

- i) Other apparatus required for a complete and functional system.
- 3) Products requiring samples shall include but not limited to the following:
- a) All cabling and wire.
 - b) Patch Cables.
 - c) All connectors and required tools.
 - d) All termination system components for each cable type.
 - e) All equipment room and telecommunications room horizontal cable management.
 - f) All grounding system components.
 - g) All firestop systems (including manufacturer published installation requirements).
 - h) All cable raceway and support hardware.

B. Drawings

- 1) The contractor shall submit shop drawings.

C. Project Closeout Test Data

- 1) The contractor shall provide test documentation.

D. As-Built Documentation

- 1) The contractor shall submit as-built documentation.

E. Warranty

- 1) The contractor shall provide a warranty.

PART 2 – PRODUCTS

2.1 CABLE

A. Singlemode Fiber Optic Cable (OS1)

- 1) Singlemode fiber optical cables shall have the following features:
 - a) All optical fiber cables shall be factory-fabricated, low-loss, glass-type fiber optic singlemode step index cables with the following operational and construction features:
 1. Reinforced with Aramid yarn for superior strength, no central strength member.
 2. Color-coded PVC buffers for easy installation, yellow jacket.
 3. Used for both vertical and horizontal applications in buildings.
 4. UL®listed type of OFNR (riser) and OFNP (plenum). All cables shall conform to Article 800 NEC.
 - b) Where armored cable is called for, cable shall be protected by flexible metal armor.
 - c) Where indoor/outdoor cable is called for, cable shall be specifically rated for indoor and outdoor use and shall include UV-resistant flame-retardant outer jacket and dry water blocking compound.

- 2) Single mode fiber optic cables shall meet the following physical specifications:

Cladding Diameter:	125.0 +/- 0.7 μm
Cladding Non-Circularity:	< 1.0%
Colored Fiber Diameter:	250 +/- 12 μm
Core Diameter: 8.3 μm	
Core/Cladding Concentricity Error:	0.8 μm
Minimum Proof Strength:	0.70 Gpa (100kpsi)
Fiber Macrobend (100 turns, 75 mm diameter)	0.05dB @ 1310 nm / 0.10dB @ 1550 nm
Fiber Macrobend (1 Turn @ 32 mm diameter)	0.5dB @ 1550 nm
Coating Strip Force:	1.3 N < F < 8.9

3) Single mode fiber optic cables shall meet or exceed the following optical specifications:

Index of Refraction:	0.37%
Mode Field Diameter	8.8 +/- 0.5 μm @ 1310 nm
Attenuation (maximum):	0.34 dB/km @ 1310 nm
	0.31 dB/km @ 1383 nm
	0.21 dB/km @ 1550 nm
	0.24 dB/km @ 1625 nm
Attenuation at Water Peak:	2.0 dB/km @ 1385nm
Point Discontinuities:	≤ 0.05 dB
Zero-Dispersion Wavelength:	1302 - 1322 10 nm
Zero Dispersion Slope:	0.092 ps/nm ² -km
Fiber Polarization Mode Dispersion for Individual fiber (maximum):	≤ 0.2 ps/ $\sqrt{\text{km}}$
Cable Cutoff Wavelength	≤ 1260 nm

4) Acceptable manufacturers and products:

a) Corning Cabling Systems.

B. 50 μm Laser Optimized Multimode Fiber Optic Cable (OM4).

1) 50 μm multimode fiber optical cables shall have the following features:

a) All optical fiber cables shall be factory-fabricated, low-loss, glass-type fiber optic singlemode step index cables with the following operational and construction features:

1. Reinforced with Aramid yarn for superior strength, no central strength member.
2. Color-coded PVC buffers for easy installation.
3. Aqua color-coded cable jacket.
4. Used for both vertical and horizontal applications in buildings.

5. UL®listed type of OFNR (riser) and OFNP (plenum). All cables shall conform to Article 800 NEC.
 6. Supports 10 Gbps ethernet applications to 300 meters or 1 Gbps to 1,000 meters.
 7. Legacy support: Ethernet, Fast Ethernet, Token Ring, ATM, FDD.
 8. Dual coating for excellent environmental performance and long-term reliability.
 9. Compliant with IEC 60793 and EIA/TIA 492 specifications.
- b) Where armored cable is called for, cable shall be protected by flexible metal armor.
- c) Where indoor/outdoor cable is called for, cable shall be specifically rated for indoor and outdoor use and shall include UV-resistant flame-retardant outer jacket and dry water blocking compound.

2) Multimode fiber optic cables shall meet the following physical specifications:

Core Diameter:	50 μm +/- 3 μm
Core/Cladding Concentricity Error:	<= 1.5 μm
Cladding Non-Circularity:	< 2.0%
Coating Diameter (uncoated):	245 +/- 10 μm
Proof Test Levels:	0.7 Gpa minimum
Operating Temperature Range:	-60o C to 85o C
Core Non-Circularity:	<= 5%
Cladding Diameter:	125 μm +/- 2μm
Colored Fiber Diameter:	250 +/- 15 μm
Coating/Cladding Concentricity Error:	+/- 8 μm
Minimum Tensile Strength:	100,000 psi

- 3) Multimode fiber optic cables shall meet or exceed the following optical specifications:

Maximum Attenuation:	2.4 dB/km at 850 nm 0.7 dB/km at 1300 nm
Minimum Bandwidth:	3500 MHz-km at 850 nm (overfilled) 500 MHz-km at 1310 nm (overfilled) 4700 MHz-km at 850 nm (laser) 500 MHz-km at 1300 nm (laser)
Numerical Aperture:	0.200 + 0.015
Nominal Refraction Index Difference bw Peak of Core and Cladding:	1.00%
Effective Group Index of Refraction @ 850 nm:	1.483
Effective Group Index of Refraction @1300 nm:	1.479
Point Discontinuities @ 850 nm and 1300 nm:	<=0.2 dB

- 4) Acceptable manufacturers and products:

- a) Corning Cabling Systems.

2.2 CONNECTORS

A. Singlemode

1) LC

- a) All singlemode cables are to be terminated with LC-duplex type connectors at each end of each strand unless specified otherwise. Singlemode LC connectors must have the following features:

1. Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.

2. LC connectors shall meet ANSI/TIA/EIA 568-C.3 standard and are duplexable.

- b) Singlemode LC connectors shall meet the following specifications:

<u>Parameter</u>	<u>Singlemode</u>
Insertion Loss	6.10 dB typical
Return Loss	<- 20 dB
Durability	500 rematings, <0.30 dBchange
Temperature Cycling	<0.30 dB Change
Material	Ferrule Tip: Ceramic Housing: Thermoplastic
Average Loss	0.2 dB, standard deviation 0.1 dB

- c) Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.

- d) Acceptable manufacturers and products:

1. Corning Cabling Systems.

2) SC

- a) Where required for use, Singlemode SC connectors must have the following features:

1. Connectors shall be on factory pre-terminated pigtailed which shall be fusion spliced to the individual fiber strand.
2. SC connectors shall meet ANSI/TIA/EIA 568-C.3 standard and are duplexable.
3. New one-step crimp ring with jacket retention.

- b) Singlemode SC connectors shall meet the following specifications:

<u>Parameter</u>	<u>Singlemode</u>
Insertion Loss	0.15 dB typical
Reflectance	<- 40 dB for Super PC
Durability	1000 rematings, <0.20 dBchange
Tensile Strength	20 lb, <0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule Tip: Zirconia Housing: Thermoplastic

- c) Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- d) Acceptable manufacturers and products: Corning Cabling Systems.
- e) Where required for the Distributed Antenna System (DAS) SC Angled Polished Connectors (APC) shall be used.

3) ST

- a) Where required for use, Singlemode ST connectors must have the following features:
 - 1. Connectors shall be on factory pre-terminated pigtailed which shall be fusion spliced to the individual fiber strand.
 - 2. ST connectors shall meet ANSI/TIA/EIA 568-C.3 standard.
- b) Singlemode ST connectors shall meet the following specifications:

<u>Parameter</u>	<u>Singlemode</u>
Insertion Loss	0.15 dB typical
Reflectance	<- 40 dB for Super PC
Durability	1000 rematings, <0.20 dBchange
Tensile Strength	20 lb, <0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule Tip: Zirconia Housing: Thermoplastic

- c) Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- d) Acceptable manufacturers and products: Corning Cabling Systems.

B. Multimode

1) LC

- a) All multimode cables are to be terminated with LC-duplex type connectors at each end of each strand unless specified otherwise. Multimode LC connectors must have the following features:
 - 1. Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
 - 2. LC connectors shall meet ANSI/TIA/EIA 568-C.3 standard and are duplexable.
- b) Multimode LC connectors shall meet the following specifications:

<u>Parameters</u>	<u>Multimode</u>
Interconnection	LC connectors
Compatibility	
Insertion Loss	Composite ferrule: 0.5 dB typical Standard ceramic ferrule: 0.3 dB typical
Durability	1000 rematings <0.20 dB change
Tensile Strength	20 lb, ≤ 0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule: Preradiused Zirconia Housing: Thermoplastic

- c) Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- d) Acceptable manufacturers and products: Corning Cabling Systems.

2) SC

a) Where required for use, SC connectors are to have the following features:

1. Connectors shall be on factory pre-terminated pigtailed which shall be fusion spliced to the individual fiber strand.

b) Multimode SC connectors shall meet the following specifications:

<u>Parameter</u>	<u>Multimode</u>
Interconnection	SC connectors
Compatibility	
Insertion Loss	Composite ferrule: 0.5 dB typical Standard ceramic ferrule: 0.3 dB typical
Durability	1000 rematings, < 0.20 dB change
Tensile Strength	20 lb, ≤ 0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule: Preradiused Zirconia Housing: Thermoplastic

c) Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.

d) Acceptable manufacturers and products: Corning Cabling Systems.

2.3 TERMINATION HARDWARE

A. Contractor shall provide and install fiber optic patch panels as indicated on drawings.

B. 144 Port Fiber Optic Fiber Termination Shelves.

1) 144 port fiber optic Fiber Termination Shelves are to have the following features:

- a) 144 Port
- b) 4 RU height max

- c) 19" rack mountable
- d) Front loading panels
- e) Fully loaded with bulkheads as required
- f) Comply with ANSI/TIA/EIA-606-A labeling
- g) Front cable management rings

2) Acceptable manufacturers and products: Corning Cabling systems

C. 48 Port Fiber Optic Fiber Termination Shelves.

1) 48 port fiber optic Fiber Termination Shelves are to have the following features:

- a) 48 port
- b) 1 RU height Maximum
- c) 19" rack mountable
- d) Front loading panels
- e) Fully loaded bulkheads as required
- f) Comply with ANSI/TIA/EIA-606-A Labeling
- g) Front cable management rings for patch cord slack.

2) Acceptable manufacturers and products: Corning Cabling Systems

2.4 PATCH CORDS

- A. The contractor shall provide each of the following patch cords to the DC-Net Project manager at such time as required for DC-Net installation of network and/or workstation equipment.
- B. All patch cords are to be factory fabricated.
- C. All patch cords are to be the recommended series intended by the manufacturer to integrate with the installed cable segments and termination hardware. All patch cords are to be manufactured by the same vendors as the optical fiber cable and hardware.
- D. Contractor shall provide patch cords in the quantities indicated in the drawings. Contractor shall provide a schedule of all cords indicating the planned lengths, quantities and colors to DC-Net for approval prior to placing any orders for cords.

2.5 SUPPORTING HARDWARE

- A. Use only the manufacturer's approved cable supporting hardware such as split mesh support grips (Kellum grips) or messenger wire approved for use.

- B. Messenger Wire shall be rated such that the planned installation weight of the cabling shall not exceed 60% of the rated breaking strength.

PART 3 – EXECUTION

3.1 GENERAL

- A. Optical fiber cabling shall be provided between facilities and furnished with the quantity of fibers as designed on the contract drawings. All fiber cable runs shall be from the same manufacturer and shall be of the same type.
- B. Design shall allow for migration of the pull-through, interconnect or splice implementation to a cross-connection implementation. Sufficient space shall be left in the telecommunications room to allow for the addition of patch panels needed for the migration of the pull-through, interconnect or splice to a cross-connection. Sufficient cable slack shall exist in the telecommunications room to allow movement of the cables when migrating to a cross-connection.
- C. Fiber cable shall have enough cable slack at the termination point to allow for routing cable through the termination hardware and back to a work table for fiber terminations, plus an additional 3 meters.
- D. Slack may be stored as either cable or unjacketed fiber. Slack storage shall provide bend radius control so that the cable and fiber bend radius limitations are not violated. Fiber slack shall be stored in a protective enclosure and slack cable may be stored on walls, cable trays or enclosures within the telecommunications.
- E. All cabling shall be labeled per specifications.
- F. All armored and non-armored fiber optic cable shall be run in conduit/innerduct. Multiple fiber cables may be run in a single conduit/innerduct.
- G. Contractor shall adhere to TIA/EIA 568/569 specifications regarding bend radius, maximum tensile strength, and maximum vertical rise.
- H. The use of field terminated connectors shall be limited to backbone cabling, campus cabling, or vendor specific requirements.

- I. All fiber optic cabling shall be terminated with either SC or LC connectors unless a vendor specific requirement requires a different type of connector for a specific and limited application.
- J. The following installation practices shall be followed:
 - 1) Fiber optic cable sheaths are not permitted to be deformed. Use only approved cable fasteners such as hook and loop.
 - 2) Do not pull fiber optic cabling with copper cabling.
 - 3) Do not exceed the fiber optic cable maximum pulling tension.
 - 4) In multiple fiber optic pulls, pull fiber optic cables of the same weight and design.
 - 5) Do not exceed the maximum pulling tension of the lowest rated fiber optic cable.
 - 6) Do not pull fiber optic cable over existing cables. Friction could be excessive and cause damage.
 - 7) Do not exceed maximum bend radius, both pulling and installed radius.
 - 8) Do not pull fiber optic cable around sharp corners such as support brackets, rods, etc.
 - 9) Protect fiber optic connectors when using pre-connectorized cables. Use approved pulling grips.
 - 10) The use of lubricants is recommended for all fiber optic cable pulls. Lubricants should be approved for use with the fiber optic cable type. Never use detergent based lubricants when installing loose tube fiber optic cable.
- K. Non-armored fiber optic cables installed within conduit shall be protected by using innerduct. If fiber optic cable is to be installed in conduit without any innerducts, the installer shall install innerducts to sectionalize the conduit. Each innerduct shall have pull tapes/line in each empty innerduct.
- L. Fiber optic cables are not permitted to provide support for other cables or hardware. Never secure other cables or hardware to fiber optic cabling.

Cable that is individually supported may be taped or tied together every 3 meters for cable management but not for support.

- M. When routing fiber optic cabling along walls to the termination or splice enclosure, protect fiber optic cabling by installing in innerduct. Place fiber optic warning signs along innerduct. Ensure there is enough cable slack to be able to move the fiber optic termination hardware to any potential installation area in the room.
- N. Fiber optic cabling termination shall follow the ANSI/TIA/EIA 598 color code chart. To retain the correct polarity through the cabling system, the correct fiber polarity must be followed. Fiber cabling must be installed to pair an odd-numbered fiber with the next sequential even-numbered fiber. Each fiber pair shall be installed in a pair crossover orientation. Off-numbered fibers at position A at one end are at position B at the other end. Even-numbered fibers are at position B at one end and position A at the other end.

3.2 INSIDE PLANT FIBER

- A. Riser cable shall be supported on every other floor using cabling manufacturer approved supporting hardware.
- B. Vertical fiber optic cable placement shall be installed by working from the top down when possible.
- C. Install a split wire mesh support grip at the top of each run. Fiber optic cable shall have its own split wire mesh support grip at the top of the run.

3.3 PATCH CABLES

- A. Patch color codes are determined by their fiber type OM3 cable shall be aqua colored. OS1 shall be yellow.
- B. Excessive patch cord lengths are not permitted. All patch cords shall be appropriately sized while maintaining proper cable bend radius.

3.4 TESTING

- A. The contractor shall test all optical fiber cable prior to the installation of the cable. The contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.
- B. Test equipment shall be specifically rated for the cabling being tested, properly configured, and calibrated per manufacturer's requirements.

C. Loss Budget:

- 1) Loss budget. Contractor shall provide calculations indicating the maximum loss budget for each fiber using the following formula.
- 2) $(\text{Allowable cable loss per KM}) * (\text{KM of Fiber in Link}) + (\text{MFR Published Connector Loss}) * (\text{Number of Connectors}) \text{ loss} = \text{Maximum Allowable Loss.}$
- 3) The contractor shall provide loss budgets to DC-Net for review prior to testing.
- 4) The contractor shall notify Dc-Net in writing a minimum of 72 hours prior to the start of testing and provide a complete testing schedule to allow for witnessing of testing.
- 5) The contractor shall submit calibration certificate(s) indicating that the test set(s) has been calibrated by the manufacturer. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.
- 6) End-to-end loss shall be less than the loss budget. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no cost to the DC-Net.

D. Test Data:

- 1) No handwritten test results will be accepted. Complete, end-to-end test results and loss budget calculations must be submitted to DC-Net in both electronic format (CD or DVD format) and hard copy. If special software or license is required to review test data electronically contractor shall provide one copy of software and appropriate license with the test data.
- 2) Test data shall reflect the DC-Net labeling scheme.
- 3) A sample Test Instrument Data Sheet is attached.

- 4) A sample Reference Power Measurement Form is attached.

E. Project closeout report shall include the following:

- 1) Installation company name, contact information, project manager and installation supervisor name.
- 2) Project scope including project start and end dates, building name and address, floors where installation work was completed.
- 3) Project summary including number of work areas or equipment cabinets/racks cabled, total number of drops and type of cabling system installed. List the types of backbone cabling installed, number of backbone space locations, and number of connections terminated. List any special or unique information regarding site conditions.
- 4) Fiber optic loss test data and OTDR test data including, at a minimum, test identification, pass/fail, test parameter title, test data and test time.
- 5) As-built drawings showing cable placement pathways and termination spaces (work areas, telecommunications rooms, equipment rooms, entrance facilities, etc.).
- 6) Elevation and plan view drawings for cabinet and rack elevations.

F. Multimode:

- 1) Testing shall be performed on all fibers in the completed end to end system. Testing shall consist of a bi-directional end-to-end system. Testing shall consist of a bi-directional end-to-end optical time domain reflectometry (OTDR) trace (all multimode strands over 100 meters) and bi-directional end-to-end light source-power meter test (all multimode strands). All tests shall be performed in accordance

with TIA/EIA-568C.3 and TIA/EIA-526-14A Method B: Intrabuilding or Riser. The system loss measurements shall be provided at 850 and 1300 nanometers for all fibers.

2) Acceptable multimode fiber optic test sets:

- a) Noyes
- b) Corning Cable Systems
- c) Alcoa Fujikura
- d) Tektronix
- e) Engineer approved equal

3) Acceptable tests for light source-power meter testing of multimode fiber optic cables:

- a) Agilent Technologies
- b) Corning Cable Systems
- c) Fluke
- d) Engineer approved equal

G. Singlemode:

1) Testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end-to-end optical time domain reflectometry (OTDR) trace (all singlemode strands) and a bi-directional end-to-end lightsource-power meter test (all singlemode strands). All tests shall be performed in accordance with TIA/EIA-568-B.3 and TIA/EIA-526-7 method A and method B. The system loss measurements shall be provided at 1310 and 1550 nanometers for all fibers.

2) Acceptable singlemode fiber optic tests:

- a) ALCOA Fujikura
- b) Corning Cable System
- c) Noyes
- d) Tektronik
- e) Engineer approved equal

3) Acceptable test sets for light source-power meter testing of singlemode fiber optic cables:

- a) Agilent Technologies
- b) Corning Cable Systems
- c) Fluke
- d) Engineer approved equal

Chapter 5.) 271500 COMMUNICATIONS HORIZONTAL CABLING

SECTION 271500 Communications Horizontal Cabling

PART 1 – GENERAL

1.1 GENERAL

- A. This section provides the requirements for the installation of 4-pair unshielded twisted pair channels and special systems cabling for distributed antenna system, Wifi antennas and security system. Included in this section are the product requirements, installation requirements and testing requirements for the cable channels. Contractor shall provide a complete and operational, as well as tested and documented 4-pair UTP system.

1.2 REFERENCES

- A. NFPA 70 National Electric Code.
- B. Authority having jurisdiction (AHJ).
- C. Local Code
- D. UL® for wiring: UL® Standard 910 Test method for fire and smoke characteristics of cable used in air handling spaces. Provide products that are UL® listed and labeled for such use. UL® testing bulletin. Underwriters Laboratories (UL®) cable certification and follow up program.
- E. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance.

- 1) ANSI/TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
- 2) ANSI/TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components.
- 3) TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces.
- 4) ANSI/TIA/EIA-606-A - Administration Standard for Commercial Telecommunications Infrastructure.
- 5) ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- 6) ANSI/TIA/EIA-862 – Building Automation Systems Cabling Standard for Commercial Buildings.
- 7) ANSI/TIA-942 – Telecommunications Standard for Data Centers.

F. National Electrical Manufacturers Association (NEMA).

G. NECA/BICSI 568-2006 Standard for Installing Commercial Building Telecommunications Cabling.

H. American Society for Testing Materials (ASTM).

I. Institute of Electrical and Electronic Engineers (IEEE).

1.3 SUBMITTALS

A. Product Data:

- 1) The contractor shall submit product data sheets and samples for all products specified under this section.
- 2) Products requiring submittals shall include but not limited to the following:
 - a) All cabling and wire
 - b) Patch cables
 - c) All connectors and required tools
 - d) All termination system components for each cable type

- e) All equipment room and telecommunications room horizontal cable management
 - f) All grounding system components
 - g) All firestop systems (including manufacturer published installation requirements)
 - h) All cable raceways and support hardware
 - i) Other apparatus required for a complete and functional system
- 3) Products requiring samples shall include but not limited to the following:
- a) All cabling and wire
 - b) Patch cables
 - c) All connectors and required tools
 - d) All termination system components for each cable type
 - e) All equipment room and telecommunications room horizontal cable management
 - f) All grounding system components
 - g) All firestop systems (including manufacturer published installation requirements)
 - h) All cable raceways and support hardware
- 4) Drawings:
- a) The contractor shall submit shop drawings.
- 5) Project closeout data:
- a) The contractor shall submit test documentation.
- 6) As-Built Documentation:
- a) The contractor shall submit As-Built documentation.

PART 2 – PRODUCTS

2.1 CATEGORY 6 CHANNELS

A. Cable

- 1) All Category 6 UTP cables shall consist of a 4-pair, 23/24 gauge solid conductor UTP and shall terminate on 8-pin modular jacks at each information outlet.
- 2) All cable jacket material shall conform to article 800 NEC for use as plenum or non-plenum cables. Cables shall be UL® type CMP (plenum), CMR (riser) or type CM (general) as appropriate. All cables running in raised floor space shall be plenum rated.
- 3) All cable shall be tested and guaranteed to meet or exceed the requirements for Category 6 performance as defined in ANSI/TIA/EIA-568-B.2, and be part of the UL® LAN certification and follow-up program.
- 4) Category 6 cables are intended for use in data applications including but not limited to 100Base-T, 1000Base-T, and 1000Base-TX.
- 5) Cable shall have the following electrical requirements in accordance with ASTM D4566:
 - a) Resistance ≤ 9.38 ohms per 100m at 20°C
 - b) Resistance unbalance between 2 conductors of any pair $\leq 5\%$ at 20°C
 - c) Capacitance @1 kHz @20°C ≤ 330 pF/100m
 - d) Characteristic impedance 100 ohms + 15% from 1MHz to highest referenced frequency.
- 6) Cables shall meet the following physical requirements:
 - a) Shall consist of four (4) 23/24 AWG twisted pairs.
 - b) Shall be suitable for the environment in which they are to be installed.
 - c) The overall diameter of the cable shall be less than 0.25 inches.
 - d) Cable shall withstand a bend radius of 4 times the cable diameter at -20°C without damage to jacket or insulation and shall have min. ultimate breaking strength of 90 lb/ft

- 7) Provide all installation materials and consumables including straps, mounting hardware, hangers, fire stop material, labels, etc.
- 8) Plenum
 - a) Shall be plenum rated and meet applicable requirements of ANSI/ICEA S-80- 576 for plenum. All four pairs must be insulated with F.E.P. No constructions that use mixed insulation materials will be allowed.

B. Telecommunications Outlets

- 1) Category 6 Information Outlets shall meet the following requirements:
 - a) All Category 6 information outlets shall meet or exceed NEXT and all other Category 6 transmission performance requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard and be part of the UL® LAN Certification and Follow-up program.
 - b) All Category 6 information outlets shall be capable of being utilized in a modular patching situation or as a modular telecommunication outlet (TO) supporting all intended data applications including but not limited to 100Base-T, 1000Base-T, and 1000Base-TX.

2) Faceplates

- a) UL® listed and CSA certified.
- b) Constructed of high-impact, ABS plastic UL® 94V-0 construction (except where noted otherwise).
- c) Faceplates shall be available in a variety of colors to match other utilities or raceways installed.
- d) Possess recessed designation windows to facilitate labeling and identification.
- e) Shall include a clear plastic cover to protect labels in the designation window.

- f) Have mounting screws located under recessed designation windows.
- g) Comply with ANSI/TIA/EIA-606-A labeling specifications.
- h) All unused ports shall have a blank cover.

C. Termination Hardware

1) Patch Panels

- a) Patch panel shall be high density such that 24-ports occupy 1 rack unit and 48-ports occupy 2 rack units, and 96-ports occupy 4 rack units.
- b) Shall use Category 6, UMJ8 RJ45 jacks in 6- or 8-port modules
- c) Patch panel jack (UMJ 8 position/8 conductor) shall terminate to a 110Dtype insulation displacement contact, printed circuit board or lead frame mounted connector.
- d) Patch panel jack shall be universal modular jack, 8 positions, un-keyed unless noted otherwise.
- e) Patch panel jack shall support termination of 22, 24 and 26 AWG solid conductor, four pair, unshielded twisted pair copper cable.
- f) Patch panel shall have cable management bar to ensure proper bend radius and strain relief.
- g) Patch panel shall have the ability to accept color-coded identification tabs and port protecting shutters.
- h) Patch panel shall be compliant with ANSI/TIA/EIA-606-A labeling specifications.

PART 3 – EXECUTION

3.1 CABLE ROUTING AND INSTALLATION

- A. All communications cabling used throughout project shall comply with the requirements of the National Electrical Code (NFPA 70) articles 725, 760, 770 and 800 in addition to all local codes. All copper cabling shall bear CM, CMR, CMP and/or other appropriate markings for the environment in which they are installed.
- B. Cables running in cable tray or duct shall not be bundled. Cables in these areas shall be loosely arranged to minimize alien crosstalk.
- C. Structural concrete on steel members shall not be drilled or pierced without prior approval from a licensed structural engineer and the authority having jurisdiction.
- D. All cable shall be installed utilizing an independent cabling support system. Cables shall not be attached to ceiling grid supports and shall not be laid directly on the ceiling grid. Cables shall not be attached to conduits, pipes, or ducts.
- E. Cable shall not be attached to or supported by fire sprinkler systems components or any environmental sensor located in the ceiling space.
- F. All cable runs between the termination hardware and the telecommunications outlet shall be continuous without any splices.
- G. Contractor shall schedule work under this contract in a manner so as to complete all above ceiling work prior to the installation of ceiling tile. If ceiling tiles are to be removed, the Contractor shall coordinate the activity with other trades.
- H. Cabling shall not be run adjacent to or parallel to power cabling on fluorescent lighting fixtures.
 - 1) Maintain at least 6 inches of clearance away from fluorescent light fixtures and electrical conductors up to 2 kVA.
 - 2) Maintain at least 24 inches of clearance away from electrical conductors up to 5 kVA.
 - 3) Maintain at least 36 inches of clearance away from electrical cabling more than 5 kVA.
 - 4) When cabling is required to crossover electrical conductors, they must do so at a 90 degree angle.
 - 5) Electrical cabling is not permitted to lie on top of communications cabling.

- I. J-Hooks installation spacing shall meet or exceed the manufacturer or local code requirements. Standard J-hook spacing is not to exceed 5 feet on center. No more than 48 cables are permitted per J-hook unless cabling manufacturer installation requirements permit it. Cables installed in J-hooks shall be secured using approved cable ties.
- J. Cable Trays shall be securely fastened in place using approved materials and methods as recommended by the manufacturer or AHJ. All supporting rod installation intervals shall be for the full load rating of the cable tray, not the rating of the tray with the planned volume of cabling. Cable fill for cable trays is not to exceed 40% of the maximum fill capacity rating of the support allowed by the manufacturers or local AHJ.
- K. Cabling placed in ceiling spaces shall maintain:
 - 1) 3 inches of clear vertical space above cabling and conduits.
 - 2) 12 inches of clear vertical space above the cable tray.
 - 3) 3 inches of clear vertical space between the top of the ceiling grid and the bottom of the cable tray.
 - 4) 3 inches of clear vertical space between the top of the ceiling grid and structured cabling.
 - 5) Cabling passing from fire rated areas shall be fire stopped to meet local and national codes.
 - 6) Cabling passing from one floor level to another should be fire stopped unless cabling is placed inside a fire rated shaft and meets the approval of the AHJ.
- L. All telecommunications cabling installed within ceiling spaces or below raised access floors shall be routed parallel or perpendicular to building structure.
- M. The minimum bend radius, under no-load conditions, for 4-pair UTP cables shall be one (1) inch or four times the diameter of the cable across its major axis, whichever is greater.
- N. Open cable tray fill ratio shall not exceed 30% or as allowed by code or the AHJ.
- O. Cable fill-in conduits and enclosed raceways shall not exceed 38% or as allowed by code or the AHJ.
- P. All cabling shall be labeled per specifications and as indicated on drawings.

3.2 HORIZONTAL CABLING