traps, drains, insulation, and all related accessories.
17.	"WIRING":	includes raceway, fittings, wire, boxes, and all related accessories.
18.	"BALLAST FACTOR":	ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
19.	"CRI":	color rendering index; a measure of the degree of color shift objects undergo when illuminated by the light source, as compared with those same objects when illuminated by a reference source of comparable color temperature.
20.	"INDICATED":	as shown or noted on the drawings or specifications.
21.	"CONTRACT DOCUMENTS"	all documents associated with the project, including all drawings and specifications of all trades.

22. "BENEFICIAL USE" the state of installation in which all equipment related to the system being described is installed, functional, tested, and has been signed off by the Owner.

23. "CABLING" the inclusion of all fittings, conductors, connectors, connections, terminations and all other items necessary and/or required in connection with such work.

1.7 RELATED DOCUMENTS

A. The General and Supplementary General Conditions accompanying these Specifications are hereby made a part of the requirements for the work under this Section of the Specifications. Where General Conditions and Supplementary General Conditions clauses are repeated in these Specifications, it is to call special attention to them, or as a further qualification. No General Conditions and/or Supplementary General Conditions clause referring to the work of this Section shall be considered waived unless specifically stated herein.

B. Refer to Owner's "Commissioning Requirements" for the scope of work related to systems furnished and installed under Division 27.

C. Certain materials will be furnished, installed, or furnished and installed, under other Sections of the Contract Documents. Examine the Contract Documents to ascertain these requirements.

D. Refer to Divisions 21, 22, 23, 25, 26 and 28 for the scope of work related to systems furnished and installed under Divisions 21, 22, 23, 25, 26 and 28.

1.8 QUALITY ASSURANCE

A. After completion of installation, but prior to Final Completion, this Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB's), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

C. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a "Materials Safety Data Sheet", as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

D. Make every effort to furnish all equipment of any equipment type (such as switchboards, panelboards, distribution boards, etc.) from one manufacturer.

E. Furnish all equipment, materials and accessories new and free from defects.

F. All equipment and material to be furnished and installed on this Project shall be approved for use in New York City, listed by UL, ETL or any other recognized agency, listed in accordance with the requirements of the City of New York or any other Authority having jurisdiction, and be suitable for their intended use on this Project.

1.9 ENGINEERING REFERENCE POINTS

A. The Construction Manager will provide bench marks, monuments, and other reference points on the job which will be available for this Contractor's use.

B. Maintain all existing bench marks, monuments and other reference points and perform all field engineering required to insure that work under this Section shall conform with grades, elevations and lines required.

1.10 GUARANTEE

A. Submit a single guarantee stating that all portions of the work are in accordance with Contract requirements. Guarantee all work against faulty and improper material and workmanship for a period of one year from date of final acceptance by the Owner; except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply. At no additional cost to Owner, within 24 hours after notification, correct any deficiencies which occur during the guarantee period, all to the satisfaction of the Owner and Architect.

B. Guarantee that the materials and workmanship supplied under this Division will be of the best quality currently available, that the apparatus will be erected in a practical manner and in accordance with best practices, that it will be complete in operation, nothing being omitted in the way of labor and material required to make this so, although not specifically shown or mentioned herein and that it will be delivered in proper working order, complete and perfect in every respect without additional cost – whether or not shown in detail on the drawings or described in detail in this Specification.

C. Be responsible for all damage to or caused by the Work performed under this Division for a period of one year from date of the acceptance of work under this Contract. Repair at no cost to Owner all such damage which occurs within 24 hours notice thereof by the Owner. Damage which occurs prior to the completion of this Work shall be repaired at once. Be responsible for any damage and repair thereof and reimburse Owner for all expense incurred thereby. Indemnify the Owner, the Architect, the Engineer and the Construction Manager against loss, liability, damage or expense, including reasonable attorneys' fees, in connection with any claim resulting from such deficiencies which may be asserted by any third party, including tenants.

1.11 INDEMNIFICATION

A. Covenant and agree that this Contractor and his Subcontractors and his and their agents, servants and employees will provide and maintain a safe place to work and that he and they will comply with all laws and regulations of any governmental authority having jurisdiction thereof. Agree to indemnify, defend and hold harmless the Owner, owner's agents and Engineer from and against any liability, loss damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of this Contractor, his Subcontractors and his and their agents, servants and employees to provide and maintain a safe place to work or to comply with all laws and regulations of any governmental authority having jurisdiction thereof.

B. Covenant and agree that this Contractor and his Subcontractors and his and their agents, servants and employees will provide and maintain a safe place to work and that he and they will comply with all laws and regulations of any governmental authority having jurisdiction thereof. This Contractor agrees to indemnify, defend and hold harmless the Owner, owner's agents and Engineer from and against any liability, loss damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of this Contractor, his Subcontractors and his and their agents, servants and employees to discharge the obligations assumed by him or them in the performance of the work, including any act or omission allegedly resulting in death or personal injury or property damage or improper construction, construct6ion techniques, or the use of improper or inappropriate material or tools

1.12 COMPLETE PERFORMANCE OF WORK

A. This Contractor and his Subcontractors under this Section of the Specifications shall provide all labor, materials, supervision, supplies, tools, scaffolding, machinery, equipment, appliances, and services (including transportation, rigging, storage utilities, etc.) and all required permits and licenses necessary to complete the Electrical Work under this Contract. All systems and equipment shall be complete in every respect and all items of material, equipment and labor shall be furnished, installed, tested and commissioned for a fully operational system.

B. This Contractor shall coordinate his Work with the Work of the other trades so as to resolve conflicts without impeding job progress or the Project construction schedule. Provide notice with the bid proposal of any concrete work required by this Section that is not indicated on the Structural or Architectural Drawings or Drawings of other trades.

C. This Contractor shall examine all Contract Documents for all Sections of the Specifications in order to determine the extent of Work required to be completed under this Section. Failure to examine all the Contract Documents for this Project will not relieve this Contractor of the responsibility to perform all the Work required for a complete, fully operational and satisfactory installation.

D. Work shall be executed in strict accordance with the best practice of the trades in a thorough, workmanlike manner by competent skilled technicians and trade personnel.

E. This Contractor shall provide a competent, experienced full-time Superintendent who is authorized to make decisions on behalf of the Contractor.

F. Provide all temporary services and standby for power and lighting as required by the Construction Manager.

G. All labor, materials, apparatus, and appliances essential to the complete and proper functioning of the systems described and/or indicated herein, or which may be reasonably implied as essential, whether mentioned in the Contract Documents or not, shall be furnished and installed by this Contractor. The entire installation shall be ready in every respect for satisfactory and efficient operation when completed.

H. In cases of doubt as to the work intended, or in the event of need for explanation thereof, request supplementary written instructions in the form of a Request For Information (RFI) from the Architect and/or Engineer.

I. Coordinate the work specified and shown on the Contract Documents with all other trades.

J. Be responsible for material and workmanship until completion and final acceptance. Replace any of same which may be damaged, lost or stolen, without additional cost to Owner. Guard the building and its contents against damage by this Contractor and repair any damage free of charge.

K. Agree that any controversy or dispute to which the Contractor, the Owner and the Engineers are parties shall be submitted to the American Arbitration Association for decision in accordance with the rules of such Association for construction industry disputes. All Contractors likewise agree to submit to such arbitration any dispute between or among them, the Contractor, the Owner and the Engineers, and the Contractor agrees to make available to the Engineers, on demand, signed copies of the contract between the Owner and the Contractor and between the Contractor and his Subcontractors or Agents acting on his behalf. The Contractor and each Subcontractor or Agents acting on his behalf agree that by submitting a bid, which is accepted, this paragraph shall be deemed a written agreement to submit any controversy thereafter arising to arbitration.

L. Where, due to union regulations or trade agreements, any of the work shown on the drawings or specified herein is not considered this trade's work, subcontract the work in question, but assume full responsibility for the complete installation. Except for such changes as may be specifically approved by the Architects and Engineer, in accordance with alternates or options stated hereinafter, all work must be in full accordance with the intent of the plans and specifications, complete in every way and ready for satisfactory and efficient operation when delivered to the Owner.

M. Provide all signage required by the authorities having jurisdiction (e.g., on communications equipment, on doors to/from Communications Room, etc.).

N. Provide all rigging required for complete installation and furnish drawings showing necessary points of support, loads imposed, reactions and supplementary bracing. This shall be submitted to Owner for approval. Should any shoring be required, provide same after Owner's approval.

O. Become thoroughly acquainted with the work involved, obtain and verify, at the building, all measurements necessary for the proper installation of work. Furnish to other contractors any information relating to work of this Division necessary for the proper installation of their contracts. Confer with other contractors for finish work adjacent to work of this section and arrange to have visible portions of the work (such as access doors, grilles, escutcheons, etc.) fit in and harmonize with the finish work of other Sections in a manner satisfactory to the Architect and Owner.

P. Transmit to trades doing work of other Sections all information required for work to be provided under their respective sections (such as fresh water connections, foundations, electric wiring, access doors, and the like) in ample time for installation.

Q. Wherever this Contractor's work interconnects with work of other Contractors, this Contractor shall coordinate his work with these Contractors to ensure that all Contractors have the information necessary so that they may properly install all the necessary connections and equipment. Identify all work items (valves, dampers, pull boxes, junction boxes, etc.) in an approved manner in order that the other Trades may know where to install such items such as access doors, panels, etc.

R. Provide required supports and hangers for conduit, cable tray, ladder rack and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid shall be deemed a representation that the Contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports. Submit drawings showing all points of support, loads imposed, etc., to the Architect for review.

S. Field drilling, cutting and/or reinforcing of all openings, including holes in structural metal deck, structural slabs, or structural walls, required for work under this Section shall be coordinated through the Construction Manager and approved by the Structural Engineer. All such drilling, cutting and reinforcing costs shall be borne by this Contractor.

T. Make every effort to furnish all equipment of any equipment type (such as conduit, busduct, cable tray, ladder rack and equipment) from one manufacturer. Consult with Trades doing the work of other Divisions, supplying similar equipment so that wherever possible motors, motor controls, pumps, valves switchboards, panelboards, and overcurrent protective devices, are of the same manufacture.

U. Provide a heavy field coat of black asphaltum paint on all steel pipe, cradles, supports, vibration isolating mounts, or the like, that will be encased or partially encased in the building construction set in cement or fill, before items are built into the general construction.

V. Sidewalks and streets adjoining the property shall be kept broom clean and free of debris, rubbish, trash and obstructions of any kind caused by work of this Contractor, which will affect the condition and safety of streets, walks, utilities and property.

W. With the exceptions as specified and/or indicated on the Drawings or in the Specifications, the Contractor shall apply, install, connect, erect, use, clean, commission and condition manufactured articles, materials and equipment per Manufacturer's current printed instructions and recommendations. Copies of such printed recommendations shall be kept at the Project site and made available as required.

X. Where the manufacturer's recommendations conflict with the Contract Documents, the conflict shall be brought to the Engineer's attention immediately.

1.13 CONTRACTOR MILESTONES

A. The following is a summary of the scheduling milestones described in the text of the Specifications. The Contractor shall start on or schedule the following upon receiving notice to proceed.

1. Immediately upon award of this Contract, this Contractor, together with his major Subcontractors, shall have a pre-construction meeting at a mutually agreed place and time with the Architect and Engineer.
2. As requested by the Construction Manager, the Contractor shall submit a complete, typed list of the Subcontractors, equipment manufacturers and suppliers they intend to use to the Engineer for review.
3. As requested by the Construction Manager, the Contractor shall prepare an index of all his shop drawings and brochures for the Project.
4. As requested by the Construction Manager, the Contractor shall furnish pull schedules and cross-connect schedules to the Engineer.
5. As requested by the Construction Manager, the Contractor shall submit "Coordination Drawings" to the Engineer for review.
6. As requested by the Construction Manager, the Contractor shall provide detailed schedule of completion indicating when each system is to be completed and outlining when tests will be performed.
7. Submit proposed test procedures, recording forms and test equipment for review by the Engineer two (2) weeks prior to execution of testing.
8. Submit six (6) final copies of the Operation and Maintenance books to the Engineer for review at least ten (10) weeks before Final Review of the Project.

1.14 DESCRIPTION OF BID DOCUMENTS

A. The Drawings show the general layout of the various items of equipment. However, layout of equipment, accessories, specialties, cabling and conduit systems (including boxes, cable trays, ladder racks, troughs, etc., are diagrammatic unless specifically dimensioned, and do not necessarily indicate every required fitting, support, or similar items required for a complete installation. Consult the Architectural Drawings and details for exact locations of fixtures and equipment located in finished construction and/or surfaces. Where same is not definitively located, obtain the information from the Architect before proceeding by submitting a dimensioned submittal for review. Any reasonable changes in locations indicated shall be made by this Contractor without additional cost to the Owner.

B. The Contractor shall follow the Drawings in laying out the Work and check drawings of all trades to verify spaces in which Work will be installed. Maintain maximum headroom and where space conditions appear inadequate, the Architect shall be notified before proceeding with the installation. (See “Submittals” Article below.)

C. Specifications in general, describe quality and type of materials and equipment.

D. The drawings show the various systems schematically. No added compensation will be permitted for variations due to field conditions.

E. Where disagreements occur within the Contract Documents, the item or arrangement of better quality, greater quantity or higher cost shall be included in the base bid. Request, through the Construction Manager clarification in writing from the Architect or Engineer on which item and manner in which the work shall be installed.

F. Work not shown on the drawings but called for in the Specifications, or vice versa, shall be provided by the Contractor without additional expense to the Owner.

G. The commercially standard items of equipment and the specific names mentioned herein are intended to identify standards of quality and performance necessary for the proper functioning of the work.

H. Equipment shown on the Drawings with particular manufacturers identified has been coordinated for structural penetrations, utility connections, operating and service (maintenance) requirements, and physical size with regard to the space where the equipment is shown. If they comply with the Project specifications, these and the other specified manufacturers of this equipment will be acceptable contingent on the Contractor providing a complete installation and maintaining full responsibility to provide, at no additional cost, any modifications to the structure, mechanical connections or electrical service that are required to properly install, operate, and service the equipment being used. These modifications shall not include additional area for equipment unless approved by the Architect.

1. Note these changes on the equipment submittal and show all differences in equipment being supplied from that shown in the Contract Documents. Failure of the Contractor to provide this information with the submittal will indicate the submitted equipment meets or exceeds the equipment shown in the Contract Documents in performance and is physically no larger in housing size.

a. Failure of the Contractor to comply with the above and any discrepancies found shall result in the Contractor providing equipment equal to that specified at the Contractor's expense.

1.15 SUBMITTALS

A. The term "shop drawings" shall include layout, detail, and assembly drawings, diagrams, schedules, catalogue sheets, printed descriptive matter, and tabular and graphical presentations of operating and performance data that describe work required by the Contract Documents. Catalogs and catalog sheets shall be clearly annotated indicating the specific items being proposed.

B. Prior to Final Acceptance, the following data shall be furnished in accordance with the Conditions of the Construction Contract, Division 01 Specifications, and this Division of the Specifications, and shall include but not be limited to:

1. Record Drawings.
2. Operating and Maintenance Manuals.
3. Contractor Coordination Drawings.

C. In addition, during the installation period, submit detailed shop layout drawings for each floor of the project, including all Equipment Rooms, showing equipment and conduit work and other distribution services described herein, including locations and sizes of all openings in cellular steel floor decks, walls and floors. Shop drawings with multiple parts shall be submitted as a package. Shop drawings shall be 3/8 inch equal to 1 ft. 0 in. scale. Conduit shop drawings shall also indicate the point loading and spacing of each hanger and the method of support. Drawings shall include full coordinated plans and sections for Equipment Rooms, floor plans and risers. In addition, required detail drawings, such as anchor and guide details, housekeeping pads for floor-mounted equipment, etc., shall be submitted.

D. While the Contractor shall have access to the Engineer's drawings, neither these Engineer's drawings nor electronic files nor any other reproduced copy of the Engineer's drawings at any scale shall be used by the Contractor to generate any shop drawings. Shop drawings shall be completely drawn at the appropriate scale on clean sheets by this Contractor and/or any Subcontractor retained by this Contractor for any purpose on the project.

E. Shop drawings for Equipment Rooms, and for conduit and similar distribution services shall show by dimension the exact size and location of each element of the system in both the horizontal and vertical plane, as well as relationship to the building structure, architectural construction, equipment, and the work of other Trades. Where new work is added to an existing structure, the shop drawings shall show the location of all existing services and equipment. Pads, foundations, anchorages, supports and attachments to the building structure where required for the installation of the work shall be shown in layout and detail with sizes, dimensions, materials and methods of construction noted. The work described in any shop drawing submission shall be carefully checked by this Contractor for all clearances (including those required for maintenance and servicing, e.g., racked-out position of equipment), field conditions, maintenance of architectural conditions and proper coordination with all Trades on the job. Each submitted shop drawing shall include a certification by the Construction Manager that all related job conditions have been checked and that no conflict exists. Shop drawing submissions will either be rejected without such certification or the Construction Manager shall remedy all conflicts without any costs to the Owner.

F. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features and all applicable accessories, options, trip settings, sizes, materials, painting, etc.

G. Prepare and submit detailed shop drawings for major conduit duct banks (more than 3 conduit run together) and other distribution services in 3/8 in. = 1 ft. 0 in. scale, including sections and locations and sizes of openings in floors, walls, roofs and beams.

H. For each room or area of the building containing switchboards, panelboards, motor control centers, transformers, emergency generators, substations, dimming cabinets, sound system cabinets, bus ducts, telephone backboards, signal system backboards, fire alarm terminal cabinets, fire alarm control panels, consoles, etc., the following is required to be submitted for review and acceptance at the time of the equipment submittal.

1. Floor Plans

a. Plan views (including sections and elevations) of equipment indicated in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1/4 in. = 1 ft. 0 in. They shall be prepared in the following manner:

1) Indicate the physical boundaries of the space, including door swings, ceiling/clear heights and ceiling types (as applicable).
2) Note all Code-required clearances from all equipment by dimensions, including all service and maintenance requirements (e.g., racked-out position of equipment, etc.).
3) Illustrate all electrical equipment proposed to be contained herein. Include top and bottom elevations of all electrical equipment. The drawings must be prepared utilizing the dimensions contained in the individual equipment submittals.
4) Illustrate all other equipment therein, such as conduits, detectors, luminaires, ducts, registers, pull boxes, crown boxes, splice boxes, wireways, structural elements, etc.
5) Note the operating weight of each piece of equipment.

6) Note the heat release from each piece of electrical equipment in terms of Btu per hour. This information shall be that which is supplied by the respective manufacturers.
7) Illustrate all concrete pads, curbs, etc.
8) Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation).

b. Equipment Removal Routes

1) Provide, in conjunction with the above, a set of documents reproduced from the then current Contract Documents indicating the methods of equipment removal for all major pieces of equipment, including size of equipment when disassembled into smallest components.
2) Indicate on floor plans by means of arrows, the complete path for equipment removal.
3) Where equipment will be required to be hung temporarily from a slab or beam, note same on the submission, including the weight of the equipment to be hung and the weight of the hoisting equipment.
4) Note all heights of conduits, ductwork, link beams, doorways, transoms, piping, etc., in the proposed path assuring that adequate headroom is provided.

I. The Contractor shall submit shop drawings of the following work for review:

1. Equipment pads, foundations and supports.
2. Routing of underground services.
3. Construction details for conduit, including routing, racking, risers, etc.
4. Control and alarm systems.
5. All items of manufactured material and equipment for associated systems.
6. Other specific items of work as required by the provisions of the technical sections of the Contract Documents should be included in Submittal section.

J. Submit manufacturer's data or shop drawings of all proposed equipment, including, but not limited to, the following:

Cable
Connectors
Couplings
Faceplates
Jack Modules
Wire Management
Termination Details
Cable Trays
Kellems Grips
Wiring Devices
Pull Boxes
Troughs
Seismic Restraints and Vibration Isolation
Cabinets
Equipment Racks
Patch Panels
Wiring Blocks
"D" Rings
Strain Relief Bars
Cable Labeling Tags
Ladder Racks
Mounting Hardware
Cable Supports
Wiremold
Floor Boxes

K. Names, sizes, catalogue numbers and/or samples of the following specialties shall also be submitted for review, unless otherwise directed:

Cable	Modules and Couplings
Connectors	Respective Labels
Floor Monument Inserts	Termination Boxes
Outlet Boxes	Faceplates
Typical Test Results for Cabling Plant	Wire Management Hardware

L. This Contractor shall provide a Compliance Review of all Specifications and drawings with submittals.

1. The first section of the Compliance Review will be a review of the drawings.
2. The second section will be a paragraph-by-paragraph review of the Specifications with the following information, “C”, “D”, or “E”, marked in the margin of the original Specification and any subsequent addenda.

   a. “C”: Comply with no exceptions.
   b. “D”: Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the specification can be satisfied.
   c. “E”: Exception, do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives.

M. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the submission is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission, or by contradiction do not release this Contractor from being in complete compliance, unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.

1.16 ARCHITECT'S AND/OR ENGINEER'S REVIEW

A. The Architect and/or Engineer will review shop drawings and samples for conformance with the design concept of the project and the information contained in the Contract Documents.

B. The Architect's and/or Engineer's review of shop drawings and samples is only for the convenience of the Owner in following the work and does not relieve the Contractor of responsibility for deviations from the requirements of the Contract Documents.

C. The Architect's and/or Engineer's review shall not be construed as a complete or detailed check of the work submitted, nor shall it relieve the Contractor of responsibility for errors of any sort in the shop drawings and samples, or from the necessity of furnishing any work required by the Contract Documents which may have been omitted from the shop drawing submittals. The review of a separate item shall not indicate review of the complete assembly in which it functions. Nothing in the Architect's and/or Engineer's review of shop drawings and samples shall be considered as authorizing 1) a departure from Contract Documents, or 2) additional cost to the Owner, or 3) a deviation from Code requirements, or 4) increased time for completion of the work.

D. The Architect and/or Engineer will review shop drawings and samples with reasonable promptness and will return them to the Contractor stamped to indicate the appropriate action as follows:

1. “NO EXCEPTIONS TAKEN” means that fabrication, manufacture or construction may proceed providing the submittal complies with the Contract Documents.
2. “MAKE CORRECTIONS NOTED” means that fabrication, manufacture or construction may proceed providing the submittal complies with the Architect's and/or Engineer's notations and the Contract Documents. A copy of the corrected submittal shall be returned to the Architect and/or Engineer for record. If, for any reason, the Contractor

cannot comply with the notations, the Contractor shall resubmit as described for submittals stamped “REVISE AND RESUBMIT”.

3. “REVISE AND RESUBMIT” means that the Contractor must comply with the Architect's and/or Engineer's notations and resubmit before fabrication, manufacture or construction may proceed. Submittals stamped in this manner are not permitted on the job site.
4. “REJECTED” means that the submittal does not comply with the Contract Documents and that fabrication, manufacture or construction shall not proceed. Submittals stamped in this manner are not permitted on the job site.
5. “REVIEWED” means the submittal has been subjected to a limited review for completeness of intended use. Submittals stamped in this manner need not be resubmitted unless review by the Architect or other Consultants has indicated otherwise.

E. All shop drawings and samples shall be identified as follows:

1. Date of submittal
2. Title of project (including floor and room designations where applicable).
3. Name of Contractor and date of his approval.
4. Name of Subcontractor, manufacturer, or supplier and date of submittal to Contractor.
5. Number of submission
6. Any qualification, departure or deviations from the requirements of the Contract Documents.
7. Federal specification, OTCR number, MEA number, BSA approval number, or ASTM number, UL or other nationally recognized listing agency standard number (including a copy of each standard), or any local listing or approval where required.
8. Such additional information as may be required by the Specifications for the particular material being furnished.
9. When the submitted materials modify components, styles, etc., on the same drawing, or alternate or options available for the intended material, the material shall be appropriately annotated in a manner to avoid any misunderstanding of the submission.

F. Architect's and/or Engineer's review is for general compliance with the design concept and contract documents. Markings or comments or the lack thereof shall not be construed as relieving the Contractor from compliance with the project Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing his work in a safe manner, and for coordinating his work with that of other Trades.

G. No part of the work shall be started in the shop or in the field until the Architect and/or Engineer have reviewed the shop drawings and samples for that portion of the work. Thereafter, the work shall be executed in accordance with the Contract Documents and the indicated status of the reviewed shop drawing.

H. Shop drawings and samples shall be submitted for review sufficiently in advance of the scheduled start of the work in the shop or in the field to allow ample time, in consideration of the number and complexity of the drawings in the submittal, for the Architect and/or Engineer to make an orderly review. No extension of the time to complete the work will be granted to the Contractor by reason of his failure in this respect.

I. The Contractor shall carefully check shop drawings and samples, including those received by him from Subcontractors and vendors, for accuracy, completeness of required information and conformance with the Contract Documents. Shop drawings found to be inaccurate, incomplete or not in conformance with the Contract Documents shall be corrected before being submitted to the Architect and/or Engineer for review.

J. Each submitted shop drawing shall bear the Contractor's stamped and signed certification that the work has been checked for all related job conditions, for maintenance of architectural conditions, for Code requirements, and coordinated with the shop drawings of other affected

trades for interrelated work, as required for the proper and complete performance of the work. No shop drawing submittal will be reviewed without this certification.

K. Shop drawings for manufactured material and equipment shall include model numbers, dimension drawings, operating weights, material specifications, operating features and controls, wiring diagrams, performance characteristics, service procedures, including clearance requirements for maintenance work, and conformance to specified Codes and Code ratings. Note that in addition to these requirements, other specific submittal data, and forms of data submission, are required by the Contract Documents for particular items of equipment and material.

L. Samples shall be identical in all respects to the material which is to be installed or applied in the execution of the work, and shall be of sufficient size or quantity to permit proper evaluation and review. Manufacturer's descriptive labels and printed application instructions which are normally attached to the material or its packaging shall be furnished with the sample. Samples shall be submitted for review when requested by the Architect and/or Engineer.

M. Within three (3) weeks after award of the Contract, the Contractor shall submit for the Architect's and/or Engineer's review, a list of the manufacturers, vendors, and Subcontractors whose products and services he proposes to use for the work. Proposed substitutions for material and equipment required by the Contract Documents shall be submitted to the Architect and/or Engineer for review during this period per the process outlined in the Contract Documents. Submittals proposing or requesting substitutions shall be expressly identified as such in a letter of transmittal, with the reasons for requesting the substitution stated. Submittals for this purpose shall be complete in every respect, shall conform to all the information requirements for shop drawing and sample submittals, and shall include, at no cost to the Owner, the necessary revisions to other related work required by the Contract Documents. The judgment of the Architect and/or Engineer with respect to the adequacy and acceptability of a proposed substitution shall be final and binding on the Contractor, and shall not be subject to question in any other place. After the expiration of this period, substitutions for material or equipment shall not be proposed or requested in shop drawing and Sample submittals, and the Contractor will be required to execute the work in accordance with the provisions of the Contract Documents.

N. Within six (6) weeks after award of the Contract, the Contractor shall submit a schedule listing all shop drawings and samples with the projected date that each item will be submitted to the Architect and/or Engineer for review.

O. Since manufacturing methods vary, reasonable minor variations are expected; however, performance and material requirements specified herein are the minimum standards acceptable. The Engineer retains the sole right to judge the equality of equipment that deviates from the Contract Documents, to reject any alternative submitted by the Contractor, and to require the specified materials and equipment which conform to the requirements of the Contract Documents be furnished.

1.17 MANUFACTURER'S RECOMMENDATIONS

A. With the exceptions as specified and/or indicated on the Contract Documents, the Contractor shall provide or install equipment per Manufacturer's current printed instructions and recommendations. Copies of such printed recommendations shall be kept at the Project site and made available as required.

B. Where the manufacturer's recommendations conflict with the Contract Documents, the conflict shall be brought to the Engineer's attention immediately.

1.18 SPACE LIMITATIONS

A. The equipment selections used in the preparation of the Contract Documents will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with Code requirements, the requirements of the Local Authorities Having Jurisdiction, and the equipment manufacturer's recommendations.

B. In the preparation of Drawings, a reasonable effort to accommodate acceptable equipment manufacturer's space requirements has been made. However, since space requirements and equipment arrangement vary according to each manufacturer, the responsibility for initial access, maintenance access, code required access, and proper fit rests with this Contractor.

C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's and Engineer's review.

D. Carefully check space requirements with other Sections of the Contract Documents to insure that all material can be installed in the spaces allotted thereto.

E. Coordinate the installation of conduit, busduct, cable tray, ladder rack and equipment, etc., installation with lighting fixtures, special ceiling construction, air distribution equipment and the structure. Provide additional rises, drops and offsets as required. If work provided under this Division is found to be in conflict with the architecture, structure, or other trade Work which is either existing or shown on the Contract Documents, the work provided under this Division shall be relocated without additional cost to the Owner.

F. No piping, equipment, ductwork, conduit, etc., shall be installed in the eight (8) inch high zone directly above the proposed finished ceiling to allow for future build-out and flexibility unless otherwise specifically shown on the Drawings or prior written authorization is received from the Engineer. Wherever possible, electrical equipment distribution and branch lines shall be installed tight to structure.

G. To avoid conflicts with the installation of future roof decking fasteners, no conduit, equipment, piping, ductwork, etc., shall be installed within 6 inches of the bottom of a metal roof deck. Whenever conduit, equipment, piping, ductwork, etc., is required to penetrate the deck, such equipment must pass through the roof at a 90 degree angle so as to preserve the 6 inch zone below the bottom of the metal deck around the penetration.

H. Architectural drawings shall be checked for ceiling height requirements. Where no ceiling height is stated, request direction from Architect prior to commencing work.

I. The Contractor shall follow the Drawings in laying out the Work and check drawings of all trades to verify spaces in which Work will be installed. Maintain maximum headroom and where space conditions appear inadequate, the Architect and Engineer shall be notified before proceeding with the installation.

1.19 CONTRACTOR'S COORDINATION DRAWINGS

A. Contractor shall furnish (in writing, with copies to the Architect and Construction Manager any information necessary to permit the Work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. This Contractor shall prepare a complete set of construction “Coordination Drawings” indicating the equipment actually purchased and the exact routing and elevations for all lines such as piping, busway, conduit, ductwork, etc., including conduit embedded in concrete. All dimensions shall be referenced to building structural center lines. The “Coordination Drawing” preparation and completion shall comply with the requirements of the project construction schedule. The sheet metal drawings, prepared on electronic media (CAD) at a scale not less

than 3/8 in. = 1 ft. 0 in., shall serve as the base drawings to which all other Contractors will overlay and add their work. Each trade shall draw their work on separate layers represented by individual colors. Each “Coordination Drawing” shall be completed and signed off by the other Contractors and this Contractor prior to the installation of the work in the area covered by the specific coordination drawing. The Contractor’s work shall be installed in accordance with the shop drawings and the “Coordination Drawings”. If the Contractor allows one trade to install their work before coordinating with the work of other trades, the Contractor shall make necessary changes to correct the condition without extra cost to the Owner. The Contractor's “Coordination Drawings” indicating piping, conduit, busway, and equipment support points and loads exceeding 200 lb. imposed on the building structure shall be submitted to the Project Structural Engineer for review and approval. The elevation, location, support points, static, dynamic and expansion forces and loads imposed on the structure at support, and anchor points, and the size of all lines shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. All work routed underground or embedded in concrete shall be indicated by dimension to column and building lines and shall be coordinated. This requirement for “Coordination Drawings” shall not be construed as authorization for the Contractor or Subcontractor to make any unauthorized changes to the Contract Drawings. Prior to final acceptance of the work of this Division, the Contractor shall give the drawing files, in AutoCAD on CD-ROM or DVD, containing the Contractor’s coordination documentation to the Owner.

1.20 COORDINATION OF CABLING AND OUTLETS

A. Coordinate work so that exact locations may be obtained for all outlets, equipment and cabling.

B. The location of all work shown is diagrammatic; cabling plans shall be considered as approximate. Before installing telecommunications work, all pertinent drawings shall be studied and precise information obtained from the architectural schedules, scale drawings, large scale and full size details of finished rooms, reviewed shop drawings or from the Architect. It shall be understood that any work may be relocated a distance not exceeding 12 ft. from the location shown, if so directed by the Owner. Make any necessary adjustment of the work to fit conditions for recessed fixtures and for outlets occurring in glazed tile, block, wood paneling or other special finish material in order that all boxes may register flush with finish and shall be centered properly. In centering outlets, make due allowance for overhead piping, ducts, window and door trim, variations in thicknesses of furring, plastering, etc., as erected, regardless of conditions which may be otherwise shown on small scale drawings. Work incorrectly located shall be properly relocated without expense to the Owner. Locate wall-mounted telephone plates near doors at the strike side of the door, unless otherwise specifically noted on plans.

1.21 SLEEVES, CUTTING, PATCHING, AND FIRESTOPPING

A. The Contractor shall be responsible for the timely placing of sleeves and boxouts for all conduit and bus ducts passing through walls, partitions, beams, floors and roofs while the same are under construction.

B. A conduit sleeve shall be at least one size larger than the size of conduit it serves, except where "Link Seal" casing seals are used in sleeves through walls below grade. Sleeves shall be sized such that the annular space between the sleeve and the conduit will not be less than 1/2 in. or more than 1 in. unless otherwise required by the firestop system. All conduit passing through concrete or masonry walls above grade shall have at least 18 gauge galvanized steel sleeves. Sleeves shall be set flush with finished wall. All sleeves in floors shall be flush with the underside of slab and extend a minimum of two inches above the finished floor 4 in. in Mechanical Rooms and 6 in. in Data Centers and Technology Rooms. Sleeves installed in fire rated construction shall be of suitable length and diameter to accommodate the fire safing system used. Sleeves set in concrete floor construction shall be at least 16 gauge galvanized steel. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve and the conduit shall be centered in the sleeve.

C. Seal all busway, conduit, conductor, cable, or cable tray penetrations of fire rated construction with factory built firestopping devices or with manufactured fill, void, or cavity materials "Classified" by Underwriters Laboratories, Inc. for use as a Through-Penetration Firestop. This includes all busway, conduit, conductor, cable or cable tray penetrations called for under this Section and Section 27 1100 “Communications Equipment Room Fittings”. All firestop devices and systems shall be approved for such use by the Authority having jurisdiction. The firestop system used shall maintain the fire resistance rating of the building component that is penetrated. Firestop systems and devices shall comply with ASTM E-814 (UL 1479) for all types of penetrations being sealed. Submittal data for firestop systems shall include the UL System Numbers listed in the UL Building Materials Directory under which the material was tested in accordance with ASTM E 814 (UL 1479) for use in a "Through-Penetration Firestop System". The firestop system or device used shall not require de-rating the ampacity of electrical conductors or busway. Excessive shrinkage of the firestop materials which would permit the transmission of smoke or water prior to exposure to a fire condition is unacceptable. Where a mastic is used to seal the surface of the firestop, the mastic shall be non-hardening. The firestop system used shall accommodate expansion and contraction of the electrical raceway systems and busways without damaging the firestop or reducing its effectiveness as a smoke barrier or water seal. The firestop manufacturer's representatives shall instruct the Contractor's representatives in the proper installation procedure so that the material will be installed in accordance with the UL listing and the manufacturer's recommendations. ***STI EZ Path shall be used in all locations where more than five (5) cables pass through a wall. Where fewer than five (5) cables pass though, alternate seals may be used.*** If it complies with these Specifications, firestop sealing component/system as manufactured by one of the following manufacturers will be acceptable:

1. Tremco Fire-Resistive Joint System using Dymeric sealant and Cerablanket-FS mineral filler.
2. Specified Technologies, Inc. SpecSeal Systems.
3. 3M Fire Barrier Penetration Sealing Systems.
4. GE Pensil Firestop Sealant by General Electric.
5. International Protective Coatings Corp. Flame-Safe Systems.
6. Thermal Ceramics FireMaster Firestop Fire Protection Systems.

D. Except as may be noted on the drawings, sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4 in. thick steel plate water seal secured to the conduit with continuous fillet weld. The water seal plate shall be located in the middle of the wall and shall be two (2) inches wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. Seal off annular opening between conduit and sleeve with "Link Seal" casing seal as manufactured by Thunderline Corporation, Wayne, Michigan. The conduit sleeve shall be sized to accommodate the Thunderline casing seal. Casing seals shall be Series 300 for conduit sizes 3/4 in. through 4 in. and Series 400 for conduit 5 in. and larger.

E. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no additional expense to the Owner. The Contractor shall undertake no cutting or patching without first securing the Architect's written approval.

F. All unused sleeves shall be sealed with firestop devices and systems to maintain the fire rating of the construction penetrated.

G. Set sleeves as construction progresses and secure in place during pouring of concrete.

H. Coordinate sleeve locations with the work of other Trades, including flooring and electrical distribution. Submit drawings showing location of holes and proposed reinforcing and obtain Architect's approval before proceeding with installation.

I. Do not support conduit by resting clamps on sleeves. Clamps must extend beyond sleeve and be supported outboard of sleeve in an approved manner.

J. Provide waterproof type sleeves, Zurn Z-197, with galvanized Schedule 40 pipe extensions where penetrating membrane waterproofed floors. Cut, extend and repath membrane.

K. For conduit passing through roofs, provide roof couplings (Zurn Z-196-3) at suitable level above roof to terminate flashings.

L. Where loose cabling penetrates fire or smoke rated walls, partitions, floor slabs, etc., provide sleeves (as described hereinbefore) through the rated construction. All cabling shall be run through these sleeves. Sleeves shall be located as required and shall be filled with a UL listed, intumescent type, firestop system approved for use in Jersey City. Quantity of cables, configuration of cables, etc., shall be in accordance with the manufacturer's requirements for the type of rated construction for which the system is to be used. The firestop systems shall be 3M Fireboard for all floor penetrations and 3M W-L403 for all wall penetrations (or as approved).

M. Coordinate support for all conduit, equipment and structural wall/floor penetrations with the Structural Engineer.

1.22 MISCELLANEOUS STRUCTURAL SUPPORT MEMBERS

A. Where, conduit, cables, cable tray, ladder rack, etc., are routed vertically through shafts, the Contractor shall provide and install all necessary miscellaneous structural members to support the loads imposed by the risers.

B. Where equipment (conduit racks, cable trays, etc.) are supported from structural slabs, the Contractor shall provide all miscellaneous structural members to support the load plus a 250 lb. live load.

C. The Contractor shall submit Shop Drawings of the riser support system inside vertical shafts to the Project Structural Engineer for approval, including details of how the riser support structure is to be attached to the building structure.

D. Miscellaneous structural support members installed in IDF Rooms, or other technology spaces, and where exposed to public view shall be galvanized.

1.23 PAINTING

A. Painting, except as specified herein or indicated otherwise, shall be done under another Division. This Division shall cooperate with the other Divisions to determine the size of equipment, sizes and lengths of conduits, etc., to be painted.

B. Equipment furnished under this Section shall be factory-finished. If the factory finish is damaged during shipment, storage, installation, etc., it shall be repainted by this Contractor subject to the Engineer’s approval. Touch-up painting is acceptable only for minor finish damage.

C. Provide a heavy field coat of black asphaltum paint on all steel conduits, cradles, vibration isolating mounts, and the like, that will be encased or partially encased in building construction, set in cement or fill, before items are built into the general construction.

1.24 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new and in good condition. The commercially standard items of equipment and the specific names mentioned herein are intended to identify standards of quality and performance necessary for the proper functioning of the Work.

B. Since manufacturing methods vary, reasonable minor variations are expected; however, performance and material requirements specified herein are the minimum standards

acceptable. The Engineer retains the sole right to judge the equality of equipment that deviates from the Contract Documents, to reject any alternative submitted by the Contractor, and to require the specified materials and equipment which conform to the requirements of the Contract Documents be furnished.

C. Materials and equipment which are found to have factory defects shall be replaced or repaired in a manner acceptable to the Owner and Engineer at no additional cost to the Owner. The Contractor shall be responsible for all costs associated with testing, replacement or repair, including, but not limited to, all replacement or repair costs, preparations prior to testing, all testing costs, extended warranties, re-commissioning of the equipment, etc.

1.25 SHIPPING, DELIVERY, AND HAULING

A. Include all shipping, delivery, hauling, hoisting, shoring, and placement in the building of equipment and materials specified herein. The Contractor shall be responsible for the timely delivery and introduction of equipment to the Project as required by the construction schedule for this Project. If any item of equipment is received prior to the time it is required, the Contractor shall be responsible for its proper storage and protection until such time as it may be required. The Contractor shall pay for all costs of demurrage or storage in a bonded warehouse.

B. If any item of equipment is not delivered to or installed at the Project site in a timely manner as required by the Project construction schedule, the Contractor shall be solely responsible for disassembly, reassembly, manufacturer's supervision, shoring, general construction modifications, delays, overtime costs, etc. No additional cost or delays shall be incurred by the Owner.

1.26 EQUIPMENT AND MATERIAL PROTECTION

A. The Contractor shall protect the work, equipment, and material of all other Trades from damage by his work or his personnel, and shall correct all damage thus caused without additional cost to the Owner.

B. The Contractor shall be responsible for all work, materials and equipment until finally inspected, tested and accepted; protect work against theft, injury or damage; and carefully store material and equipment received on site which is not immediately installed. The Contractor shall close open ends of work with temporary covers or plugs during construction to prevent entry of dust, dirt, and obstructing material. The Contractor shall cover and protect all his equipment and materials from damage due to weather, water, spray-on fireproofing, construction debris, etc., in a manner acceptable to the Engineer and/or Owner.

C. The Contractor shall be responsible to ensure that floor loading capacities are not exceeded either by any installed componentry or by any materials that may be stored on site.

D. All products stored off site and delivered to the site must be kept in factory packing with shipping bars, retainers and positioning devices in place until installation. Equipment, which is subject to damage from moisture, must be stored indoors with factory covering in place.

E. Cover and protect all openings in floors for passage of conduit or cable trays in accordance with OSHA requirements.

F. Prior to starting equipment, remove all productive materials, shipping bars, retainers, positioning devices.

G. After commissioning systems, remove all dirt, dust, smears, stains, paint spots, and the like; clean and touch up finishes; and leave in like-new condition.

1.27 CUTTING AND PATCHING

A. Cutting and patching, except as specified herein or indicated otherwise, will be done under other Divisions.

B. Where other Trades are required to do cutting and patching, furnish to the Construction Manager necessary information so that openings for this work can be built into the floors and walls in time. Such cooperation is required to keep cutting of walls and floors to a minimum.

C. Set sleeves for conduit accurately before concrete floors are poured, or set boxes on the forms to leave openings in the floors and subsequently set required sleeves in the openings.

D. Should Contractor neglect to perform preliminary work, and should cutting be required in order to install equipment, the expense of this cutting and restoring of surfaces to their original condition shall be borne by this Contractor.

1.28 RUBBISH REMOVAL

A. Comply with the project's Construction Waste Management Plan.

B. At the conclusion of each day's work, clean up and stockpile on site, at location designated by the Construction Manager all rubbish, debris and trash, which may have accumulated during the day as a result of work of this Division and of this Division's presence on the job. Construction Manager will then remove stockpiled rubbish.

1.29 IDENTIFICATION OF SYSTEMS AND EQUIPMENT

A. Pull boxes, racks, cabinets and equipment shall be identified by means of phenolic nameplates screw-fastened to the equipment. In addition, all major components of the IT distribution system shall be provided with such identification.

B. Pull wires in empty conduits shall have tags indicating their destination. Tags shall be made of pressure sensitive tape or embossed self-attached ribbon.

C. Nameplates and tag symbols shall correspond to the identification on the Contract Drawings and on the "Record Drawings".

1.30 ELECTRICAL EQUIPMENT AND ELECTRICAL ROOM PRECAUTIONS

A. Caution workers both verbally and in writing as to the dangers involved in doing work both within or adjacent to electrical and mechanical equipment and their spaces, due to the dangers caused by the presence of high voltages and currents and rotating equipment in these spaces

1.31 EQUIPMENT PADS AND MOUNTING

A. Concrete pads for various pieces of equipment systems will be furnished under another Division as follows:

B. Concrete waterproof curbs shall be provided around all vertical cable slots or cable tray/ladder rack openings. These curbs shall be a 4 in. high and shall be poured as part of the floor slab. Coordinate exact dimensions of slab penetration and curb with the various telecommunications equipment suppliers.

C. Furnish and install galvanized anchor bolts for all telecommunications equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs as part of this project. Bolts shall be the size and number recommended by the manufacturer of the equipment and as required for seismic restraint. Anchor bolts shall be located by means of suitable templates. When

equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or supported as recommended by the vibration isolation manufacturer.

D. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and be securely attached to the partition studs or framework. At the Contractor's option, the mounting screws may pass through the gypsum board and be securely attached to 6 in. square, 18 gauge galvanized metal backplates which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions will not be acceptable.

1.32 RECORD DRAWINGS

A. The Contractor shall maintain on a daily basis at the Project site a complete set of "Record Drawings". The "Record Drawings" shall consist of a set of black and white prints and AutoCAD files of the Contractor Coordination Drawings for this Division. The prints shall include the updated AutoCAD files which shall be periodically electronically updated to show the precise location of all buried or concealed work and equipment, including embedded piping and valves, and all changes and deviations in the work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without written definite instructions from the Architect or Engineer. Prior to commencing work, the Contractor shall obtain from the Architect or Engineer a set of AutoCAD format Architectural and Engineering Drawings on CD-ROM or DVD, to be used only to produce the Contractor's Coordination Drawings. The continuously updated coordination drawings shall be used to produce the final "Record Drawings" which shall be delivered to the Owner in AutoCAD electronic format upon Project completion. The Contractor shall give to the Engineer a written release signed by a corporate officer of the Contractor prior to receipt of the Engineering Drawings.

B. Dimensions shall clearly and accurately delineate the work as installed; locations shall be suitably identified by at least two dimensions to permanent structures.

C. Upon completion of the Work, the Contractor shall certify all "Record Drawings" on the front lower right hand corner adjacent to the above marking with a rubber stamp impression or an electronic image that states the Project name, the Contractor's name, the area covered and the date.

D. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified "Record Drawings" to the Architect and Engineer for review and shall make changes, corrections, or additions as the Architect and/or Engineer may require to the "Record Drawings". Submit four (4) prints of each version until accepted.

E. After the Architect's and Engineer's review, and any required Contractor revisions, the "Record Drawings" shall be delivered to the Construction Manager on CD-ROM or DVD in AutoCAD format for the Owner's use. Upon acceptance, provide ten (10) black-and-white prints and four (4) electronic versions on discs within sixty (60) days of Final Acceptance.

1.33 VERIFYING EXISTING CONDITIONS

A. Before commencing work, examine all adjoining work on which this work is in any way dependent for perfect workmanship according to the intent of this Specification, and report to Construction Manager any condition which prevents performance of first-class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before with sufficient notice prior to commencing work.

1.34 FINAL REVIEW

A. At a time designated, the entire installation shall be reviewed for compliance with the Contract Documents. The Contractor shall be available at all times during this Review.

B. The Contractor shall demonstrate prior to the Final Review that all systems and all equipment have been properly installed, balanced and adjusted and are in compliance with the requirements of the Contract Documents. After these demonstration tests are completed satisfactorily, but prior to the Final Review field visit by the Engineer, submit to the Engineer a written certification that 1) attests to Contract Document compliance for this Project, and 2) certifies that the equipment and materials installed in this Project under this Division contain no asbestos or PCB's.

C. Certificates and Documents required herein shall be in order and presented to the Architect and Engineer at least two (2) weeks prior to the Final Review.

D. After the Final Review, any changes or corrections noted as necessary for the Work to comply with the Contract Documents shall be accomplished without delay in order to secure final acceptance of the Work.

1.35 EARLY OCCUPANCY

A. All Divisions are responsible for completing those systems which are necessary to allow partial occupancy of the buildings even if systems in the unoccupied areas are incomplete. Partial or early occupancy schedules will be developed by the Construction Manager. Specific attention is necessary for any areas involving special spaces such as technology areas, fire alarm systems, smoke control systems, elevators, generators, etc., which will require early operation to allow the occupancy to be arranged on a schedule consistent with the needs of the project. Refer to the construction schedule for this Project for the schedule of completion dates assigned to the various portions of the Project and schedule all work accordingly.

B. Requirements for temporary occupancy shall be verified with the Authorities Having Jurisdiction.

1.36 ACCEPTABLE MANUFACTURERS

A. If they comply with these Specifications, equipment and materials as manufactured by one of the manufacturers listed herein are acceptable.

B. Being listed herein as an acceptable manufacturer does not allow the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements of these Specifications.

C. Any and all substitutions must be included in the Contractor's Base Bid, as a voluntary DEDUCT alternate in the Contractor's Bid Proposal, and must be accompanied by a letter of equivalency certifying the product's equivalency in all performance and physical characteristics to the products listed herein. The proposed substitutions shall be all inclusive of all cost and physical implications throughout the project. Under no circumstances should the substitution result in added cost to the project. Project Specifications/documents will not be revised to reflect the substitution should the substitution be approved.

1.37 UNIT PRICES

A. Any additional work not called for under this Contract will be performed at any time and in any quantity as directed by the Construction Manager at the unit prices set forth below. Such work will be performed upon request at any time until final acceptance of all work under this Contract. All such additional work will be performed in accordance with the terms and conditions of this Contract. In the event that the Construction Manager shall direct the elimination of any work

under this Contract, the Construction Manager will be credited with the cost of said eliminated work at the unit prices set forth below.

B. The unit prices shall include all hangers, inserts, couplings, pull and junction boxes, terminations, testing, tools, supervision, labor, coordination, materials, equipment, and all other necessary items to provide the telecommunications installation unless noted otherwise. Included in the unit prices set forth below are receiving, handling, distributing, storing, hoisting and protecting all items provided by him. These unit prices shall include all overhead, profit and taxes.

C. This Contractor shall state in its proposal unit prices in accordance with the following schedule:

1. Furnish and install cabling in existing conduit or conduit to be furnished under another Section. This price should not include the cost of innerduct for fiber cabling.

		RISER RATED	PLENUM RATED
a.	Cat 6E – 4 pr.	$_____/l.f.	$_____/l.f.
b.	Cat 5E – 25 pr.	$_____/l.f.	$_____/l.f.
c.	MM Fiber, 6 strand,	$_____/l.f.	$_____/l.f.
d.	SM Fiber, 4 strand,	$_____/l.f.	$_____/l.f.
e.	SM Fiber, 12 strand,	$_____/l.f.	$_____/l.f.
f.	RG-11 Coax Cable,	$_____/l.f.	$_____/l.f.
g.	RG-6 Coax Cable,	$_____/l.f.	$_____/l.f.

2. Furnish and install cabling in open ladder rack, cable tray, etc. This price should not include the cost of innerduct for fiber cabling.

		NON-PLENUM	PLENUM
a.	Cat 6E – 4 pr.	$_____/l.f.	$_____/l.f.
b.	Cat 5E – 25 pr.	$_____/l.f.	$_____/l.f.
c.	MM Fiber, 6 strand,	$_____/l.f.	$_____/l.f.
d.	SM Fiber, 4 strand,	$_____/l.f.	$_____/l.f.
e.	SM Fiber, 12 strand,	$_____/l.f.	$_____/l.f.
f.	RG-11 Coax Cable,	$_____/l.f.	$_____/l.f.
g.	RG-6 Coax Cable,	$_____/l.f.	$_____/l.f.

D. When included as part of this Contract, as indicated on the drawings, furnish and install 1900 type double gang backbox with single gang plaster ring and cover for wall-mounted telecommunications outlet junction box and provide 3/4 in. EMT conduit stub-up with an elbow and drag line bushed at both ends, to 6 in. above accessible hung ceiling.

$_____/each

E. Furnish and install 1900 type double gang backbox with single gang plaster ring and cover for wall-mounted telecommunications outlet junction box and provide 1 in. EMT conduit stub-up with an elbow and drag line bushed at both ends, to 6 in. above accessible hung ceiling.

$_____/each

F. Furnish and install cable tray, trough and ladder rack systems as specified below. Include all required accessories, including mounting hardware, cable retainers, aligning brackets, cover plates, etc., to provide a complete system solution.

1. ~~24~~ ***30*** in. wide x ~~6~~ ***4*** in. high, ~~open ladder~~***cable tray***~~, 9 in. rungs~~ $_____/l.f.
2. ~~9~~ ***24 in. ladder rack with 6*** in. outboard rungs $_____/l.f.

G. Furnish and install EMT conduit.

		Concealed (in hung ceiling, wall cavity, etc.)	Exposed (in Telecommunications Rooms, MDF, IDF, etc.)
1.	1/2 in.	$_____/l.f.	$_____/l.f.
2.	3/4 in.	$_____/l.f.	$_____/l.f.
3.	1 in.	$_____/l.f.	$_____/l.f.
4.	1-1/4 in.	$_____/l.f.	$_____/l.f.
5.	1-1/2 in.	$_____/l.f.	$_____/l.f.
6.	2 in.	$_____/l.f.	$_____/l.f.
7.	2-1/2 in.	$_____/l.f.	$_____/l.f.
8.	3 in.	$_____/l.f.	$_____/l.f.
9.	3-1/2 in.	$_____/l.f.	$_____/l.f.
10.	4 in.	$_____/l.f.	$_____/l.f.

H. Furnish and install rigid aluminum conduit.

		Concealed (in hung ceiling, wall cavity, etc.)	Exposed (in Telecommunications Rooms, MDF, IDF, etc.)
1.	1/2 in.	$_____/l.f.	$_____/l.f.
2.	3/4 in.	$_____/l.f.	$_____/l.f.
3.	1 in.	$_____/l.f.	$_____/l.f.
4.	1-1/4 in.	$_____/l.f.	$_____/l.f.
5.	1-1/2 in.	$_____/l.f.	$_____/l.f.
6.	2 in.	$_____/l.f.	$_____/l.f.
7.	2-1/2 in.	$_____/l.f.	$_____/l.f.
8.	3 in.	$_____/l.f.	$_____/l.f.
9.	3-1/2 in.	$_____/l.f.	$_____/l.f.
10.	4 in.	$_____/l.f.	$_____/l.f.

I. Furnish and install galvanized rigid steel conduit.

		Concealed (in hung ceiling, wall cavity, etc.)	Exposed (in Telecommunications Rooms, MDF, IDF, etc.)
1.	1/2 in.	$_____/l.f.	$_____/l.f.
2.	3/4 in.	$_____/l.f.	$_____/l.f.
3.	1 in.	$_____/l.f.	$_____/l.f.
4.	1-1/4 in.	$_____/l.f.	$_____/l.f.
5.	1-1/2 in.	$_____/l.f.	$_____/l.f.
6.	2 in.	$_____/l.f.	$_____/l.f.
7.	2-1/2 in.	$_____/l.f.	$_____/l.f.
8.	3 in.	$_____/l.f.	$_____/l.f.
9.	3-1/2 in.	$_____/l.f.	$_____/l.f.
10.	4 in.	$_____/l.f.	$_____/l.f.
11.	5 in.	$_____/l.f.	$_____/l.f.
12.	6 in.	$_____/l.f.	$_____/l.f.

J. Furnish and install flexible metal conduit.

		Concealed (in hung ceiling, wall cavity, etc.)	Exposed (in Telecommunications Rooms, MDF, IDF, etc.)
1.	1/2 in.	$_____/l.f.	$_____/l.f.
2.	3/4 in.	$_____/l.f.	$_____/l.f.
3.	1 in.	$_____/l.f.	$_____/l.f.
4.	1-1/4 in.	$_____/l.f.	$_____/l.f.
5.	1-1/2 in.	$_____/l.f.	$_____/l.f.
6.	2 in.	$_____/l.f.	$_____/l.f.
7.	2-1/2 in.	$_____/l.f.	$_____/l.f.
8.	3 in.	$_____/l.f.	$_____/l.f.
9.	3-1/2 in.	$_____/l.f.	$_____/l.f.
10.	4 in.	$_____/l.f.	$_____/l.f.

K. Furnish and install liquid-tight flexible conduit.

1.	1/2 in.	$_____/l.f.
2.	3/4 in.	$_____/l.f.
3.	1 in.	$_____/l.f.
4.	1-1/4 in.	$_____/l.f.
5.	1-1/2 in.	$_____/l.f.
6.	2 in.	$_____/l.f.
7.	2-1/2 in.	$_____/l.f.
8.	3 in.	$_____/l.f.
9.	3-1/2 in.	$_____/l.f.
10.	4 in.	$_____/l.f.

1.38 ALTERNATE PRICES

A. State an alternate price to cover all labor, material, equipment, appurtenances, overhead, profit, taxes, delivery, etc., as required to provide the specified alternate work as a modification to, addition to, subtraction from or as a substitution for the original work specified for the Base Bid. All additional work required under this Section of the Specifications shall be governed by all applicable Sections of the Base Bid Specifications, as if originally included therein. See drawing set for list of alternates.

1.39 DATE OF COMPLETION

A. The date for the final performance and acceptance testing shall comply with the Project construction schedule and shall be sufficiently in advance of the Contract completion date to permit the execution of the testing and commissioning by this Division prior to occupancy and the close-out of the Contract. Any adjustments and/or alterations which the final acceptance tests indicate as necessary for the proper and satisfactory functioning of all equipment and systems shall be completed prior to the close-out of the Contract. Re-tests shall not relieve this Division of completion date responsibility.

B. Provide a detailed schedule of completion indicating when each system component and entire system is to be completed outlining when tests will be performed. Completion schedule shall be submitted to the Architect, Engineer, and Owner for review at a time requested by the Construction Manager after the notice to proceed has been given to this Division. This schedule shall be updated periodically by this Division as the Project progresses. Each update shall be submitted to the Construction Manager, Architect, Engineer, and Owner for review.

1.40 OPERATING INSTRUCTIONS

A. Provide the services of a factory-trained specialist to supervise the commissioning and testing, startup, and operation of all equipment specified herein and to instruct the Owner's operators during a five (5) day operating instruction period at or near the Project site. The operating instruction period shall be defined as straight time working hours and shall not include nights, weekends, or travel time to and/or from the Project and shall include a period for videotaping of the operating instructions. See individual sections of these specifications for additional instructions by manufacturer trained specialists.

B. The Owner shall be notified in writing at least two (2) weeks before each operating instruction period begins. Do not commence the instruction period until the Owner has issued his written acceptance of the starting time.

1.41 OPERATION AND MAINTENANCE MANUALS

A. Provide operating instructions and maintenance data books for all equipment and materials furnished under this Division.

B. Submit six (6) copies of operation and maintenance manuals for review at least ten (10) weeks before Final Review of the Project. Assemble all data in a completely indexed electronic volume(s) and identify the size, model, and features indicated for each item. Include the Project Name and Logo printed on the outside of the CD-ROM's/DVD's. The media shall be submitted and subjected to the same approval process as detailed for shop drawings and samples as described hereinbefore, but shall be returned as "Reviewed". Submit six (6) copies of the "Reviewed" operation and maintenance books to the Construction Manager upon Project completion.

C. Operation and Maintenance manuals shall include complete lubrication, cleaning, and servicing data compiled in clearly and easily understandable form. Data shall show serial numbers and model numbers of each piece or equipment, complete lists of replacement parts (including part numbers), motor ratings, and actual loads. Manuals shall include information specific to the actual equipment model installed, including all options.

D. Include the following information where applicable:

1. Identifying name and mark number.
2. Locations of major equipment (where several similar items are used, provide a list).
3. Complete nameplate data.
4. "Reviewed" submittals.
5. Parts lists.
6. Performance curves and data.
7. Wiring diagrams.
8. Lubrication charts.
9. Manufacturers' recommended operation and maintenance instructions with all non-applicable information deleted.
10. List of spare parts recommended for normal service requirements.
11. Assembly and disassembly instructions with exploded view Drawings where available.
12. Troubleshooting diagnostic instructions where available.
13. Description of alarm and trouble codes for software-based systems.
14. Set points.

1.42 CERTIFICATION

A. Any certifications required by the Contract Documents, in addition to those required for shop drawings, product data, equipment and other items, shall be so certified by the Owner, a Partner, or a Corporate Officer of the firm required to provide the Certification, or by another

person duly authorized to sign binding agreements for and in behalf of the Owner, Partner, or Corporation.

1.43 WARRANTY PERIOD

A. The warranty period shall be no less than fifteen (15) full years, unless specified otherwise hereinafter.

B. During the warranty period, the Contractor shall guarantee the following in a form satisfactory to the Owner:

1. All work installed will be free from any and all defects in workmanship and/or materials.
2. All equipment, systems and apparatus will develop capacities and performance characteristics specified.
3. The systems shall operate without malfunction.

C. Remedy, without cost to the Owner, any defects within a reasonable time to be specified in notice from the Architect or Engineer. In default thereof, the Owner may have such work done and charge back all costs.

D. The start of the warranty period, as defined in the General Conditions, shall commence on the issue of a “Certificate of Substantial Completion” by the Owner or the Owner's Representative for each item of material, equipment, or system.

E. Confer with the Construction Manager prior to the bid date concerning the project schedule and determine if there is a need to operate any items of equipment or systems for temporary light, power, heating and/or cooling or other reasons prior to “Substantial Completion”. All required extended warranty costs for equipment, materials, and systems shall be included in the bid.

F. Provide complete documentation of all prefunctional, functional, component, and system tests prior to Owner acceptance and turnover of components or systems. In addition, the Owner reserves the right to review all test objectives, test plans and test cases, and witness all preoperational tests. Provide the Owner with a comprehensive schedule detailing the preparation of testing documentation and the conduct of all component or system tests.

G. Warrant that all components, subsystems and systems will perform their specified functions from the date of turnover and commercial operation through the useful life of the system, as determined by the various equipment manufacturers and installing Contractor(s). In the event components fail for any reason, be responsible to repair, replace and reimburse the Owner for all costs associated with the component, subsystem or system that failed to perform the specified function.

1.44 DELIVERY, DRAYAGE AND HAULING

A. Include all drayage, hauling, hoisting, shoring, and placement in the building of equipment and materials specified herein, including any equipment prepurchased by the Construction Manager for installation by this Contractor. Be responsible for the timely delivery, introduction and placement of equipment to the Project as required by the construction schedule for this Project. If any item of equipment is received prior to the time it is required, be responsible for its proper storage and protection until such time as it may be required. Pay for all costs of demurrage or storage in a bonded warehouse.

B. If any item of equipment is not delivered to or installed at the Project site in a timely manner as required by the Project construction schedule, the Contractor shall be solely responsible for disassembly, re-assembly, manufacturer's supervision, shoring, general construction modifications, delays, overtime costs, manufacturer’s re-certification, etc. No additional cost or delays shall be incurred by the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to all other Divisions for additional equipment requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the Contract Documents for all Divisions pertaining to the individual equipment and/or systems.

END OF SECTION 27 0500

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SECTION 27 0506 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all conduit as specified herein and as required for proper distribution of all wire, cable, and electrical conductors throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0400 - Communications Ladder Rack.
3. Section 27 0500 - Common Work Results for Communications.
4. Section 27 1000 - Communications Conduit.
5. Section 27 1100 - Communications Equipment Room Fittings.
6. Section 27 1300 - Communications Backbone Cabling.
7. Section 27 1500 - Telecommunications UTP Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCES

A. The entire installation and all equipment, materials and methods shall comply with the currently enforced versions of all applicable laws, rules, regulations, standards, legislation, codes and ordinances of New York City, Underwriters Laboratory and New York City Electrical Code, Telecommunications Industries Association/Electronic Industries Association/(TIA/EIA) and Building Industry Consulting Service International (BICSI) Standards where they do not conflict with any applicable requirements of laws, codes, ordinances, legislation, etc., of all federal, state and local authorities whether indicated on the Contract Documents or not. All equipment shall be MEA and/or BS&A approved or have an OTCR approval and approved for use in New York City. Modifications required by the above said authorities having jurisdiction shall be made without additional cost to the Owner.

1. Except as modified herein, the requirements and recommendations of the latest editions of the following documents are made part of these Specifications:

   a. ANSI/TIA/EIA - 568 C “Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements”.
   b. ANSI/TIA/EIA - 568B.3 “Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard”.
   c. ANSI/TIA/EIA - 569 “Commercial Building Standard for Telecommunications Pathways and Spaces”.
   d. ANSI/TIA/EIA - 606-A “Administration Standards for the Telecommunications Pathways and Spaces”.
   e. ANSI/J-STD- 607-A “Commercial Buildings Grounding and Bonding Requirements for Telecommunications”.
   f. ANSI/NFPA-70 - “National Electrical Code”.
   g. ANSI/NFPA-780 - “Lightning Protection Code”.
   h. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards – A Background Report.”
   i. BICSI “Telecommunications Distribution Methods Manual”.
   j. IEEE Std. 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
   k. ANSI R211.
   l. BOCA National Building Code, 1996; Seismic exposure Group II - Performance Category “C”.
   m. UL Standard 1 - Flexible Metal Electrical Conduit.
   n. UL Standard 6 - Rigid Galvanized Conduit.
   o. UL Standard 360 - Liquid-Tight Flexible Conduit
   p. UL Standard 467 - Electrical Grounding and Bonding.
   q. UL Standard 651 - Non-Metallic Conduit
   r. UL Standard 797 - Electrical Metallic Tubing.
   s. UL Standard 1242 - Intermediate Metal Conduit.
   t. ANSI C80.1 - Rigid Galvanized Conduit.
   u. ANSI C80.3 - Electrical Metallic Tubing.
   v. ANSI C80.5 - Rigid Aluminum Conduit
   w. NYCEC - New York City Electrical Code.
   x. UL Standard 651 (ANSI F512, NEMA TC-2) - Non-Metallic Conduit.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to Substantial Completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB’s), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC’s), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a “Materials Safety Data Sheet”, as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by

the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority Having Jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to Section 27 1000 and shall include but not be limited to:

1. Conduit, including samples, complete with fittings, materials, connector details, etc.

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and Section 27 0500.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this Section shall not contain asbestos, polychlorinated biphenyls (PCB's) or other hazardous materials identified by the Owner.

2.2 GENERAL

A. All equipment and materials provided under this Section of the Specifications shall be new, UL listed, and bear the UL label.

B. All technology spaces shall be provided with a copper telecommunications ground bar (TGB) bolted, brazed, or riveted to the associated enclosure or cabinet. Refer to each individual equipment Specification Section for additional grounding requirements.

C. All conduit, cable tray, raceways, junction boxes, pull boxes, etc., shall be made electrically continuous by means of grounding conductors, bonding jumpers, grounding bushings, couplings, fittings, etc., as recommended by the TIA J-STD-607-A.

2.3 ACCEPTABLE MANUFACTURERS

A. Being listed herein as an acceptable manufacturer does not permit the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements of the Contract Documents.

B. All substitutions must be included in the Contractor's Base Bid, and must be accompanied by a letter of equivalency certifying the products equivalency in all performance and physical characteristics to the products listed herein. The proposed substitutions shall be all inclusive of all cost and physical implications throughout the project. Under no circumstances should the substitution result in added cost to the project. Project specifications/documents will not be revised to reflect the substitution should the substitution be approved.

2.4 GROUND BAR

A. Solid copper ground bar, 1/4 in. thick for wall mounting in Data Center Rooms, complete with insulated standoffs, 20 in. x 4 in.

2.5 GROUNDING CONDUCTORS

A. All grounding electrode conductors shall be bare or green insulated copper conductors sized as indicated on the Drawings.

B. All conductors shall be run in conduit unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Telecommunications Signal Ground System (J-STD-607-A Compliant System)

1. Furnish and install in data/communication closets or adjacent to wall-mounted technology cabinets which are mounted in non-Technology Rooms (such as an MER) as indicated on plans, a telecommunications grounding and bonding (TGB) infrastructure for low-noise signal grounding of sensitive electronic equipment.
2. The TGB grounding system shall include the following:

a. All bonding conductors and connectors shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL).
b. All bonding conductors shall be insulated and copper. The minimum bonding conductor size shall be a No. 6 AWG.
c. Bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place bonding conductors in ferrous metallic conduit that exceeds 1 m. (3 ft.) in length, the conductors shall be bonded to each end of the conduit with a conductor sized as a No. 6 AWG, minimum.
d. Each telecommunications bonding conductor shall be labeled. Labels shall be located on conductors as close as practicable (i.e., ease of access to read the label) to their point of termination. Labels shall be nonmetallic and include the information depicted below. Refer to ANSI/TIA/EIA 606 for additional labeling requirements.

WARNING
IF THIS CONNECTOR OR CABLE IS
LOOSE OR MUST BE REMOVED,
PLEASE CALL THE BUILDING
TELECOMMUNICATIONS
MANAGER

e. Each telecommunications bonding conductor shall be marked appropriately by a distinctive green color.
f. The bonding conductor for telecommunications shall bond the telecommunications main grounding busbar (TMGB), located in the designated Technology Room as shown on Plan (see grounding riser), to the main electrical service ground bus bar.
g. A telecommunications bonding backbone cable (TBB) shall be the conductor that interconnects the TMGB to all telecommunications grounding busbars (TGB's) which are located in the Technology Rooms, and the Main Incoming Service (Power) Switchboard Room.
h. The TBB shall be an insulated copper conductor. TBB conductors shall be installed and protected from physical and mechanical damage.
i. TBB conductors should be installed without splices, where practicable. Where splices are necessary, they should be minimum and shall be accessible and located in telecommunications spaces. Joined segments of a TBB shall be connected using irreversible compression-type connectors, exothermic welding, or equivalent. All joints shall be adequately supported and protected from damage.

j. The TMGB should be located to result in the straightest route considering the total length of the bonding conductor from the telecommunications primary protectors to the TMGB. This bonding conductor is intended to conduct lightning and AC fault currents from the ***telecommunications*** primary protectors. A minimum of 300 mm (1 ft.) separation shall be maintained between this insulated conductor and any DC power cables, switchboard cable, or high frequency cables, even when isolated by metallic conduit or EMT.

k. The TMGB shall:

1) be a predrilled copper busbar with electronic plating provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used, and
2) be sized in accordance with the immediate requirements of the application and with consideration of future growth, and
3) have minimum dimensions of 6 mm thick x 100 mm wide and be variable in length.

l. Where a lighting, utility, distribution, PDU, etc., panelboard for telecommunications is located in the same room or space as the TMGB, that panelboard's equipment ground shall be bonded to the TMGB.

m. The connections of the bonding conductor for telecommunications and the TBB's to the TMGB shall utilize listed 2-hole compression connectors, exothermic-type welded connections, or equivalent.

n. All metallic raceways for telecommunications cabling located within the same room or space as the TMGB shall be bonded to the TMGB. In addition, all power conduit which enters Technology Rooms shall be bonded to the TMGB. Bond straps shall be connected to power conduit at the immediate entrance to the room.

o. The TMGB shall be insulated from its support with a 50 mm (2 in.) separation.

p. The extension of the telecommunication grounding system (from the TMGB) to local grounding centers in technology riser closets and/or rooms shall be the Telecommunication Grounding Bus Bar (TGB). TGB's shall be located in all Technology Rooms. The TGB shall:

1) be a predrilled copper busbar with electrotin plating provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used, and
2) have minimum dimensions of 6 mm thick x 50 mm wide and be variable in length to meet the application requirement with consideration of future growth.

q. The bonding conductor between a TBB and TGB shall be continuous and routed in the shortest possible straight-line path.

r. Where a panelboard for telecommunications is located within the same room or space as the TGB, that panelboard's equipment ground shall be bonded to the TGB.

s. All metallic raceways for telecommunications cabling located within the same room or space as the TGB shall be bonded to the TGB.

t. All technology racks and cabinets shall be bonded to the TGB.

u. Connections of TBB's to the TGB shall utilize listed 2-hole compression connectors.

v. The TGB shall be insulated from its support with a 50 mm (2 in.) separation.

3.2 TESTING

A. Grounding System Testing

1. Upon completion of the electrical system, including all grounding, the Subcontractor shall test the system for continuity, stray currents, ground shorts, etc. These tests shall be performed in a manner acceptable to the Engineer. Approved instruments, apparatus, services, and qualified personnel shall be utilized. If stray currents, shorts, etc., are detected, eliminate or correct as required. The test procedure shall be as outlined:

a. An ohmmeter reading less than 100 ohms shall indicate that the system contains ground shorts (stray currents), as well as to confirm continuity, at some point along the system neutral.
b. The systems shall be retested after correction of all ground shorts is complete. Final readings shall be tabulated for review by the Engineer.

2. The maximum resistance to ground from any point in the electrical system shall be 5 ohms.

3.3 "AS-BUILTS"

A. Provide "as-built" drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction.

END OF SECTION 27 0506

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SECTION 27 1000 - COMMUNICATIONS CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all conduit as specified herein and as required for proper distribution of all wire, cable, and electrical conductors throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0400 - Communications Ladder Rack.
3. Section 27 0500 - Common Work Results for Communications.
4. Section 27 0506 - Grounding and Bonding for Communications Systems.
5. Section 27 1100 - Communications Equipment Room Fittings.
6. Section 27 1300 - Communications Backbone Cabling.
7. Section 27 1500 - Telecommunications UTP Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCES

A. The entire installation and all equipment, materials and methods shall comply with the currently enforced versions of all applicable laws, rules, regulations, standards, legislation, codes and ordinances of New York City, Underwriters Laboratory and New York City Electrical Code, Telecommunications Industries Association/Electronic Industries Association/(TIA/EIA) and Building Industry Consulting Service International (BICSI) Standards where they do not conflict with any applicable requirements of laws, codes, ordinances, legislation, etc., of all federal, state and local authorities whether indicated on the Contract Documents or not. All equipment shall be MEA and/or BS&A approved or have an OTCR approval and approved for use in New York City. Modifications required by the above said authorities having jurisdiction shall be made without additional cost to the Owner.

1. Except as modified herein, the requirements and recommendations of the latest editions of the following documents are made part of these Specifications:

a. ANSI/TIA/EIA - 568 C “Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements”.
b. ANSI/TIA/EIA - 568B.3 “Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard”.
c. ANSI/TIA/EIA - 569 “Commercial Building Standard for Telecommunications Pathways and Spaces”.
d. ANSI/TIA/EIA - 606-A “Administration Standards for the Telecommunications Pathways and Spaces”.
e. ANSI/J-STD- 607-A “Commercial Buildings Grounding and Bonding Requirements for Telecommunications”.
f. ANSI/NFPA-70 - “National Electrical Code”.
g. ANSI/NFPA-780 - “Lightning Protection Code”.
h. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards – A Background Report.”
i. BICSI “Telecommunications Distribution Methods Manual”.
j. IEEE Std. 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
k. ANSI R211.
l. BOCA National Building Code, 1996; Seismic exposure Group II — Performance Category “C”.
m. UL Standard 1 - Flexible Metal Electrical Conduit.
n. UL Standard 6 - Rigid Galvanized Conduit.
o. UL Standard 360 - Liquid-Tight Flexible Conduit
p. UL Standard 467 - Electrical Grounding and Bonding.
q. UL Standard 651 - Non-Metallic Conduit
r. UL Standard 797 - Electrical Metallic Tubing.
s. UL Standard 1242 - Intermediate Metal Conduit.
t. ANSI C80.1 - Rigid Galvanized Conduit.
u. ANSI C80.3 - Electrical Metallic Tubing.
v. ANSI C80.5 - Rigid Aluminum Conduit
w. NYCEC - New York City Electrical Code.
x. UL Standard 651 (ANSI F512, NEMA TC-2) - Non-Metallic Conduit.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to Substantial completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB’s), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC’s), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a “Materials Safety Data Sheet”, as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to Section 27 1000 and shall include but not be limited to:

1. Conduit, including samples, complete with fittings, materials, connector details, etc

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and Section 27 0500.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyl's (PCB) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. If it complies with these Specifications, conduit and fittings manufactured by one of the following Rigid Steel and Intermediate Metal Conduit:

1. Allied.
2. Republic.
3. Triangle.
4. Western.
5. Wheatland.

B. Rigid Steel and Intermediate Metal Conduit Fittings:

1. Appleton.
2. Crouse-Hinds.
3. Efcor.
4. Midwest.
5. O.Z./Gedney.
6. Raco.
7. Spring City.
8. Steel City.
9. Thomas and Betts.

C. Rigid Steel Conduit and Fittings (exposed to the weather):

1. Occidental Coating Company.
2. Perma-Cote.
3. Robroy Industries "Plasti-Bond-Red".
4. Triangle.

D. Rigid Aluminum Conduit and Fittings:

1. Alcoa.
2. Harvey

3. Kaiser.
4. Reynolds.

E. Electrical Metallic Tubing (EMT):

1. Allied.
2. Republic.
3. Robroy Industries.
4. Triangle.
5. Western.
6. Wheatland.

F. Flexible Metal Conduit:

1. AFC.
2. ALFLEX.
3. American Metal Molding.
4. Anaconda.
5. Cerro.
6. International Metal Hose.

G. Flexible Metal Conduit Fittings:

1. Appleton.
2. Efcor.
3. Midwest.
4. OZ/Gedney.
5. Raco.
6. Steel City.
7. Thomas and Betts.

H. Liquid-tight Flexible Metal Conduit:

1. American Brass Company.
2. Anaconda (Type “UA”).
3. Electri-Flex Company.
4. Liquid-tight Flexible Metal Conduit Fittings:
5. American Brass Company.
6. Midwest.
7. O.Z./Gedney.

I. Rigid Nonmetallic Electrical Conduit and Fittings:

1. Carlon.
2. Certainteed.
3. Triangle.

2.3 NON-FLEXIBLE CONDUIT

A. General

1. The minimum size conduit that shall be permitted is 3/4 inch.
2. In general, conduit shall not be embedded in the floor slabs except specifically where permitted on the Contract Drawings.

B. Rigid Steel Conduit: Rigid steel conduit (RGS) shall be used where conduit is underground, exposed to the weather, in concrete slabs (where permitted by an accepted deduct alternate), in hazardous locations, used for systems operating at over 600 volts, or greater than 4 in. in

diameter. Conduit shall have a cross-section formed with a sufficient degree of accuracy to permit the cutting of clean, true, full threads. Conduit shall be joined with pipe couplings and shall be secured in cabinets, outlets, etc., with double locknuts. Conduits terminating in cabinets, outlets, etc., shall be provided with Midwest Catalog Number 931 to 942, or approved equal steel insulating grounding bushings. All fittings shall be cast iron or galvanized or cadmium-plated and threaded.

1. Rigid steel conduit shall be hot-dipped galvanized inside and out.
2. Where exposed to weather, rigid steel conduit shall be Robroy Industries "Plasti-Bond-Red" complete with "Plasti-Bond-Red" fittings, or approved equal plastic coated non-flexible metal conduit and fit-tings. Exposed threads, damaged coatings, etc., shall be field-coated with Robroy Industries "Plasti-Bond-Red Touch-Up", or approved equal.
3. Full lengths of pipe shall have galvanized or zinc-coated threads on both ends.
4. Running threads shall not be used. Where such a device is required, use T&B "Erickson" type union or O.Z./Gedney Type SSP split coupling, or approved equal.

C. Rigid Aluminum Conduit: At the option of the Contractor, aluminum rigid conduit may be used instead of rigid steel conduit except where conduit is underground, in concrete slabs (where permitted by an accepted deduct alternate), exposed to the weather, used for systems operating at over 600 volts, used in parking areas, used in loading docks, encased in concrete, where specifically noted otherwise in the Construction Documents, and where required by applicable Codes. Aluminum couplings and fittings, shall be used and installed as recommended by the Manufacturer using Crouse-Hinds STL-6 compound, or approved equal. All elbows shall be hot-dipped or electroplated galvanized steel. Rigid aluminum conduit shall be used for telecommunications signal ground systems.

D. Intermediate metal conduit (IMC) may be used in lieu of RGS where subjected to any water or moisture condition or where buried in slab. Conduit shall be hot-dipped or electroplated galvanized. All fittings shall be cast iron or cast iron alloy, galvanized or cadmium plated.

E. Electrical Metallic Tubing (EMT)

1. At the Contractor's option, electrical metallic tubing (EMT) may be used instead of rigid aluminum conduit or IMC except where RGS, IMC or rigid aluminum conduit are specifically required.
2. EMT may not be utilized in sizes above 4 inch diameter.
3. EMT shall be formed with a sufficient degree of accuracy to permit the use of connectors. EMT shall be joined with Midwest Catalog Nos. 460-469 steel couplings, or approved equal. EMT and rigid steel conduit shall be joined with Midwest Catalog Nos. 420-422 steel couplings, or approved equal. Conduits shall be secured with Midwest Catalog Nos. 1450-1459 or approved equal steel set screw type insulated connectors at panels, junction boxes, outlets, etc. All connectors and couplings, etc., shall be steel and set screw type.
4. At the Contractor's option, metallic tubing using "Unicouple" type connectors may be used instead of tubing and individual couplings. Where "Unicouple" connectors are used in vertical conduit runs, all flared conduit ends shall be oriented downward to prevent moisture from being "funneled" into the conduit.
5. PVC Conduit: PVC conduit shall be used where conduit is underground, in concrete slabs, where required to be encased in concrete, used for systems operating at over 600 volts, or greater than 4 in. in diameter. Conduit shall have a cross-section formed with a sufficient degree of accuracy to permit the cutting of clean, true, full threads. Conduit shall be joined with weatherproof solvent, cement and approved pipe couplings. PVC conduit shall be provided with steel insulating grounding bushings as manufactured by Kraloy, Carlon, or approved equal. All rigid PVC (nonmetallic conduit) shall be Schedule 80 (extra-heavy wall EPC-80). All elbows shall be cast iron or galvanized or cadmium-plated and threaded.

2.4 FLEXIBLE CONDUIT

A. Flexible Metal Conduit: Flexible metal conduit shall be steel and shall only be used for connections to the following:

1. Motors.
2. Transformers.
3. Control equipment and devices.
4. Lighting fixtures not connected by non-flexible metal conduit. See Section 26 0519 titled “Low-Voltage Electrical Power Conductors and Cables" for requirements for the use of type "AC" and "MC" conductor cables.
5. Receptacles: See Section 26 0519 titled “Low-Voltage Electrical Power Conductors and Cables" for requirements for the use of type "AC" and "MC" conductor cables.
6. Appliances.
7. Equipment and devices requiring adjustment or removal for maintenance.
8. Busway switches.
9. Fan-powered terminal units.
10. Capacitors.
11. Equipment and devices subject to movement or vibration.

B. Liquid-Tight Flexible Metal Conduit

1. Shall be same as flexible metal conduit, with heavy-duty, inert, watertight outer jacket.
2. Shall be used for all connection to:

a. Pumps.
b. Outdoor flexible connections.
c. Vibrating equipment in wet locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Non-Flexible Conduit

1. Non-flexible metal conduit shall be sized in accordance with the per-cent fill requirements of the New York City Electrical Code and as indicated on the Drawings (whichever is larger, in the event of a conflict) and shall be of ample size to permit the ready insertion and withdrawal of conductors without abrasion. Non-flexible metal conduit shall not be smaller than 3/4 in. Doubling up of "home runs" is unacceptable.
2. Non-flexible metal conduit, including rigid and intermediate metal conduit and electrical metallic tubing, shall not be embedded in any structural slabs, unless specifically noted on the Drawings or when permitted by Owner’s acceptance of the deduct alternate. The specifically noted non-flexible metal conduit to be embedded in any structural slab shall be installed strictly in accordance with the Project Structural Engineer's written instructions. The electrical subcontractor shall forward two (2) copies of the Project Structural Engineer's written approval and instructions for installation to the Engineer for his file prior to proceeding with the installation. Non-flexible metal conduits embedded in structural slabs shall have watertight joints.
3. Conduit in finished portions of the building, except in mechanical and electrical equipment rooms, or where otherwise indicated on the Drawings, shall be concealed. Concealed non-flexible metal conduits shall be run in as direct a manner and with as long a bend as possible. Exposed non-flexible metal conduit shall be run parallel to or at right angles with the lines of the building. All bends shall be made with screw-jointed conduit fittings or with standard ells manufactured only in sizes exceeding 1-1/2 inches. Conduit bends shall have a radii not less than that shown in Table 346-10 of the New York City Electrical Code, or noted elsewhere in the Contract Documents. All bends shall be free from dents

or flattening. Not more than the equivalent of four (4) 90° bends shall be used in any run between terminals and cabinets, or between outlets and junction or pull boxes. Specification conformity of field bends shall be demonstrated if so requested by the Architect by passing of mandrel of size compatible with inner diameter of conduit through bend.

4. Non-flexible metal conduit shall be continuous from outlet to outlet and from outlet to cabinets, junction or pull boxes and shall enter and be secured at all boxes in such a manner that each system shall be electrically continuous throughout.
5. Terminals of all non-flexible metal conduits shall be furnished with bushings, locknuts, connectors, etc., as specified herein. All joints shall be cut square, reamed smooth, and drawn-up tight.
6. So far as is practicable, all exposed non-flexible metal conduit shall be run without traps. Where traps or dips are unavoidable, a junction or pull box shall be placed at each low point.
7. Non-flexible metal conduit hangers and fasteners shall be of the type appropriate in design and in dimensions for the particular applications and shall be securely fastened in place as specified herein at Code minimum spacings and at each elbow.
8. Each entire non-flexible metal conduit system shall be installed complete before any conductors are drawn in. To guard against obstructions and omissions, each run of conduit shall be finished before gypsum board is installed. All non-flexible metal conduit shall be swabbed after plaster is finished and dry.
9. As soon as non-flexible metal conduit has been permanently installed in place, conduit ends shall be capped or plugged with standard accessories.
10. Non-flexible metal conduit for telephone, signal, communication, and security systems shall be provided with pull boxes of approved sizes after two right angle bends and at intervals not exceeding 100 feet. Boxes shall be in accessible locations.
11. A 1/8 in. braided polypropylene rope or No. 14 galvanized iron fish wire shall be left in all empty non-flexible metal conduit systems. At least 12 in. of properly secured rope or wire shall be folded back into each end of the empty non-flexible metal conduits.
12. Furnish and install OZ/Gedney Company expansion fittings, type DX for rigid metal conduit, type EX for rigid metal conduit exposed to the weather and type TX for electrical metallic tubing (EMT), or equivalent manufactured by Appleton, Crouse -Hinds, or Spring City, where non-flexible metal conduits cross building expansion joints. See the Section 27 0506 entitled "Grounding and Bonding for Communications Systems".
13. Non-flexible metal conduit installed in the ground shall have water-tight joints and shall be painted the entire length with two coats of protective finish such as asphaltum or factory-coated with a phenolic resin epoxy material. All coating shall be applied in accordance with the manufacturer's recommendations. The entire length of non-flexible metal conduit, including fittings, in contact with the ground, to a point 6 in. above the ground (or concrete slab), shall be completely coated, subject to the Engineer's approval.
14. In areas designated as Class I, Division 2 hazardous areas, rigid metal conduit (or liquid-tight flexible metal conduit for motor terminations) with approved terminations and fittings shall be used. The Class I, Division 2 hazardous areas shall be as defined by the Authority having jurisdiction for this Project.
15. Prior to the installation of any plastic coated non-flexible metal conduit, the Contractor shall submit a 12 in. sample of the proposed conduit, fittings and miscellaneous materials for review by the Engineer.
16. The power leads to all motors shall be in conduit. Where motors have conduit terminal boxes, the feeder conduit shall not be connected directly into same. Provide a flexible conduit for final connection to motor terminal box. Flexible conduit shall be long enough (but in no case less than 36 inches long) and of suitable arrangement to achieve a true flexible connection between motor and rigid conduit. Under no circumstances shall rigid conduit terminate in or be fastened to motor foundation. Liquid-tight flexible metal conduit shall be installed to all motors.

B. Flexible Conduit

1. Continuity of the equipment ground across flexible metal conduit connections shall be maintained for all systems that are over 150 volts to ground. The continuity shall be maintained by installing a grounding conductor sized in accordance with the current New York City Electrical Code. The grounding conductor shall be inside the flexible conduit and shall be connected on one end of the flexible metal conduit by a suitable binding post and similarly connected on the opposite end with another suitable binding post. All grounding conductors shall be solid copper conductors.
2. For flexible metal conduit sizes 1-1/4 in. and smaller and lengths of 6 feet or less, UL listed liquid-tight flexible conduit with grounding provisions and watertight fittings may be used in lieu of a flexible metal conduit and separate grounding conductor described above in accordance with New York City Electrical Code requirements for liquid-tight flexible conduit.
3. Flexible metal conduit shall be secured with Midwest Catalog Nos. 1708-1715 or approved equal insulated throat clamps. Liquid-tight flexible metal conduit shall be secured with Midwest Catalog Nos. LTB-38 through LTB-300 or approved equal insulated throat watertight fittings and shall be used where subject to weather or moisture conditions. Connectors shall be steel type. Die cast connectors will not be acceptable.

C. Telecommunications Raceway System

1. The telecommunications raceway system shall consist of conduit, sleeves, enclosed trough, open cable tray, outlet boxes, faceplates, bushed cover plates, junction boxes, terminal strip cabinets, pull boxes, etc. The entire layout shall be installed as indicated and in accordance with the requirements of the company supplying telecommunications service.
2. Wall outlet boxes shall be of size and type to suit each individual location. In general, double-gang 4 inch square boxes with plaster rings, 2-1/2 inches deep, and bushed cover stainless steel plates shall be provided at each telephone location. Plaster rings and cover plates shall be suitable for single gang or double gang outlets, as required.
3. Provide empty conduit, 1 ¼" inch minimum (u.o.n.), for standard telecommunications outlets.
4. Provide empty conduit, ¾" inch minimum (u.o.n.), for standard telephone only outlets.
5. Where conduit bends are required in telecommunications raceway systems, the radius of the raceway bend shall not be less than twelve times the diameter of the raceway.
6. All telecommunications raceways shall be provided with a suitably sized "true-measure" drag line indicating length of pull, tied off at each end, for cable installation by others.
7. Telecommunications cabling shall be provided. Firesafing of telecommunications raceways shall be by this Section after installation of telecommunications cabling.
8. All runs of 2 inches and larger shall not contain more than 90 degrees of bends or 100 feet in length without a pull box. For each 90 degree turn, make the turn in a conduit bend adjacent to the box. Boxes shall not be used for 90 degree turns.
9. It is the responsibility of this Contractor to coordinate all under-raised-floor and in-ceiling telecom cable paths with electrical work.
10. Install identification stickers (furnished by others) on each raceway as follows:

a.	Vertical runs	Every 15 feet (minimum of one per floor)
b.	Horizontal runs	Every 25 feet (minimum of one per run)
c.	Pull boxes	Each

11. All conduit shall be EMT except where rigid galvanized steel is specified (i.e., parking garage, roof, etc.).
12. ***A minimum of three (3) orange nylon drag lines shall be left in each installed conduit.***

3.2 CONDUIT HANGERS AND SUPPORTS

A. All horizontal conduits throughout the building shall be thoroughly and substantially supported with individually approved expansion ring hangers or supported in groups using Unistrut or Kindorf channels and suitable hangers. Hangers shall not be spaced more than ten feet apart. Perforated extension bar hangers will not be accepted in any part of the Work. All vertical conduits shall be substantially supported at floor lines to carry the weight of the conduit and cable in a satisfactory manner with allowance for expansion and contraction. Special hangers and supports shall be provided where they may be required because of any peculiarities of construction. Where exposed to weather, conduit hangers and supports shall be Robroy Industries "Plasti-Bond-Red", or approved equal. Damaged hangers and supports shall be field-coated with Robroy Industries "Plasti-Bond-Red Touch-Up", or approved equal. Hanger rod sizes shall be as recommended by the hanger manufacturer for the service intended.

B. Horizontal conduit runs may be supported by beam, special brackets or adjustable trapeze hangers with each conduit strapped at each support point. Conduits 3/4 in. in size within hung ceilings may be supported to black iron ceiling structural members with heavy iron tie wire.

3.3 “AS-BUILTS”

A. Provide “as-built” drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction.

END OF SECTION 27 1000

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SECTION 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all entry points, patch panels, ladder racks, equipment racks, cabinets and wire managers as specified herein and as required for proper distribution of all wire, cable, and electrical conductors throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. This Contractor shall refer to Division 01 for all general requirements for the project, which include, but are not limited to, the following:

1. Section 01 1000 - Summary.
2. Section 01 2100 - Allowances.
3. Section 01 2200 - Unit Prices.
4. Section 01 2300 - Alternates.
5. Section 01 2600 - Contract Modification Procedures.
6. Section 01 2900 - Payment Procedures.
7. Section 01 3100 - Project Management and Coordination.
8. Section 01 3200 - Construction Progress Documentation.
9. Section 01 3300 - Submittal Procedures.
10. Section 01 4000 - Quality Requirements.
11. Section 01 4200 - References.
12. Section 01 5000 - Temporary Facilities and Controls.
13. Section 01 5639 - Temporary Tree and Plant Protection.
14. Section 01 6000 - Product Requirements.
15. Section 01 7300 - Execution.
16. Section 01 7329 - Cutting and Patching.
17. Section 01 7700 - Closeout Procedures.
18. Section 01 7823 - Operation and Maintenance Data.
19. Section 01 7839 - Project Record Documents.
20. Section 01 7900 - Demonstration and Training.
21. Section 01 9113 - General Commissioning Requirements.

C. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0400 - Communications Ladder Rack.
3. Section 27 0500 - Common Work Results for Communications.
4. Section 27 0506 - Grounding and Bonding for Communications Systems.
5. Section 27 1000 - Communications Conduit.
6. Section 27 1300 - Communications Backbone Cabling.
7. Section 27 1500 - Telecommunications UTP Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCE STANDARDS

A. All entry ways, patch panels, ladder racks, equipment racks, cabinets, and wire managers shall be designed, manufactured, and tested in accordance with the latest applicable industry standards, regulations, Codes and ordinances of federal, state, and local authorities having jurisdiction. Modifications required by the above-said authorities having jurisdiction shall be made without additional cost to the Owner. The following Codes and standards shall be included:

1. UL Standard 651 - (ANSI F512, NEMA TC-2).
2. ANSI/TIA/EIA-569.A.
3. NYCEC- New York City Electrical Code.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to final completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB's), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC's), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a "Materials Safety Data Sheet", as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to this Section and shall include but not be limited to:

1. Entrance protection.
2. Racks, cabinets, frames and enclosures.
3. Termination blocks and patch panels.
4. Cable management and ladder rack.
5. Rack-mounted power protection and power strips.
6. Firestop and penetration sealant.

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and this Section.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyls (PCB's) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. Being listed herein as an acceptable manufacturer does not permit the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements of the Contract Documents.

B. All substitutions must be included in the Contractor's Base Bid, and must be accompanied by a letter of equivalency certifying the products equivalency in all performance and physical characteristics to the products listed herein. The proposed substitutions shall be all inclusive of all cost and physical implications throughout the project. Under no circumstances should the substitution result in added cost to the project. Project specifications/documents will not be revised to reflect the substitution should the substitution be approved.

C. If it complies with these Specifications, Racks, Cabinets, Cable Management Hardware and fittings manufactured by the following manufacturers will be acceptable:

1. Ortronics Mighty-Mo 10.

D. If it complies with these Specifications, Termination Blocks and Patch Panels manufactured by the following manufacturer will be acceptable:

1. Ortronics.

E. If it complies with these Specifications, Ladder Racks manufactured by one of the following manufacturers will be acceptable:

1. Chatsworth Products Inc.
2. Legrand/ Cablofil.
3. ***Cooper B-line.***

F. If it complies with these Specifications, Fire Stop and Penetration Sealant manufactured by one of the following manufacturers will be acceptable:

1. 3M.
2. Ez Path.
~~3. GSD.~~
~~4.~~**3.** Hilti Pathway System.
~~5. IPC.~~

~~6. Nelson.~~

2.3 EQUIPMENT RACKS, CABINETS AND ENCLOSURES

A. Free-standing Racks (Ortronics Mighty-Mo 10)

1. Used to mount network control equipment and patch panels.
2. Complies with EIA and IEC standards.
3. IDF Rack Size: 19 in. (23 in.) wide EIA standard x ~~8~~ ***7*** ft. high. as indicated on drawings.
4. Racks shall be 19 inch panel width, EIA standard hole configuration, steel construction with raceway provisions for inter-rack cabling, all required brackets, wire management trough installed vertically on both sides.
5. Provide complete with mounting screws.
6. Front- and rear-mounted vertical wire management rings.
7. All equipment racks and cabinets shall be installed with seismic restraints and vibration isolation devices at all locations as described on the drawings.
8. Three (3) 1-3/4 in. holes in each base angle (see drawings).

2.4 CABLE MANAGEMENT HARDWARE

A. Vertical Wire Management Trough: Shall be ~~8~~ ***7*** ft. in height, 6 in. or 12 in. in width; aluminum construction, installed as double sections at open rack ends, protective edge guards and all assembly hardware; color black.

B. Horizontal 19 in. Rack-mounted Wire Management Troughs: Shall be full metal construction; for use of managing patch cords in cabinets and racks; 1, 2 or 4 units height as indicated on drawings; color: black.

C. Velcro Cable Ties: Attached to backboards using flat headed screws with rigid support; lengths vary as required.

D. "J" Hooks: Shall be sized appropriately by the Contractor and approved for Category 6A cables; suitable for attachment to beam flanges, "U" channel, purlings, deck plates, smooth or threaded rod; for use as a cable support in ceilings and beneath access floors; provided every 5 ft. OC (max) for open cable runs; not to be fastened to hung ceiling support structures.

2.5 RACK-MOUNTED MODULAR CATEGORY 6A PATCH PANELS

A. Modular jacks (individual jacks).

B. 48-port ***angled*** high density unless otherwise indicated on plans.

C. Quantities per Drawings and Cabling Schedule.

D. Complete with T568B RJ-45 (Category 6A) jacks.

E. 110 style rear side terminations.

F. Patch panels shall have each port number and patch panel name permanently labeled.

G. Each jack shall be color coded with either colored jacks or colored insert tabs.

H. Rack-mountable in standard 19 inch EIA racks.

I. Provide one (1) strain relief bracket attached to rear of rack behind each patch panel.

2.6 RACK-MOUNTED CATEGORY 5E PATCH PANELS

A. Printed circuit patch panel.

B. 48-port ***angled*** high density unless otherwise indicated on plans.

C. Quantities per Drawings and Cabling Schedule.

D. Complete with T568B RJ-45 (Category 5e) jacks.

E. 110 style rear side terminations.

F. Patch panels shall have each port number and patch panel name permanently labeled.

G. Rack-mountable in standard 19 inch EIA racks.

H. Provide one (1) strain relief bracket attached to rear of rack behind each patch panel.

2.7 RACK-MOUNTED FIBER-OPTIC PATCH PANELS

A. Port quantities as indicated on the drawings.

B. To accept LC adapter modules.

C. Complete with door lock, connector panels, slide-out rails, jumper troughs, strain relief spool.

D. Loaded with connector panels and LC couplers unless otherwise indicated on plans.

E. Rack-mountable in standard 19 inch EIA racks.

2.8 WALL-MOUNTED COAXIAL PATCH PANELS

A. Port quantities as indicated on the drawings.

B. To accept both RG-11/U and RG-6/U 7F-connector type terminations.

C. Telcom wall-mountable.

D. Contractor may provide wall-mounted bracket to support patch panel.

2.9 LADDER RACK

A. All ladder rack and ladder runway shall be installed with seismic restraints and vibration isolation devices at all locations as described on the drawings.

B. Ladder rack system shall be made of straight sections, fittings, including brackets, rods, clamps, jumpers, fasteners, concrete inserts, etc., and accessories as defined in the latest NEMA standards publication VE-1. Ladder rack shall be UL classified as equipment grounding conductors.

C. Ladder rack shall consist of two (2) longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 9 inches on center for straight sections. Rung spacing in radiused fittings shall be 2 inches on center and measured at the center of the tray's width. Rungs shall have a minimum cable bearing surface of 7/8 in. with raised edges. No portion of the rungs shall protrude below the bottom plane of the side rails.

D. Cable Tray shall have an overall nominal depth of 4 in. unless otherwise noted on plans. Load width shall be as indicated on the drawings.

E. Straight sections side rails shall be I-beam and shall be supplied in standard lengths of 12 feet.

F. Side rails of straight sections and fittings shall be compatible so that standard splice plates can be used to join straight sections and fittings. Fittings shall have 3 inch tangents beyond the curved section to accommodate the standard splice plates.

G. Splice plates shall be the bolted type, using either square neck or ribbed-neck carriage bolts and serrated flange locknuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed .00033 ohm. The cable tray shall be designed so that a splice plate located anywhere along the span shall not decrease the strength of the cable tray system.

H. Splice plates shall be furnished with straight sections and fittings.

I. All accessories shall be furnished as required to protect, support and install the ladder rack system.

J. Ladder rack shall be capable of carrying a uniformly distributed load of 132 lbs./ft. with safety factor of 2.0 when supported as simple span and tested per NEMA VE1-4.01. Load and safety factors specified are applicable to both the side rails and rung capacities.

K. Ladder rack shall be made to manufacturing tolerances as specified by NEMA (see NEMA VE1-2.03 and VE1-2.04).

L. Provide bend sections with a minimum 24 inch radius.

M. Coordinate installation of ladder rack with all other Trades.

N. 6 in. outboard rungs shall be installed as indicated on drawings.

O. Submit proposed supporting criteria, including loading characteristics, to the Structural Engineer for review.

P. Submit shop drawings indicating routing and proposed method of installation complete with dimensions BEFORE commencing work.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine and compare the telecommunications pathway drawings and specifications with the drawings and specifications of other Trades; report any discrepancies between them to the Engineer and obtain from him written instructions for changes necessary in the work.

B. Install and coordinate the telecommunications pathways work in cooperation with other Trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner accepted by the General Contractor. All repairs or changes required in the work of the Contractor caused by his neglect shall be made by him at his own expense.

C. The locations of ladder racks, conduits, outlets and other equipment indicated on the drawings are approximately correct and are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed.

D. Telecommunications pathways running parallel to electrical cables/conduits shall be separated by a minimum of 12 in. When crossing, maintain a 3 in. minimum separation. Maintain a minimum 12 in. separation from all fluorescent lighting fixtures.

E. Telecommunications pathways shall cross electrical cables/conduits at 90 degree angles only.

F. The Contractor shall maintain a current copy of this bid specification at the job site at all times.

G. The Contractor shall maintain a complete file of shop drawings and other submissions at the job site at all times. These shop drawings and submissions shall be made available to the General Contractor, Owner, Engineer or Architect at his request.

H. Keep all items protected before and after installation, with dust- and moisture-proof barrier materials. It shall be the Contractor's responsibility to ensure the integrity of these protective measures throughout the life of the project.

I. Clean up all debris generated by installation activities.

J. At all times during the construction, the Contractor shall protect all equipment from damage and theft.

K. Upon project completion, provide "as-built" drawings and documentation as defined herein.

L. All telecommunications pathways provided as part of this work shall provide smooth surfaces wherever contact could be made with correctly installed telecommunications cabling. All burrs, threaded sections, or other sharp or abrasive edges or surfaces in cable bearing sections shall be finished smooth or with rounder edging provided.

M. Provide expansion joints in the cable trays/runways wherever trays/runways span a building expansion joint.

N. Cables shall follow conduit routes and trunk patterns or main pathways reflected on drawings. Tributary pathways shall be established for cable distribution from the main cable pathway to the telecommunications outlet. Where specific routes are not indicated, cables shall follow room boundaries under raised floor or above hung ceiling for distribution into walls, outlets, channels, or conduits. Cabling below raised floors shall follow specified routes and shall always be routed parallel or perpendicular to building construction (no diagonals).

3.2 "J" HOOKS

A. No more than twenty-four (24) 4-pair cables shall be suspended in each 2 in. "J" hook support. If smaller cable supports are used, do not fill support more than 40% full.

B. All cable distribution from the cable trays/conduits to points of vertical transition to outlet locations shall be supported by means of 2 inch "J" hooks on 5 foot centers (max). Ceiling support grids and service hangers shall not be used for support of telecommunications cabling.

C. Main cabling pathways consist of the pathways out from the IDF in conduit or other means of cable support as detailed below. Tributary cable paths consist of the pathways from the main cable pathway to the telecommunications outlet.

D. "J" hooks shall be directly attached to the ceiling deck or hung from the deck by a threaded rod. (Length of the threaded rod shall not exceed 3 feet and the distance between rings shall not exceed 5 feet.)

E. Using removable hook and loop type (Velcro®) cable fasteners, cables must be neatly tie-wrapped in bundles at the midpoint between "J" hooks.

3.3 LADDER RACK

A. Ladder racks shall be supported by trapeze hangers. Supports shall be located where practicable so that connections between the sections of the ladder rack fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span requirements as outlined by the manufacturer. A support shall be placed within 2 feet on each side of any connection to a fitting.

B. Splice plates shall be the bolted type, using either square-neck or ribbed-neck carriage bolts and serrated flange locknuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed .00033 ohm. The ladder rack shall be designed so that a splice plate located anywhere along the span shall not decrease the strength of the ladder rack system.

C. Splice plates shall be furnished with straight sections and fittings.

D. All accessories shall be furnished as required to protect, support and install a ladder rack system.

E. Ladder rack shall be capable of carrying a uniformly distributed load of 132 lbs./ft. with safety factor of 2.0 when supported as simple span and tested per NEMA VE1-4.01. Load and safety factors specified are applicable to both the side rails and rung capacities.

F. Ladder rack shall be made to manufacturing tolerances as specified by NEMA (see NEMA VE1-2.03 and VE1-2.04).

G. Where runways come together, use adjustable, junction splice kits, and appropriate radial junction kits in order to maintain proper cable turning radius.

H. Where cables spill over the side of the ladder rack, or through the ladder rack, provide cable runway radius drops.

I. Provide all required appurtenances required for installation of runway ladder rack system.

J. Submit shop drawings indicating proposed method of installation complete with dimensions before commencing work.

K. Ladder rack shall have an overall nominal depth and width as shown on plans.

L. Coordinate with all other Trades.

M. Submit proposed supporting criteria, including loading characteristics, to the Structural Engineer for review.

N. Ladder rack shall be routed to maintain the minimum EMI spacing as defined under the EMI/RFI Avoidance section.

O. Ladder rack shall not be routed directly above fluorescent light fixtures.

P. Cable runways shall be supported in the IDF using wall mounting brackets and/or ceiling supports as indicated in accordance with manufacturer's recommendations. Support all cable runways which do not run adjacent to walls with ceiling-hung threaded rod for all spans in excess of five (5) feet. Use manufacturer's original fittings at all bends, joints, offsets, etc.

3.4 ENTRY FIRESTOP – PENETRATION SEALANT

A. When passing through partitions or floors, provide firestopping in the following manner:

1. Rigidly connect appropriate raceway between the trays passing through partition or floor. Raceways shall afford same area as tray.
2. Place firestop material at each end and around each conduit as specified for Electrical Penetration Fire Seals.
3. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations utilized for the installation of the telecommunications wiring system. All materials must be UL classified and meet NEC and local Code.
4. Seal all penetrations through fire-rated walls, floors and walls created by or made on the behalf of the Contractor to prevent the passage of smoke, fire, toxic gas or water through the penetration before, during or after a fire. Seal all penetrations through which the Contractor routes telecommunications cabling. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electric Code.
5. When damming or lining materials are to be left in place after the seal is complete, all such materials shall be non-flammable.
6. Any sealant shall be applied to the opening as per the manufacturer's printed instructions.
7. The sealant chosen shall remain resilient and pliable to allow for the removal and/or addition of cable without the necessity of drilling holes. It shall adhere to itself to allow any and all repairs to be made with the same material. It shall allow for vibration, expansion and/or contraction of anything passing through the penetration without affecting the seal, or cracking, crumbling and spalling.
8. When sealant is placed into a penetration, the material shall completely surround all the items within the penetration and maintain pressure against the walls of the penetration as well as the pass-through items. No heat shall be required to further expand the material to prevent the passage of smoke.
9. The material shall be distinctively colored to clearly distinguish it from standard construction materials such as mortar, cement, caulking, etc., which are not approved for restoration of the fire rating of building structures.
10. The material shall have been subjected to fire exposure in accordance with standard time-temperature curve in the Standard, UL, ASTM E 119, and NFPA 251. The firestop material shall have also been subjected to the hose stream test in accordance with UL IOB.
11. Where conduits or sleeves penetrate fire- or smoke-rated walls, partitions, floor slabs, etc., the space between pass holes and the conduit shall be caulked with a UL listed, intumescent type, firestop system. Space between pass hole and conduit shall be sized in accordance with the manufacturer's requirements for conduit size and damming material thickness for the type of rated construction for which the system is to be used.
12. When firestops have been compromised during the construction process, always provide temporary firestopping until installation is complete.

B. See Section 27 0500, Article 1.19 "Sleeves, Cutting, Patching, and Firestopping" for more details.

3.5 "AS-BUILTS"

A. Provide "as-built" drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction.

END OF SECTION 27 1100

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SECTION 27 1300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all Backbone cabling as specified herein and as required for proper distribution of all cable throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. This Contractor shall refer to Division 01 for all general requirements for the project, which include, but are not limited to, the following:

1. Section 01 1000 - Summary.
2. Section 01 2100 - Allowances.
3. Section 01 2200 - Unit Prices.
4. Section 01 2300 - Alternates.
5. Section 01 2600 - Contract Modification Procedures.
6. Section 01 2900 - Payment Procedures.
7. Section 01 3100 - Project Management and Coordination.
8. Section 01 3200 - Construction Progress Documentation.
9. Section 01 3300 - Submittal Procedures.
10. Section 01 4000 - Quality Requirements.
11. Section 01 4200 - References.
12. Section 01 5000 - Temporary Facilities and Controls.
13. Section 01 5639 - Temporary Tree and Plant Protection.
14. Section 01 6000 - Product Requirements.
15. Section 01 7300 - Execution.
16. Section 01 7329 - Cutting and Patching.
17. Section 01 7700 - Closeout Procedures.
18. Section 01 7823 - Operation and Maintenance Data.
19. Section 01 7839 - Project Record Documents.
20. Section 01 7900 - Demonstration and Training.
21. Section 01 9113 - General Commissioning Requirements.

C. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0400 - Communications Ladder Rack.
3. Section 27 0500 - Common Work Results for Communications.
4. Section 27 0506 - Grounding and Bonding for Communications Systems.
5. Section 27 1000 - Communications Conduit.
6. Section 27 1100 - Communications Equipment Room Fittings.
7. Section 27 1500 - Telecommunications UTP Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCE STANDARDS

A. All backbone cabling shall be designed, manufactured, and tested in accordance with the latest applicable industry standards and codes including the following:

1. ANSI/TIA/EIA - 568 C “Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements”.
2. ANSI/TIA/EIA - 568B.3 “Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard”.
3. ANSI/TIA/EIA - 569 “Commercial Building Standard for Telecommunications Pathways and Spaces”.
4. ANSI/TIA/EIA - 606-A “Administration Standards for the Telecommunications Pathways and Spaces”.
5. ANSI/TIA/EIA - 607 “Commercial Buildings Grounding and Bonding Requirements for Telecommunications”.
6. ANSI/NFPA-70 - “National Electrical Code”.
7. ANSI/NFPA-780 - “Lightning Protection Code”.
8. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards - A Background Report.”
9. BICSI “Telecommunications Distribution Methods Manual”.
10. IEEE Std. 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
11. ANSI R211.
12. BOCA National Building Code, 1996; Seismic exposure Group II - Performance Category “C”.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to final completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB’s), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC’s), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a “Materials Safety Data Sheet”, as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to Sections 27 0300, 27 1300, 27 1500 and 27 1600, and shall include, but not be limited to:

1. Single Mode and Multimode fiber optic cable, including samples, complete with fittings, materials, connector details, etc.
2. Category 5E – 25 Pair Copper Riser Cable, including samples, complete with fittings, materials, connector details, etc.
3. Broadcast Coaxial 75 Ohm RG 11/U Quad Shielded Cable, including samples, complete with fittings, materials, connector details, etc.

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and Section 27 0500.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyls (PCB's) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. Being listed herein as an acceptable manufacturer does not permit the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements of the Contract Documents.

B. All substitutions must be included in the Contractor's Base Bid, and must be accompanied by a letter of equivalency certifying the products equivalency in all performance and physical characteristics to the products listed herein. The proposed substitutions shall be all inclusive of all cost and physical implications throughout the project. Under no circumstances should the substitution result in added cost to the project. Project specifications/documents will not be revised to reflect the substitution should the substitution be approved.

C. If it complies with these Specifications, fiber optic cable manufactured by the following manufacturer will be acceptable:

1. Corning Cable Systems
2. *Systimax*

D. If it complies with these Specifications, UTP and coaxial cable manufactured by the following manufacturer will be acceptable:

1. ~~Berk-tek~~***Superior Essex***/Ortronics.
2. *Belden/Belden*
3. *Systimax/Systimax*

2.3 MULTI-MODE FIBER-OPTIC CABLE ***(OM4)***

A. Provide ***armored*** plenum and/or riser rated fiber, ***OM4*** ~~multi-mode~~***LOMMF***, fiber cable with integral strength member and individually jacketed 50 μm strands.

B. Cabling shall be rated, and installed in a manner consistent with the requirements of the National Electrical Code (NEC).

C. All fibers in the cable must be usable and meet required specifications.

~~D. All fiber shall be run in 1-1/4 in. innerduct, orange in color~~

~~E.~~**D.** All fiber jackets shall be ***armored*****,** orange in color.

~~F.~~**E.** Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this Specification.

~~G.~~**F.** Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

~~H.~~**G.** Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m^2).

~~I.~~**H.** The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

~~J.~~**I.** The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5°C on the original shipping reel.

~~K.~~**J.** All fiber shall support 300 meter link lengths for 40Gb/s applications.

~~L.~~**K.** The fiber shall meet the requirements of TIA/EIA-492AAAD, "Detail Specification for 850-nm Laser-Optimized, 50-μm Core Diameter/125-μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers."

~~M.~~**L.** Core Diameter: 50.0 ± 2.5 μm.

~~N.~~**M.** Core Non-Circularity: <=5 %.
Defined as: $\left(1-\frac{\text{Minimum Core Diameter}}{\text{Maximum Core Diameter}}\right)\times 100$

~~O.~~**N.** Cladding Diameter: 125.0 ± 2.0 μm

~~P.~~**O.** Cladding Non-Circularity: < =1.0 %.
Defined as: $\left(1-\frac{\text{Minimum Cladding Diameter}}{\text{Maximum Cladding Diameter}}\right)\times 100$

~~Q.~~**P.** Core-to-Cladding Concentricity: <= 1.5 μm.

~~R.~~**Q.** Coating Diameter: 245 ± 5 μm.

~~S.~~**R.** Refractive Index Profile: Graded index.

~~T.~~**S.** Numerical Aperture: 0.200 ± 0.015.Attenuation: < 3.5/1.5 dB/km at 850/1300 nm.

~~U.~~**T.** IEEE 802.3ba Performance: The fiber shall support laser-based 40 Gigabit Ethernet (GbE) operation in the 1000BASE-SX (850 nm) and 1000BASE-LX (1300 nm) operating windows at 550 meters.

~~V.~~**U.** Minimum cabled Effective Modal Bandwidth (EMB) determined by Restricted Mode Launch (RML) measurement method (FOTP-204): 2000 MHz•km at 850 nm.

~~W.~~**V.** Minimum OFL Bandwidth: 1500/500 MHz•km at 850/1300 nm.

~~X.~~**W.** Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.

~~Y.~~**X.** Attenuation at the Water Peak: The attenuation coefficient at 1380 nm shall not exceed the attenuation coefficient at 1300 nm by more than 3.0 dB/km.

~~Z.~~**Y.** Macrobend Attenuation: The attenuation due to 100 turns of fiber around a 75 ± 2 mm diameter mandrel shall not exceed 0.5 dB at 850 nm or 1300 nm.

2.4 SINGLE-MODE OPTICAL FIBER ***(OS2)***(DISPERSION UNSHIFTED):

A. The single-mode fiber utilized in the optical fiber cable shall meet TIA/EIA-492CAAA, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers," and ITU recommendation G.652, “Characteristics of Single-Mode Optical Fibre Cable”.All single-mode jackets shall be yellow in color.

B. All fiber shall ~~be run in 1-1/4 in. innerduct~~ ***armored OS2***, yellow in color

C. Cladding Diameter: 125.0 ± 0.7 μm

D. Core-to-Cladding Concentricity: ± 0.5 μm

E. Cladding Non-Circularity: <= 1.0 %

Defined as: $\left(1-\frac{\text{Minimum Cladding Diameter}}{\text{Maximum Cladding Diameter}}\right)\times 100$

F. Coating Diameter: 250 ± 10 μm.

G. Attenuation: ≤ 0.7 dB/km at 1310 nm and ≤ 0.7 dB/km at 1550 nm.

H. Attenuation Uniformity: No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.

I. Attenuation at the Water Peak: ≤ 2.1 dB/km at 1383 ± 3 nm.

J. Cutoff Wavelength (λ_{ccf}): < 1260 nm.

K. IEEE 802.3z Performance: The fiber shall support laser-based Gigabit Ethernet (GbE) operation in the 1000BASE-LX (1310 nm) operating window at 10000 m.

L. Mode Field Diameter: 9.2 ± 0.4 μm at 1310 nm /10.5 ± 1.0 μm at 1550 nm.

M. Macrobend Attenuation: The attenuation due to 1 turn of fiber around a 32 ± 2 mm diameter mandrel shall not exceed 0.50 dB at 1550 nm.

N. The attenuation due to 100 turns of fiber around a 75 ± 2 mm diameter mandrel shall not exceed 0.05 dB at 1310 nm and 0.10 dB at 1550 nm.

O. Zero Dispersion Wavelength (λo): 1300 nm $\leq \lambda o \leq$ 1324 nm.

P. Zero Dispersion Slope (So): $\leq$ 0.092 ps/(nm²/km).

Q. Dispersion: $\leq$ 3.55 ps/(nm/km) from 1285 - 1330 nm $\leq$ 18 ps/(nm/km) at 1550 nm.

R. Fiber Curl: > 4.0 m. radius of curvature.

S. Cabled Fiber Polarization Mode Dispersion (PMD): $\leq 0.5\ ps/\sqrt{km}$

2.5 CATEGORY 5E – 25-PAIR CABLE

A. Category 5e – 25-Pair Cable shall be furnished and installed as shown on plan and in accordance with the most current requirements of the applicable ANSI/TIA/EIA Standards.

B. Cabling shall be rated and installed in a manner consistent with the requirements of the National Electrical Code (NEC).

C. 24 AWG bare copper wire insulated with polyethylene.

D. Cable jacket to be plenum/non-plenum rated.

E. Cable to meet the following Electrical Performance Requirements based on a dB per 100 meter length:

Frequency (MHz)	Insertion Loss (dB/100 m max.)	RL (dB min.)	SRL (dB min.)	PS-NEXT (dB min.)	NEXT (dB min.)	ELFEXT (dB min.)	PS-ELFEXT (dB min.)
1	2	20	25	62.3	65.3	63.8	60.8
4	4.1	23	25	53.2	56.3	51.7	48.7
10	6.5	25	25	47.3	50.3	43.8	40.8
16	8.2	25	25	44.2	47.3	39.7	36.7
20	9.3	25	25	42.7	45.8	37.7	34.7
31.25	11.7	23.6	23.6	39.8	42.9	33.9	30.9
62.5	17	21.5	21.5	35.3	38.4	27.8	24.8
100	22	20.1	20.1	32.3	35.3	23.8	20.8
150	27.5	18.9	18.9	29.7	32.7	20.2	17.2
200	32.4	18	18	27.8	30.8	17.7	14.7
250	36.9	17.3	17.3	26.3	29.3	15.8	12.8

2.6 BROADCAST COAXIAL 75 OHM RG-11/U TRUNK CABLE

A. Cabling shall be rated, and installed in a manner consistent with the requirements of the National Electrical Code (NEC).

B. 14 AWG solid bare copper.

C. Polyethylene dielectric.

D. Foil shield 100% coverage.

E. Aluminum braid 40% coverage.

2.7 75 OHM F-CONNECTOR MODULE

A. Used to terminate 75 ohm RG-11/U trunk cable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Cable Installation

1. The wiring system shall be used for interconnecting telephones, PBX, LAN/WAN equipment (i.e. switches, routers, computers, etc.), televisions, fax machines, and any other equipment compatible with the wiring system herein described. The wiring system, including both copper and fiber optic applications, shall be configured as documented on the Contract/Bid Documents.
2. Furnish and install the telecommunications cables/wires in accordance with the drawings and instructions provided by the Engineer and manufacturer's recommendations.
3. All cables shall be installed in an electrically or optically continuous fashion between the designated origin and destination points. That is, all cables must be "homerun" with no unspecified splices, couplers, or intermediate connection points along the specified channel.
4. All cables shall be securely held in place by an industry-acceptable practice, which also meets applicable Codes.
5. Each reel of cable shall be provided with a manufacturer's report certifying performance.

B. EMI/RFI Avoidance

1. To avoid electromagnetic interference (EMI), cables shall be routed in such a way as to maintain the following minimum distance from possible sources of EMI:

    a. Forty-eight (48) inches from large motors or transformers.
    b. Twelve (12) inches from fluorescent or any other lighting type that requires a transformer or ballast.
    c. Three (3) inches from fluorescent fixtures with remotely installed ballasts.
    d. Wherever possible, pathways shall cross perpendicular (at a 90 degree angle) to electrical power cables and conduit. When this is not possible and telecommunications cables must take a path parallel to electrical cables or conduit, the telecommunications cables shall maintain a distance of no less than twelve (12) inches from the electrical cabling and conduit.

C. Cable Pulling

1. To limit the incidence of micro-bending of the individual fiber strands, mesh-type, swivel-eye fiber optic pulling grips shall be employed for all fiber optic cable pulling. This type of pulling grip is recommended for all other building cable as required.

    a. Pulling tension shall be monitored with a dynamometer (tension gauge) to ensure that manufacturer's recommended tensile ratings are not exceeded.
    b. Follow manufacturers' instructions for installing, connecting, and adjusting all equipment and telecommunications cabling. Where no instructions are included or available, follow industry standards.
    c. Sheaves and cable guides shall be used to maintain recommended cable bend radii when pulling. At no times shall the cable be bent to less than ten (10) times its outside diameter.
    d. The maximum length of horizontal UTP cable from any work station to the termination point must not exceed 90 meters (295 feet).

e. Completely install each horizontal station cable as an uninterrupted segment from the appropriate IDF Room to the designated outlet location as indicated on the drawings. There shall be no unspecified splices or mechanical couplers installed between the cable points of origin and termination.

D. Cable Dressing and Terminating

1. General

a. Cables shall be securely held in place by an industry-acceptable practice, and installed with sufficient bending radius so as not to kink, shear, or damage the cables (10 times the respective cable's outside diameter).
b. Provide a "mockup" of all cable terminations, labeling and dressing for each workstation, patch panel, and every other type of terminating device for Owner's review prior to commencing work.
c. All cables shall be dressed in a neat manner, observing cable and bend radius limit at each workstation, equipment rack, and within furniture systems.
d. Work deemed by the Consulting Engineer not to conform to the cable dressing and termination methods described within the Contract Documents shall be redressed or removed and replaced as required at the direction of the Consulting Engineer at no additional cost to the Owner. Failure to properly dress and terminate cable as reflected in the documents shall result in the forfeiture of all or a portion of the Contract.
e. Location and placement of the required terminating and distribution hardware shall be as shown on the drawings.
f. After dressing UTP cable to its final location, its outer sheath shall be removed to a point that allows the conductor to be splayed and terminated in a neat and uniform fashion. Every effort shall be made to maintain sheath integrity by removing only as much as is practical to accomplish termination.
g. The Contractor shall be responsible for the provision of all frames, blocks, terminations, supports, frame anchors, and mounting hardware necessary to fully install a complete telecommunications cabling system.

2. Technology Rooms

a. All cables shall be dressed in a neat manner at all points throughout the installation.
b. At every two-foot interval in Technology Rooms, provide removable hook and loop type (Velcro®) cable fasteners for each cable bundle segment that is within the room. Submit cable tie criteria to the Engineer for review prior to pulling cable.
c. Technology Rooms shall be utilized to provide a point of interconnection between the telecommunications risers, telecommunications equipment and horizontal (station outlet) wiring.
d. Patch cords shall be dressed across ladder rack and/or wire guide.

3. Modular Patch Panels

a. Cabling shall be properly installed using sufficient management hardware (jumper troughs, etc.).
b. Cabling shall be installed across the top of the strain-relief bar (parallel to the bar), in neat large-radius sweeps, tie-wrapped and routed into the area between the applicable 110 termination strips located in the rear of the modular patch panel.
c. Desi-strip label shall be installed between the 110 termination strips located in the rear of the modular patch panel.
d. No more outer insulation than is needed to terminate the cable in this position shall be stripped from the cable.
e. Individual pairs shall maintain twist integrity to within 0.5 in. of the termination point.

E. Cable Connector Protection

1. Keep all items protected before and after installation, with dust and moisture proof barrier materials. It shall be the Contractor's responsibility to ensure the integrity of these protective measures throughout the life of the project.
2. All installed connectors shall be protected and insulated by one of the following methods.

    a. Any installed connector exposed to construction activities shall be protected with a clear, heat-sealed 3 mil plastic bag sealed shut with waterproof tape after installation. The bag must be removable for testing. Any protective bags removed for testing or other installation activities must be replaced immediately after such activities are completed.
    b. Any connector, which is normally shipped with an insulating protective cover over the connector pins, shall be left with the cover in place after the connector has been installed on the cable. The protective cover shall be taped in place if easily dislodged.
    c. Any connector fouled or damaged as a result of activities related to the construction process shall be replaced at no cost to Owner.

3.2 TESTING

A. General

1. Contractor shall provide sufficient skilled labor to complete testing within the agreed-upon test period.
2. Contractor must fulfill all Owner's, Engineer's, and Manufacturer's Warranty/Test requirements.
3. Contractor must be qualified to provide system certification for the cabling solution provided. At the completion of the installation, Contractor must supply said system certification along with copies of all applications and correspondence pertaining to the system certification.
4. Contractor's company shall have a minimum of 3 years experience installing and testing fiber optic cabling systems. All installers assigned by the Contractor to the installation shall have factory certification that they are qualified to install and test the provided products.
5. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
6. Contractor is responsible for submitting acceptance documentation as defined below.
7. Owner reserves the right to be present during any or all of testing.
8. Testing shall be of the permanent link. A link is defined as the passive cabling network between two cross-connects (patch panels or outlets). This includes cable, connectors and splices but does not include active components. The link test contains the representative connector loss at the patch panel associated with the mating of patch cords but does not include the performance of the connector at the equipment interface.
9. Prior to testing, submit for review and approval copies of test report forms proposed for use.

    a. Each test report form shall contain the following general information: Date of preparation, date of test, project name, Contractor's name, media type, make, model, software revision, and serial number of test equipment used, date of last calibration and names of test crew.
    b. Paired and Multi-Conductor Metallic Cable Test Reports: As a minimum, also provide cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.
    c. 25-Pair, Category 5e, UTP Cables: Provide test reports created by automated cable tester for each tested cable.

10. All cabling not tested strictly in accordance with these procedures shall be retested at no additional cost to the Owner.
11. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation.
12. Either the test equipment shall be fully charged prior to each day's testing or a fresh set of batteries shall be brought to the job site.
13. Remove all defective cables from the cable pathways. Do not abandon cables in place.
14. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.
15. The Engineer further reserves the right to conduct, using the Contractor's equipment and labor, a random retest of up to five (5) percent of the cable plant to confirm documented test results.
16. All test results and corrective procedures are to be documented and submitted to the Engineer within ten (10) working days of test completion.
17. In addition to the specified test, be prepared to be present while the Owner or Owner's designated representatives install and conduct performance tests of the transport electronics connected to the cabling system. Be prepared to conduct on-the-spot cable tests and effect cable plant repairs, as necessary. Successful equipment performance tests do not relieve the Contractor of the specified testing, repair, and documentation requirements.
18. All cables shall be factory tested for continuity before shipment. Submit documentation to the Engineer that the cable has been tested by the manufacturer to industry standards.
19. The Contractor shall provide a thorough testing program for the communications cabling plant, and final acceptance testing. The testing program being proposed shall be submitted to the Engineer for approval before testing begins. Provide all required test equipment. The Owner's representatives may choose to observe any or all testing. Final acceptance testing shall be performed jointly by the Contractor and the Owner's representative. The Contractor shall provide procedures, a list of test equipment and operating instructions before the tests.
20. Subsystems shall be tested individually before testing for end-to-end connectivity. All faults shall be corrected and retested. All test results shall be completely documented.
21. All cable that fails manufacturer's or specified testing criteria shall be replaced at no additional expense to Owner.
22. Owner reserves the right to independently test any or all of the cable plant. If more than 3% of the tested cable plant within a floor, system or area fails, the Contractor will be required to take the following actions at no additional cost to Owner:

    a. Reimburse Owner for all costs incurred for independent testing.
    b. Work overtime to remedy defects and retest entire floor, system or area as defined by Owner. This corrective work shall not impact the planned occupancy dates.
    c. Reimburse Owner for supervision representation by their duly appointed representative during action taken in b. above.
    d. Contractor shall provide all test results to Owner at periods of 20% of scheduled test completion time.

B. Test Equipment

1. General

    a. Test equipment used under this Contract shall be from manufacturers that have a minimum of five (5) years experience in producing field test equipment. Manufacturers must be ISO 9001 certified.
    b. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output.
    c. Test equipment shall store at least 100 tests in internal memory.
    d. Test equipment shall employ a serial port to facilitate uploading of saved information from tester to PC.

e. Test equipment shall be capable of nulling out the loss and length of the test jumpers used to interface with the cable plant.

2. Fiber Cable Testing Equipment

a. Corning Tester

1) Fiber Continuity Test: The Contractor shall utilize the Corning UniCam continuity test system during the termination of all fiber connectors. The Contractor shall be responsible for obtaining all equipment that is necessary to perform the continuity test, including, but not limited to, the following:

a) Enhanced UniCam installation tool.
b) LC UniCam tool coupler.
c) Fault finder test box assembly.
d) UniCam length gauge.

2) LC/Dual Fiber Field Test: The Contractor shall be responsible for performing a dual-fiber test. This test will return results of the actual loss that will be realized during day-to-day transmissions over the fiber. The Contractor shall be responsible for obtaining the proper training on this procedure from Corning, as well as obtaining all the testers and adapters that are required.

b. Test equipment shall be capable of measuring relative or absolute optical power in accordance with ANSI/TIA/EIA-526-14A, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant", and ANSI/TIA/EIA-526-7 Method A, "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Insertion Loss Using An Optical Power Meter".
c. Test equipment shall incorporate 850 nm and 1300 nm LED sources in same unit with output power of ≥ -20 dBm at each wavelength. Detectors shall have a dynamic range of at least +3 dB to –55 dB.
d. Sources and meters shall automatically synchronize wavelengths to prevent calibration-related errors.
e. The time-of-flight methodology shall be employed when measuring the fiber length optically.
f. Type of fiber test equipment must be approved by the Engineer prior to use on the job.

C. Fiber-optic Tests

1. After installation of connectors, visually inspect each fiber end-face at 10X magnification. Refinish any fibers showing visible defects and/or striations in the core area.
2. Unless otherwise specified, 50 micron enhanced multimode fiber cabling must meet the performance specifications of ANSI/TIA/EIA-568-C. Attenuation and length shall be tested.
3. All optical fibers shall be individually tested with connectors attached. Each cable span shall be tested individually. Tests shall be conducted selectively after cross-connection of the cable spans.
4. An optical loss set (OLS) which combines the optical power meter (OPM) and optical source with adjustable output power level shall be used. The OLS/OPM shall display measured transmission loss directly in dB by comparing the optical power received after transmission through the fiber path to its own optical source power. Once this difference is adjusted to "zero" for a cable under test, all fibers in the cable are then measured relative to the "zeroed" source power and displayed in dB.
5. Link attenuation shall be tested in accordance with ANSI/TIA/EIA-526-14A. Reference measurements shall be made in accordance with Reference Method A, Two Jumper

Reference. Optical loss shall be measured on each fiber at both 850 nm and 1300 nm. Loss shall be measured on each fiber in both directions.

6. Strands whose measured attenuation fall outside the acceptable range by power meter testing shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, an OTDR shall be used to determine a loss factor for each connector pair, the exact length of the fiber and to identify the presence of any core damage.
7. Faults related to connectorization shall be corrected, and the fiber retested as stated above, until acceptable attenuation measurements are received.
8. Where defects cannot be corrected, replace any cable having fewer that the manufacturer's guaranteed number of serviceable fibers.
9. Link length shall be optically measured and shall not be calculated using cable sheath length markings.
10. Cabling shall meet the ANSI/TIA/EIA-568-A loss and length criteria for all links. It includes the cross-connect connectors and splices (if any). Calculate the total expected link loss based on the number of mated connector pairs, the connector's published loss per mated pair and the cable's published loss based on distance. Demonstrate that measured link loss does not exceed the calculated link loss by more than 5%.

    Link Criteria:

Attenuation @ 850 nm ≤	fiber length (km) x 3.5 dB/km + number of connector pairs x 0.75 dB + number of splices x 0.3 dB
Attenuation @ 1300 nm ≤	fiber length (km) x 1.5 dB/km + number of connector pairs x 0.75 dB + number of splices x 0.3 dB
Length:	≤ 2000 m. (6560 ft.)

D. Testing of Installed Single-Mode Fiber Cable

1. Link attenuation shall be tested in accordance with ANSI/TIA/EIA-526-7 Method A. Reference measurements shall be made in accordance with Method A.1 or equivalent. Optical loss shall be measured on each fiber at 1310 nm. Loss shall be measured on each fiber from each direction (bi-directionally).
2. Link length shall be optically measured and shall not be calculated using cable sheath length markings.
3. Cabling shall meet the following loss and length criteria. It includes the cross-connect connectors and splices (if any).

    Link Criteria:

Length	< = 90 m	91-1000 m	1001-2000 m	2001-5000 m
(295 ft)	(3281 ft)	(6562 ft)	(16404 ft)	
Attenuation 1310 nm	< = 2.0 dB	< = 3.0 dB	< = 3.3 dB	< = 4.7 dB

4. Contractor must warrant in writing that 100% of the installation meets the requirements specified above.
5. Random retesting, if performed, shall be at the expense of the Owner, using standard labor rates. Any failing cabling shall be retested and restored to a passing condition.

E. Unshielded Twisted Pair Tests (UTP) Test Report shall include:

1. For all unshielded twisted pair connections, tests shall include, but not necessarily be limited to, tests for: Polarity reversals, wire transpositions, resistance, continuity, AC and DC voltages, opens, shorts, power and ground faults, and proper station operating conditions.

2. For Category 5E Cabling: Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz. to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
3. Fiber test reports shall include the following information for each cabling element tested:

    a. Actual measured attenuation (loss) at 850 nm and 1300 nm, expected attenuation at 850 nm and 1300 nm per Part 2 Section 3, and the margin. An individual test that fails the link attenuation criteria shall be marked as FAIL.
    b. Reference method.
    c. Number of mated connectors and number of splices (if any).
    d. Actual length and expected length. Any individual test that fails the link length criteria shall be marked as FAIL.
    e. Group refractive index (GRI) at 850 nm and 1300 nm.
    f. Tester manufacturer, model, serial number and software version.
    g. Circuit ID number and project/job name.
    h. Auto-test specification used.
    i. Overall pass/fail indication.
    j. Date and time of test.
    k. As a minimum, also provide cable number, fiber count, individual fiber numbers, connector types, number of connectors/patches; calculated maximum link loss, length of run, measured link loss for each fiber.

4. Test reports shall be submitted at 20% intervals of testing schedule, within seven (7) business days of completion of testing.

F. Documentation

1. Upon completion of all tests, six (6) copies of the test results shall be submitted for review. Prior to cutover, the Contractor shall perform a random sampling test, jointly with the Owner or Owner's representative, of one in six optical fibers selected by the representative, to verify conformance to the Specifications.
2. Test reports shall be submitted in electronic format. Hand-written or hard copy test reports are not acceptable.
3. Electronic reports are to be submitted on 3.5 inch diskettes or CD format. If proprietary software is used, disk or CD shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., then software to read these files is not provided. Electronic reports must be accompanied by a certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
4. Test reports shall be submitted at 20% intervals of testing schedule, within seven (7) business days of completion of testing.

G. Acceptance: Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with the Contract Documents, the Owner shall notify the Contractor in writing of the formal acceptance of the system.

3.3 “AS-BUILTS”

A. Provide “as-built” drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction.

END OF SECTION 27 1300

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SECTION 27 1500 - TELECOMMUNICATIONS UTP CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all UTP cable as specified herein and as required for proper distribution of all wire, cable, and electrical conductors throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0400 - Communications Ladder Rack.
3. Section 27 0500 - Common Work Results for Communications.
4. Section 27 0506 - Grounding and Bonding for Communications Systems.
5. Section 27 1000 - Communications Conduit.
6. Section 27 1100 - Communications Equipment Room Fittings.
7. Section 27 1300 - Communications Backbone Cabling.
8. Section 27 1600 - Communications Connector Cords, Devices and Adapters.

1.4 REFERENCE STANDARDS

A. All conduit and all components shall be designed, manufactured, and tested in accordance with the latest applicable industry standards and codes including the following:

1. ANSI/TIA/EIA - 568 C "Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements".
2. ANSI/TIA/EIA - 568B.3 "Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard".
3. ANSI/TIA/EIA - 569 "Commercial Building Standard for Telecommunications Pathways and Spaces".
4. ANSI/TIA/EIA - 606-A "Administration Standards for the Telecommunications Pathways and Spaces".
5. ANSI/TIA/EIA - 607 "Commercial Buildings Grounding and Bonding Requirements for Telecommunications".

6. ANSI/NFPA-70 - “National Electrical Code”.
7. ANSI/NFPA-780 - “Lightning Protection Code”.
8. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards - A Background Report.”
9. BICSI “Telecommunications Distribution Methods Manual”.
10. IEEE Std 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
11. ANSI R211.
12. BOCA National Building Code, 1996; Seismic exposure Group II - Performance Category “C”.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to Substantial Completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB’s), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC’s), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a “Materials Safety Data Sheet”, as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to Division 27 and shall include but not be limited to:

1. Category 6A 4-Pair UTP cable.
2. Category 5E 25-Pair UTP cable.

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and Division 27.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyl’s (PCB) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. If it complies with these Specifications, UTP cable manufactured by the following manufacturer shall be acceptable:

1. ~~Bertek~~***Superior Essex***/Ortronics.
2. ***Belden/Belden***
3. ***Sytimax/Sytimax***

2.3 CATEGORY 6A – 4 PAIR CABLE

A. General

1. Category 6A – 4 Pair Cable, known as Augmented Category 6 cabling, shall be furnished and installed as shown on plan and in accordance with the most current requirements of the applicable ANSI/TIA/EIA Standards.
2. Cabling shall be plenum rated and installed in a manner consistent with the requirements of the National Electrical Code (NEC).
3. All Cat 6Acabling shall be installed such that the permanent link length does not exceed 90 meters.
4. Cat 6A cabling shall be colored coded as shown on plan and as approved by the IT Engineer. Where colors are not specified, the Contractor shall include a multitude of colors and shall submit a request for coloration from the Engineer as part of the shop drawing process.

2.4 CATEGORY 5E – 25-PAIR CABLE

A. General

1. Category 5E – 25 Pair Cable shall be furnished and installed as shown on plan and in accordance with the most current requirements of the applicable ANSI/TIA/EIA Standards.
2. Cabling shall be rated and installed in a manner consistent with the requirements of the National Electrical Code (NEC).
3. All Cat 6A cabling shall be installed such that the permanent link length does not exceed 90 meters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Cable Installation

1. The wiring system shall be used for interconnecting telephones, LAN/WAN equipment (i.e. switches, routers, computers, etc.), televisions, fax machines, and any other equipment compatible with the wiring system herein described. The wiring system, including both copper and fiber optic applications, shall be configured as documented on the Contract/Bid Documents.
2. Furnish and install the telecommunications cables/wires in accordance with the drawings and instructions provided by the Engineer and manufacturer’s recommendations.
3. All cables shall be installed in an electrically or optically continuous fashion between the designated origin and destination points. That is, all cables must be “homerun” with no unspecified splices, couplers, or intermediate connection points along the specified channel.
4. All cables shall be securely held in place by an industry-acceptable practice, which also meets applicable Codes.
5. Each reel of cable shall be provided with a manufacturer's report certifying performance.

B. Horizontal Cable Distribution

1. Follow room boundaries when pulling cables through ceilings and floors for distribution into walls, conduits, wiring channels, outlets, etc.
2. All cable distribution from the Telecom Rooms to all work locations (except as noted) shall be via the overhead cable trays. Utilize ceiling-mounted supports (“J” hooks) when cables exit the trays and for main cable runs when cable tray is not included on the Contract Drawings.
3. Cable shall be loose bundled into the cable trays. No cable ties or wrapping shall be used to secure the cables in the cable trays outside of the Telecom Rooms.
4. All other outlet configurations shall be provisioned in accordance with the plans.

C. EMI/RFI Avoidance

1. To avoid electromagnetic interference (EMI), cables shall be routed in such a way as to maintain the following minimum distance from possible sources of EMI:

    a. Forty-eight (48) inches from large motors or transformers.
    b. Twelve (12) inches from fluorescent or any other lighting type that requires a transformer or ballast.
    c. Three (3) inches from fluorescent fixtures with remotely installed ballasts.
    d. Wherever possible, pathways shall cross perpendicular (at a 90 degree angle) to electrical power cables and conduit. When this is not possible and telecommunications cables must take a path parallel to electrical cables or conduit, the telecommunications cables shall maintain a distance of no less than twelve (12) inches from the electrical cabling and conduit.

D. Cable Pulling

1. To limit the incidence of micro-bending of the individual fiber strands, mesh-type, swivel-eye fiber optic pulling grips shall be employed for all fiber optic cable pulling. This type of pulling grip is recommended for all other building cable as required.

    a. Pulling tension shall be monitored with a dynamometer (tension gauge) to ensure that manufacturer’s recommended tensile ratings are not exceeded.
    b. Follow manufacturers’ instructions for installing, connecting, and adjusting all equipment and telecommunications cabling. Where no instructions are included or available, follow industry standards.
    c. Sheaves and cable guides shall be used to maintain recommended cable bend radii when pulling. At no times shall the cable be bent to less than ten (10) times its outside diameter.
    d. The maximum length of horizontal UTP cable from any work station to the termination point must not exceed 90 meters (295 feet).
    e. Completely install each horizontal station cable as an uninterrupted segment from the appropriate Equipment Room to the designated outlet location as indicated on the drawings. There shall be no unspecified splices or mechanical couplers installed between the cable points of origin and termination.

E. Cable Dressing and Terminating

1. Cables shall be securely held in place by an industry-acceptable practice, and installed with sufficient bending radius so as not to kink, shear, or damage the cables (10 times the respective cable's outside diameter).
2. Provide a "mockup" of all cable terminations, labeling and dressing for each workstation, patch panel, and every other type of terminating device for Owner’s review prior to commencing work.
3. All cables shall be dressed in a neat manner, observing cable and bend radius limit at each workstation, equipment rack, within furniture systems, and below raised floors.

4. Cables installed under a raised floor shall be routed in a coordinated manner with the power conduit and cabling in a neat “Streets and Avenues” methodology, maintaining all applicable bending radii. No unnecessary slack under the floor shall be accepted, except where there is to be slack maintained at the end on a homerun (adjacent to the outlet).
5. Work deemed by the Consulting Engineer not to conform to the cable dressing and termination methods described within the Contract Documents shall be redressed or removed and replaced as required at the direction of the Consulting Engineer at no additional cost to the Owner. Failure to properly dress and terminate cable as reflected in the documents shall result in the forfeiture of all or a portion of the Contract.
6. Location and placement of the required terminating and distribution hardware shall be as shown on the drawings.
7. After dressing UTP cable to its final location, its outer sheath shall be removed to a point that allows the conductor to be splayed and terminated in a neat and uniform fashion. Every effort shall be made to maintain sheath integrity by removing only as much as is practical to accomplish termination.
8. The Contractor shall be responsible for the provision of all frames, blocks, terminations, supports, frame anchors, and mounting hardware necessary to fully install a complete telecommunications cabling system.

F. Cable Identification

1. Labels for the individual cables shall be furnished by the Owner and installed by the IT Contractor. Temporary labels required for installation purposes shall be the responsibility of the IT Contractor.
2. Color coding shall be in accordance with the ANSI/TIA/EIA-606-A standards.
3. All cabling shall be labeled with machine-generated black uppercase lettering on a permanent adhesive label stock, covered with a permanent water-resistant sealer.
4. Labels shall be placed on both ends of every cable at least 4 inches from the point at which the cable jacket is opened to expose individual copper pairs or fiber strands, or from the connector or terminal block.
5. All labels shall be visually and physically accessible at work locations, and when cables are mounted to frames, blocks, racks, etc., where the proper mounting procedure allows ready access to individual cables. When cables are mounted to punch-down wiring blocks with integrated labeling capacity, the wiring labels shall be affixed on cables as above, and the blocks shall be labeled using machine-generated black uppercase lettering on a permanent adhesive stock, duplicating the information on the cable identification label.
6. Provide all cable tags. Label each tag with the appropriate cable number as shown on the drawings, and as indicated on the cable schedules provided by the Engineer.
7. Cable identification numbers shown on the plans are presented in an abbreviated format. All cable ID’s shall (at minimum) indicate their floor, originating closet ID, and cable ID at the direction of the Owner or Engineer.
8. After pulling and terminating cables, place the appropriate cable tag as noted above. Temporary tags are acceptable for use during construction. All temporary tags must be removed and replaced with permanent machine-generated tags prior to acceptance.
9. If at any time during the job, the permanent cable tag becomes illegible or is defaced or removed, immediately replace it with a duplicate preprinted cable tag.
10. Labeling for patch panels, faceplates and jacks shall be installed as shown on drawings detail.
11. Provide a nameplate on each patch panel, cross-connect field, equipment rack, cabinet, etc. Unless otherwise noted, use a permanent adhesive label stock, covered with a permanent water-resistant sealer.

3.2 TESTING

A. General

1. Contractor shall provide sufficient skilled labor to complete testing within the agreed-upon test period.

2. Contractor must fulfill all Owner's, Engineer's and Manufacturer's warranty/test requirements.
3. Contractor must be qualified to provide system certification for the cabling solution provided. At the completion of the installation, Contractor must supply said system certification along with copies of all applications and correspondence pertaining to the system certification.
4. Contractor's company shall have a minimum of three (3) years experience installing and testing fiber optic cabling systems. All installers assigned by the Contractor to the installation shall have factory certification that they are qualified to install and test the provided products.
5. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
6. Contractor is responsible for submitting acceptance documentation as defined below.
7. Owner reserves the right to be present during any or all of testing.
8. Testing shall be of the permanent link. A link is defined as the passive cabling network between two cross-connects (patch panels or outlets). This includes cable, connectors and splices but does not include active components. The link test contains the representative connector loss at the patch panel associated with the mating of patch cords but does not include the performance of the connector at the equipment interface.
9. Prior to testing, submit for review and approval copies of test report forms proposed for use.

    a. Each test report form shall contain the following general information: Date of preparation, date of test, project name, Contractor's name, media type, make, model, software revision, and serial number of test equipment used, date of last calibration and names of test crew.
    b. Paired and Multi-Conductor Metallic Cable Test Reports: As a minimum, also provide cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.
    c. 4-Pair, Category 6A, UTP Cables: Provide test reports created by automated cable tester for each tested cable.
    d. 25 pair, Category 5E, UTP Cables: Provide test reports created by automated cable tester for each tested cable.

10. 4-Pair UTP Cables: Provide test reports created by automated cable tester for each tested cable.
11. All cabling not tested strictly in accordance with these procedures shall be retested at no additional cost to the Owner.
12. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation as described below.
13. Either the test equipment shall be fully charged prior to each day's testing or a fresh set of batteries shall be brought to the job site.
14. Remove all defective cables from the cable pathways. Do not abandon cables in place.
15. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.
16. The Engineer further reserves the right to conduct, using the Contractor's equipment and labor, a random retest of up to five (5) percent of the cable plant to confirm documented test results.
17. All test results and corrective procedures are to be documented and submitted to the Engineer within ten (10) working days of test completion.
18. In addition to the specified test, be prepared to be present while the Owner or Owner's designated representatives install and conduct performance tests of the transport electronics connected to the cabling system. Be prepared to conduct on-the-spot cable tests and effect cable plant repairs, as necessary. Successful equipment performance tests do not relieve the Contractor of the specified testing, repair, and documentation requirements.
19. All cables shall be factory tested for continuity before shipment. Submit documentation to the Engineer that the cable has been tested by the manufacturer to industry standards.
20. The Contractor shall provide a thorough testing program for the communications cabling plant, and final acceptance testing. The testing program being proposed shall be submitted to the Engineer for approval before testing begins. Provide all required test equipment. The Owner's representatives may choose to observe any or all testing. Final acceptance testing

shall be performed jointly by the Contractor and the Owner's representative. The Contractor shall provide procedures, a list of test equipment and operating instructions before the tests.

21. Subsystems shall be tested individually before testing for end-to-end connectivity. All faults shall be corrected and retested. All test results shall be completely documented.
22. All cable that fails manufacturer's or specified testing criteria shall be replaced at no additional expense to Owner.
23. Owner reserves the right to independently test any or all of the cable plant. If more than 3% of the tested cable plant within a floor, system or area fails, the Contractor shall be required to take the following actions at no additional cost to Owner:

    a. Reimburse Owner for all costs incurred for independent testing.
    b. Work overtime to remedy defects and retest entire floor, system or area as defined by Owner. This corrective work shall not impact the planned occupancy dates.
    c. Reimburse Owner for supervision representation by their duly appointed representative during action taken in b. above.
    d. Contractor shall provide all test results to Owner at periods of 20% of scheduled test completion time.

B. Test Equipment

1. Test equipment used under this Contract shall be from manufacturers that have a minimum of five (5) years experience in producing field test equipment. Manufacturers must be ISO 9001 certified.
2. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output.
3. Test equipment shall store at least 100 tests in internal memory.
4. Test equipment shall employ a serial port to facilitate uploading of saved information from tester to PC.
5. Test equipment shall be capable of nulling out the loss and length of the test jumpers used to interface with the cable plant.
6. 4-pair UTP automated cable tester shall:

    a. Be compliant with TIA/ISO/IEC standards.
    b. Provide bi-directional testing to the latest standards for both basic links and channels.
    c. Provide certification for Cat5E/6A links to 500 MHz with Level 3 accuracy.
    d. Microtest OMNIScanner 2, Fluke DSP-4000 Series or equivalent.

C. Unshielded Twisted Pair Tests (UTP) Test Report shall include:

1. For all unshielded twisted pair connections, tests shall include, but not necessarily be limited to, tests for: Polarity reversals, wire transpositions, resistance, continuity, AC and DC voltages, opens, shorts, power and ground faults, and proper station operating conditions.
2. For Category 5E Cabling: Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
3. Category 6A Cable Unshielded Twisted Pair Tests (UTP): Each cable shall be capable of carrying a bit rate signaling of 10 Gbps as outlined by the most current (at the time of the installation) revision of the ANSI/TIA/EIA Category 6A standard. Signal amplifiers shall not be required for channel lengths of up to 100 meters (including patch cords). Each individual cable shall be tested and certified to meet or exceed the following minimum performance criteria as outlined by the ANSI/TIA/EIA standards.

D. Documentation

1. Upon completion of all tests, six (6) copies of the test results shall be submitted for review. Prior to cutover, the Contractor shall perform a random sampling test, jointly with the Owner or Owner's representative, of one in six optical fibers selected by the representative, to verify conformance to the Specifications.
2. Test reports shall be submitted in electronic format. Hand-written or hard copy test reports are not acceptable.
3. Electronic reports shall be submitted on 3.5 inch diskettes or CD format. If proprietary software is used, disk or CD shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., then software to read these files is not provided. Electronic reports must be accompanied by a certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
4. Test reports shall be submitted at 20% intervals of testing schedule, within seven (7) business days of completion of testing.

E. Acceptance: Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with the Contract Documents, the Owner shall notify the Contractor in writing of the formal acceptance of the system.

3.3 "AS-BUILTS"

A. Provide "as-built" drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction.

END OF SECTION 27 1500

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SECTION 27 1600 - COMMUNICATIONS CONNECTOR CORDS, DEVICES AND ADAPTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all fiber, coaxial and UTP patch cords, connectors, and mounting devices as specified herein and as required for proper distribution of all wire, cable, and electrical conductors throughout the Project as indicated on the Drawings, and in accordance with the Contract Documents.

B. Related LEED Sections

1. Section 01 7419 - Construction Waste Management.
2. Section 01 8113 - Sustainable Design Requirements.
3. Section 01 8114 - Indoor Air Quality Requirements.
4. Section 01 8115 - Indoor Finish Requirements.

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving the LEED Certification specified in Section Sustainable Design Requirements. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the stated LEED requirements.

1.3 RELATED DOCUMENTS

A. The following specification sections apply to all Work herein:

1. Section 27 0300 - Communications Fiber Optic Cabling.
2. Section 27 0400 - Communications Ladder Rack.
3. Section 27 0500 - Common Work Results for Communications.
4. Section 27 0506 - Grounding and Bonding for Communications Systems.
5. Section 27 1000 - Communications Conduit.
6. Section 27 1100 - Communications Equipment Room Fittings.
7. Section 27 1300 - Communications Backbone Cabling.
8. Section 27 1500 - Telecommunications UTP Cabling.

1.4 REFERENCE STANDARDS

A. All conduit and all components shall be designed, manufactured, and tested in accordance with the latest applicable industry standards and codes including the following:

1. ANSI/TIA/EIA - 568 C "Commercial Building Telecommunications Cabling Standard - Part 1 General Requirements".
2. ANSI/TIA/EIA - 568B.3 "Commercial Building Telecommunication Cabling Standard - Part 3 Optical Fiber Cabling Components Standard".
3. ANSI/TIA/EIA - 569 "Commercial Building Standard for Telecommunications Pathways and Spaces".
4. ANSI/TIA/EIA - 606-A "Administration Standards for the Telecommunications Pathways and Spaces".

5. ANSI/TIA/EIA - 607 “Commercial Buildings Grounding and Bonding Requirements for Telecommunications”.
6. ANSI/NFPA-70 - “National Electrical Code”.
7. ANSI/NFPA-780 - “Lightning Protection Code”.
8. NCS-TIB 93-12 - “Grounding and Bonding for Commercial and Governmental Buildings Conforming to Telecommunications Infrastructure Standards - A Background Report.”
9. BICSI “Telecommunications Distribution Methods Manual”.
10. IEEE Std. 1100-1992 “Powering and Grounding Sensitive Electronic Equipment”.
11. ANSI R211.
12. BOCA National Building Code, 1996; Seismic exposure Group II - Performance Category “C”.
13. NEMA PB-VE-1 - Cable Tray.

1.5 QUALITY ASSURANCE

A. After completion of installation, but prior to Substantial Completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB’s), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC’s), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a “Materials Safety Data Sheet”, as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.

C. All adhesives specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed the VOC limits of South Coast Air Quality Management District Rule No. 1168. All sealants specified herein or utilized in the manufacture of equipment or components which are specified herein shall meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. Submit as part of the shop drawing process for review by the Engineer and/or Owner, supporting documentation which demonstrates conformance with these requirements.

D. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.

1.6 SUBMITTALS

A. The following submittal data shall be furnished according to Division 27 and shall include but not be limited to:

1. Ladder Rack, including samples, complete with fittings, materials, connector details, etc.

1.7 WARRANTY

A. Comply with the requirements of the Contract Documents and Division 27.

PART 2 - PRODUCTS

2.1 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyl’s (PCB) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. Being listed herein as an approved manufacturer does not permit the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements of the Contract Documents.

B. All substitutions must be included in the Contractor's Base Bid, and must be accompanied by a letter of equivalency certifying the products equivalency in all performance and physical characteristics to the products listed herein. The proposed substitutions shall be all inclusive of all cost and physical implications throughout the project. Under no circumstances should the substitution result in added cost to the project. Project specifications/documents will not be revised to reflect the substitution should the substitution be approved.

C. If it complies with these Specifications, copper patch cords, coaxial patch cords manufactured by the following manufacturer will be acceptable:

1. ~~Berk-tek~~***Superior Essex***/Ortronics.
2. ***Belden/Belden***
3. ***Systimax/Systimax***

D. If it complies with these Specifications, fiber patch cords manufactured by one of the following manufacturers will be acceptable:

1. Corning.
2. Systimax.

2.3 ENHANCED CATEGORY 6 STRANDED PATCH CORD

A. Category 6A rated.

B. 22-24 AWG, 4-pair stranded cable construction.

C. 8-position modular plugs.

D. Category 6A patch cords shall be cut to length in field as directed by the Owner.

E. Cable Management System Patching Schedules to be provided by the contractor and submitted to the Engineer for approval prior to installation.

F. Provide factory terminated and tested Category 6e patch cords in quantities as indicated on the drawings and in lengths as required.

2.4 OPTICAL FIBER PATCH CORD

A. LC connector to LC connector, as required.

B. LC connector to SC connector, as required.

C. LC connector to MTRJ connector, as required.

D. Laser Optimized, 50 micron, MultiMode, as required. Patch cords must meet the same performance specifications as outlined in Section 27 1300 for 50 micron, laser-optimized optical fiber cable.

E. Single mode, as required. Patch cords must meet the same performance specifications as outlined in Section 27 1300 for single-mode, laser-optimized optical fiber cable.

F. Provide factory terminated and tested LC connector-type patch cords in quantities as indicated on the drawings and in lengths as required.

2.5 BROADCAST COAXIAL 75 OHM

A. RG 6/U Quad Shield Cable

1. Cabling shall be rated, and installed in a manner consistent with the requirements of the National Electrical Code (NEC).
2. 18 AWG solid bare copper.
3. Polyethylene dielectric.
4. Dual Foil shield 100% coverage.
5. Double Aluminum braid 40% coverage. Used for video display and broadcast applications.
6. Frequency swept to 2.2 GHz.
7. Temperature Rating: -20°C to +60°C NEC Article 800, UL Subject 444, Type CATV.
8. F-Connector on both ends of the cable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Cable Installation

1. The wiring system shall be used for interconnecting telephones, LAN/WAN equipment (i.e. switches, routers, computers, etc.), televisions, fax machines, and any other equipment compatible with the wiring system herein described. The wiring system, including both copper and fiber optic applications, shall be configured as documented on the Contract/Bid Documents.
2. Furnish and install the telecommunications cables/wires in accordance with the drawings and instructions provided by the Engineer and manufacturer's recommendations.
3. All cables shall be installed in an electrically or optically continuous fashion between the designated origin and destination points. That is, all cables must be "homerun" with no unspecified splices, couplers, or intermediate connection points along the specified channel.
4. All cables shall be securely held in place by an industry-acceptable practice, which also meets applicable Codes.
5. Each reel of cable shall be provided with a manufacturer's report certifying performance.

B. EMI/RFI Avoidance

1. To avoid electromagnetic interference (EMI), cables shall be routed in such a way as to maintain the following minimum distance from possible sources of EMI:

a. Forty-eight (48) inches from large motors or transformers.
b. Twelve (12) inches from fluorescent or any other lighting type that requires a transformer or ballast.
c. Three (3) inches from fluorescent fixtures with remotely installed ballasts.
d. Wherever possible, pathways shall cross perpendicular (at a 90 degree angle) to electrical power cables and conduit. When this is not possible and telecommunications cables must take a path parallel to electrical cables or conduit, the telecommunications cables shall maintain a distance of no less than twelve (12) inches from the electrical cabling and conduit.

C. Cable Pulling

1. To limit the incidence of micro-bending of the individual fiber strands, mesh-type, swivel-eye fiber optic pulling grips shall be employed for all fiber optic cable pulling. This type of pulling grip is recommended for all other building cable as required.

   a. Pulling tension shall be monitored with a dynamometer (tension gauge) to ensure that manufacturer's recommended tensile ratings are not exceeded.
   b. Follow manufacturers' instructions for installing, connecting, and adjusting all equipment and telecommunications cabling. Where no instructions are included or available, follow industry standards.
   c. Sheaves and cable guides shall be used to maintain recommended cable bend radii when pulling. At no times shall the cable be bent to less than ten (10) times its outside diameter.
   d. The maximum length of horizontal UTP cable from any work station to the termination point must not exceed 90 meters (295 feet).
   e. Completely install each horizontal station cable as an uninterrupted segment from the appropriate IDF Room to the designated outlet location as indicated on the drawings. There shall be no unspecified splices or mechanical couplers installed between the cable points of origin and termination.
   f. ***All conduit shall have three (3) nylon drag cords left in each installed conduit for future pulling.***

D. Cable Dressing and Terminating

1. General

   a. Cables shall be securely held in place by an industry-acceptable practice, and installed with sufficient bending radius so as not to kink, shear, or damage the cables (10 times the respective cable's outside diameter).
   b. Provide a "mockup" of all cable terminations, labeling and dressing for each workstation, patch panel, and every other type of terminating device for Owner's review prior to commencing work.
   c. All cables shall be dressed in a neat manner, observing cable and bend radius limit at each workstation, equipment rack, and within furniture systems.
   d. Work deemed by the Consulting Engineer not to conform to the cable dressing and termination methods described within the Contract Documents shall be redressed or removed and replaced as required at the direction of the Consulting Engineer at no additional cost to the Owner. Failure to properly dress and terminate cable as reflected in the documents shall result in the forfeiture of all or a portion of the Contract.
   e. Location and placement of the required terminating and distribution hardware shall be as shown on the drawings.
   f. After dressing UTP cable to its final location, its outer sheath shall be removed to a point that allows the conductor to be splayed and terminated in a neat and uniform fashion. Every effort shall be made to maintain sheath integrity by removing only as much as is practical to accomplish termination.
   g. The Contractor shall be responsible for the provision of all frames, blocks, terminations, supports, frame anchors, and mounting hardware necessary to fully install a complete telecommunications cabling system.

2. Technology Rooms

   a. All cables shall be dressed in a neat manner at all points throughout the installation.
   b. At every two-foot interval in Technology Rooms, provide removable hook and loop type (Velcro®) cable fasteners for each cable bundle segment that is within the room. Submit cable tie criteria to the Engineer for review prior to pulling cable.

c. Technology Rooms shall be utilized to provide a point of interconnection between the telecommunications risers, telecommunications equipment and horizontal (station outlet) wiring.
d. Patch cords shall be dressed across ladder rack and/or wire guide.

3. Modular Patch Panels

a. Cabling shall be properly installed using sufficient management hardware (jumper troughs, etc.).
b. Cabling shall be installed across the top of the strain-relief bar (parallel to the bar), in neat large-radius sweeps, tie-wrapped and routed into the area between the applicable 110 termination strips located in the rear of the modular patch panel.
c. Desi-strip label shall be installed between the 110 termination strips located in the rear of the modular patch panel.
d. No more outer insulation than is needed to terminate the cable in this position shall be stripped from the cable.
e. Individual pairs shall maintain twist integrity to within 0.5 in. of the termination point.

E. Cable Connector Protection

1. Keep all items protected before and after installation, with dust and moisture proof barrier materials. It shall be the Contractor's responsibility to ensure the integrity of these protective measures throughout the life of the project.
2. All installed connectors shall be protected and insulated by one of the following methods.

a. Any installed connector exposed to construction activities shall be protected with a clear, heat-sealed 3 mil plastic bag sealed shut with waterproof tape after installation. The bag must be removable for testing. Any protective bags removed for testing or other installation activities must be replaced immediately after such activities are completed.
b. Any connector, which is normally shipped with an insulating protective cover over the connector pins, shall be left with the cover in place after the connector has been installed on the cable. The protective cover shall be taped in place if easily dislodged.
c. Any connector fouled or damaged as a result of activities related to the construction process shall be replaced at no cost to Owner.

3.2 TESTING

A. General

1. Contractor shall provide sufficient skilled labor to complete testing within the agreed-upon test period.
2. Contractor must fulfill all Owner's, Engineer's, and Manufacturer's Warranty/Test requirements.
3. Contractor must be qualified to provide system certification for the cabling solution provided. At the completion of the installation, Contractor must supply said system certification along with copies of all applications and correspondence pertaining to the system certification.
4. Contractor's company shall have a minimum of 3 years experience installing and testing fiber optic cabling systems. All installers assigned by the Contractor to the installation shall have factory certification that they are qualified to install and test the provided products.
5. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
6. Contractor is responsible for submitting acceptance documentation as defined below.
7. Owner reserves the right to be present during any or all of testing.
8. Testing shall be of the permanent link. A link is defined as the passive cabling network between two cross-connects (patch panels or outlets). This includes cable, connectors and splices but does not include active components. The link test contains the representative

connector loss at the patch panel associated with the mating of patch cords but does not include the performance of the connector at the equipment interface.

9. Prior to testing, submit for review and approval copies of test report forms proposed for use.

    a. Each test report form shall contain the following general information: Date of preparation, date of test, project name, Contractor's name, media type, make, model, software revision, and serial number of test equipment used, date of last calibration and names of test crew.
    b. Paired and Multi-Conductor Metallic Cable Test Reports: As a minimum, also provide cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.
    c. 4-Pair, Category ~~6e~~***6A***, UTP Cables: Provide test reports created by automated cable tester for each tested cable.

10. All cabling not tested strictly in accordance with these procedures shall be retested at no additional cost to the Owner.
11. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation.
12. Either the test equipment shall be fully charged prior to each day's testing or a fresh set of batteries shall be brought to the job site.
13. Remove all defective cables from the cable pathways. Do not abandon cables in place.
14. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.
15. The Engineer further reserves the right to conduct, using the Contractor's equipment and labor, a random retest of up to five (5) percent of the cable plant to confirm documented test results.
16. All test results and corrective procedures are to be documented and submitted to the Engineer within ten (10) working days of test completion.
17. In addition to the specified test, be prepared to be present while the Owner or Owner's designated representatives install and conduct performance tests of the transport electronics connected to the cabling system. Be prepared to conduct on-the-spot cable tests and effect cable plant repairs, as necessary. Successful equipment performance tests do not relieve the Contractor of the specified testing, repair, and documentation requirements.
18. All cables shall be factory tested for continuity before shipment. Submit documentation to the Engineer that the cable has been tested by the manufacturer to industry standards.
19. The Contractor shall provide a thorough testing program for the communications cabling plant, and final acceptance testing. The testing program being proposed shall be submitted to the Engineer for approval before testing begins. Provide all required test equipment. The Owner's representatives may choose to observe any or all testing. Final acceptance testing shall be performed jointly by the Contractor and the Owner's representative. The Contractor shall provide procedures, a list of test equipment and operating instructions before the tests.
20. Subsystems shall be tested individually before testing for end-to-end connectivity. All faults shall be corrected and retested. All test results shall be completely documented.
21. All cable that fails manufacturer's or specified testing criteria shall be replaced at no additional expense to Owner.
22. Owner reserves the right to independently test any or all of the cable plant. If more than 3% of the tested cable plant within a floor, system or area fails, the Contractor will be required to take the following actions at no additional cost to Owner:

    a. Reimburse Owner for all costs incurred for independent testing.
    b. Work overtime to remedy defects and retest entire floor, system or area as defined by Owner. This corrective work shall not impact the planned occupancy dates.
    c. Reimburse Owner for supervision representation by their duly appointed representative during action taken in b. above.
    d. Contractor shall provide all test results to Owner at periods of 20% of scheduled test completion time.

B. Test Equipment

1. Test equipment used under this Contract shall be from manufacturers that have a minimum of five (5) years experience in producing field test equipment. Manufacturers must be ISO 9001 certified.
2. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output.
3. Test equipment shall store at least 100 tests in internal memory.
4. Test equipment shall employ a serial port to facilitate uploading of saved information from tester to PC.
5. Test equipment shall be capable of nulling out the loss and length of the test jumpers used to interface with the cable plant.
6. 4-Pair UTP Automated Cable Tester shall:

    a. Be compliant with TIA/ISO/IEC standards.
    b. Provide bi-directional testing to the latest standards for both basic links and channels.
    c. Provide certification for Cat5E/6A links to ~~300~~ ***500*** MHz. with Level 3 accuracy.
    d. Microtest OMNIScanner 2, Fluke DSP-4000 Series or equivalent.

C. Unshielded Twisted Pair Tests (UTP) Test Report shall include:

1. For all unshielded twisted pair connections, tests shall include, but not necessarily be limited to, tests for: Polarity reversals, wire transpositions, resistance, continuity, AC and DC voltages, opens, shorts, power and ground faults, and proper station operating conditions.
2. Category 6A Cable Unshielded Twisted Pair Tests (UTP): Each cable shall be capable of carrying a bit rate signaling of 10 Gbps as outlined by the most current (at the time of the installation) revision of the ANSI/TIA/EIA Category 6A standard. Signal amplifiers shall not be required for channel lengths of up to 100 meters (including patch cords). Each individual cable shall be tested and certified to meet or exceed the following minimum performance criteria as outlined by the ANSI/TIA/EIA standards.

D. Documentation

1. Upon completion of all tests, six (6) copies of the test results shall be submitted for review. Prior to cutover, the Contractor shall perform a random sampling test, jointly with the Owner or Owner's representative, of one in six optical fibers selected by the representative, to verify conformance to the Specifications.
2. Test reports shall be submitted in electronic format. Hand-written or hard copy test reports are not acceptable.
3. Electronic reports are to be submitted on 3.5 inch diskettes or CD format. If proprietary software is used, disk or CD shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., then software to read these files is not provided. Electronic reports must be accompanied by a certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate must reference traceable circuit numbers that match the electronic record.
4. Test reports shall be submitted at 20% intervals of testing schedule, within seven (7) business days of completion of testing.

E. Acceptance: Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with the Contract Documents, the Owner shall notify the Contractor in writing of the formal acceptance of the system.

3.3 “AS-BUILTS”

A. Provide “as-built” drawings at the completion of the work to document the location of all buried conduit, boxes, cable, etc. Drawings shall clearly identify locations, quantities, sizes, etc., for coordination with future construction

1. ***“As-builts” shall be submitted within thirty (30) business days of job completion.***

END OF SECTION 27 1600

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SECTION 27 2627 – WIRING DEVICES

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.

1.2 SUMMARY

A. Work Included: The Work of this Section includes, but is not limited to the following:

1. Concrete Floor Boxes Type 1
2. Concrete Poke Through Devices Type 1
3. Flat Panel Wall Box Type 1
4. Flat Panel Wall Box Type 2

1.3 SYSTEM DESCRIPTION

A. Boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Boxes are shown in approximate locations unless dimensioned.

1.4 SUBMITTALS

A. Refer to the General Conditions section for project specific submittal procedures.

B. Product Data: Manufacturer’s data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation instructions.

C. Verification Samples: Two samples of each device illustrating size, material, configuration and finish for each product specified.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.7 COORDINATION

A. Coordinate Work with other operations and installation of finish materials to avoid damage to adjacent materials.

B. Coordinate installation of outlet boxes for equipment connected as per the junction box, conduit and power receptacle specification section.

PART 1 - PRODUCTS

1.8 MANUFACTURERS

A. Acceptable Manufacturer: FSR Inc., which is located at: 244 Bergen Blvd. ; West Paterson, NJ 07424; Toll Free Tel: 800-332-3771; Tel: 973-785-4347; Email: request info (sales@fsrinc.com); Web: www.fsrinc.com

B. Acceptable Manufacturer: Legrand Wiremold., which is located at: 60 Woodlawn St.; West Hartford, CT 06110; Toll Free Tel: 800-621-0049;

C. Acceptable Manufacturer: Chief Mfg., which is located at: 6436 City West Parkway.; Eden Prairie, MN 55344; Toll Free Tel: 800-582-6480; Tel: 952-894-6280; Email: request info (chief@chiefmfg.com); Web: www.chiefmfg.com

D. Requests for substitutions will be considered in accordance with the General Conditions.

1.9 CONCRETE FLOOR BOXES

A. Concrete Floor Boxes General: Comply with NEMA OS 1 and are both UL and CUL listed. For power, audio, video, telecommunications and data.

1. Concrete Floorbox Model Type 1 FSR Inc. FL-500P-3

1.10 CONCRETE POKE THROUGH DEVICES

1. Concrete Poke Through Device Type 1 Wiremold 8AT**

A. "**" Refers to finish style. Refer to architect for cover plate finish type: Gray (GY), Black (BK), Nickel (NK), Bronze (BZ), or Brass (BS).

1.11 FLAT PANEL WALL BOXES

1. Flat Panel Wall Box Type 1 FSR Inc. PWB-100
2. Flat Panel Wall Box Type 2 Chief Mfg. PAC 522

PART 1 - EXECUTION

1.12 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify locations of floor boxes and outlets in prior to rough-in.

C. Verify openings in access floor are in proper locations.

D. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

1.13 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

1.14 INSTALLATION

A. Set floor boxes level.

1.15 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

1.16 ADJUSTING

A. Adjust floor box flush with finish flooring material.

1.17 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION 272627