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

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. This section of the horizontal cabling portion of a structured cabling system includes:

1. UTP Copper cabling
2. Termination and patch cables

B. Provide all horizontal cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in communications rooms.

C. Related Sections

1. Section 270526 Grounding and Bonding for Communications Systems
2. Section 270528 Interior Pathways for Communications Systems
3. Section 270543 Exterior Pathway for Communications Systems
4. Section 270553 Identification for Communications Systems
5. Section 271100 Communications Equipment Room Fittings
6. Section 271300 Communications Backbone Cabling
7. Section 272100 Data Communication Network Equipment

1.2 REFERENCES

A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

C. Conflicts

1. Refer to section 270000

D. Codes and Standards

1. Refer to section 270000

1.3 SUBMITTALS

A. Refer to sections 270000

1.4 QUALITY ASSURANCE

A. Refer to sections 270000

B. In addition to the Contractor Qualifications requirements of section 270000, the Contractor shall be a CommScope Uniprise certified installer (authorized Uniprise reseller) and capable of providing a CommScope Uniprise System warranty. Provide satisfactory evidence of certification in the form of a current letter or certificate from the manufacturer as part of the bid submission and pre-construction submittals.

C. Monitor and maintain quality control over manufacturers, suppliers, subcontractors, work force, site conditions, products, and services to ensure Work is of specified quality.

D. Workmanship: Install material and equipment in neat and workmanlike manner, in accordance with NEC Section 800-6. Specified requirements represent minimum acceptable quality for Work. Comply with industry standards except when more stringent requirements are specified herein, and tolerances indicate higher standards or more precise workmanship.

E. All communications work shall be performed under the direct on-site supervision of a Building Industry Consulting Service International, Inc. (BICSI) Certified Registered Communications Distribution Designer (RCDD). Include resumes and RCDD registration in Product Data Submittal to the A&E team and CoH IT representative for review and approval. Paperwork must be approved by the A&E team and CoH IT representative in writing prior to construction. The RCDD must be at the job site during construction. The RCDD shall be present during all cable testing, pulling and termination procedures.

F. Provide all materials, equipment, and installation in compliance with the latest applicable standards from ANSI, FCC, ASTM, TIA, IEEE, NEC, NFPA, NEMA, REA, and UL.

G. Install products only by qualified technicians certified by manufacturers.

H. Provide all electronic equipment with the UL label when applicable.

I. Comply in every way with the requirements of local laws and ordinances, the National Board of Fire Underwriters, and the National Electrical Code. Anything in the plans or specifications that does not strictly comply with the above laws, ordinances, and rules must be referred to the attention of the Engineer for a decision before proceeding. No change in the IT plans and specifications shall be made without full consent in writing by HITS.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to sections 270000

1.6 PROJECT/SITE CONDITIONS

A. Refer to section 270000

1.7 WARRANTY

A. Refer to section 270000

1.8 MAINTENANCE AND SUPPORT

A. Refer to section 270000

PART 2 PRODUCTS

2.1 GENERAL

A. City of Houston has established CommScope as the standard for horizontal cabling system installation.

B. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to CommScope and other manufacturers as referenced in this document. However, substitutions for CommScope products are not permitted.

C. The project shall be registered for a 25-year warranty and test data submitted for acceptance.

D. Horizontal Cable and Termination Components specified are to function as a System.

1. All horizontal cabling components shall be from the sane manufacturer to obtain the system warranty..

E. Horizontal Cable types include:

1. 4-pair Copper Unshielded Twisted Pair (UTP) CAT6A

F. UTP Cabling Color Code:

1. See table below for the color standard by applications

Application	Horizontal Cable Color	RJ45 Jack Color	Patch Cord Color
Data	Blue	Blue	Blue
WiFi	Green	Green	Green
Security	Purple	Purple	Purple
Fire Alarm	Red	Red	Red
POTS Voice	**Yellow**	**Yellow**	**Yellow**
BAS	White	White	White
Audio-Video	Gray	Gray	Gray
Public Safety Video	**Orange**	**Orange**	**Orange**

2.2 4-PAIR UTP HORIZONTAL COPPER CABLE

A. The 4 pair UTP cable installed inside the buildings shall be Underwriter Laboratories (UL) listed type CMP, unless cables are routed through underground or unconditioned spaces where OSP cables shall be used.

B. Plenum Rated Horizontal UTP CAT6A Cable Products:

1. CommScope # CS44P

C. Outside Plant (OSP)–rated Category 6A Cable Products:

1. CommScope # CS44P-IO (black, outdoor and plenum rated, but not for direct burial installations)

2. Provide surge protector that can pass POE for each OSP cable at both ends.

2.3 TELECOMMUNICATIONS OUTLETS FACEPLATE

A. Manufacturers:

1. CommScope

B. Faceplate housing shall be one piece, flush mount style that fits standard NEMA openings.

C. Faceplates shall have two separate labeling areas.

D. Label areas shall be covered with a clear plastic insert.

E. Unused ports shall have blank inserts installed.

F. Plastic, color white

G. Faceplate Products

1. CommScope # M12L-262 (2-port)

2. CommScope # M14L-262 (4-port)

3. CommScope # M20AP-262 (blank dust cover)

2.4 SURFACE MOUNT OUTLETS

A. Surface mounted plenum rated biscuit block with plenum rated modular jack or connector.

B. Made of High Impact thermoplastic.

C. Surface mounted outlet shall be used when data outlet is located in an equipment enclosure box, or above an accessible ceiling . or inside a recessed outlet box with surface mounted device (camera, WiFi Access Point, etc.).

D. Surface Mount Outlet Products

1. CommScope # SMB-1P-262 (1-port)
2. CommScope # SMB-2P-262 (2-port)

2.5 MODULAR UTP CONNECTORS

A. Modular jacks shall be RJ45, 8 pin-8onductor, non-keyed, CAT6A rated.

B. Insulation displacement type contact.

C. RJ-45 Jack Products

1. CommScope # UNJ-10G

D. Data drops for cameras shall be terminated to a RJ45 plug (CommScope # FT-MP) with a boot on the camera end, and terminated to patch panel on the IDF room end.

2.6 DATA PATCH CABLES

A. All data patch cables shall be manufacturer pre-assembled.

B. Provide two (2) patch cables per horizontal data cable installed and match the cable type and color of the horizontal cables.

C. Patch cord lengths

1. 50% 10-ft long, 30% 5-ft long and 20% 7-ft long

D. Data Patch Cable Products

1. CommScope # MiNo6A

2.7 DATA PATCH PANELS

A. Products

1. CommScope # CPP-UDDM-M-2U-48 (48-port, 2U)
2. CommScope # CPP-UDDM-M-1U-24 (24-port, 1U)

2.8 POE ETHERNET SURGE PROTECTION DEVICE (SPD)

A. Roof or Tower Mount

1. Unit shall pass POE+
2. Use in the field for pole and roof mount Access Points. The device shall be rated for out-door use. Bond to approved building ground.
3. Ditek# DTK-MRJPOEX or approved equal.

B. Install in IDF/MDF

1. Unit shall pass POE+
2. Use in MDF/IDF closet. Bond to PBB/SBB.
3. Rackmount: DTK-RM##NETS (##: 12, 16, or 24), if 4 or more are required in MDF/IDF.

2.9 HORIZONTAL CABLE SOLUTIONS FOR OVER 295'

A. Cable Distance 500' or less

1. CommScope GigaREACH XL 1573A (OSP)

2. CommScope GigaREACH XL 2073A (Plenum)

B. Cable Distance Over 500'

1. CommScope FiberREACH Powered Fiber (OS2, 2 Fibers, 16AWG or 12AWG depending on the distance.

2. DC Power Supply: PFP-PX-8M

3. Media Converter: PFU-P-C-O-090-02 (outdoor)

C. Using the above solutions in a project is subject to HITS' approval. Consultant and contractors shall submit a COH IT Standard Variance Request form and obtain the approval before submitting the final design documents or shop drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Refer to Section 270000

3.2 PREPARATION

A. Refer to section 270000

B. The Contractor shall check pathways, raceways, and other elements for compliance with space allocations, installation tolerances, debris, hazards to cable installation, and other conditions affecting installation prior to installation.

C. All conduits shall be provided with bushings before cable pulling to start

3.3 INSTALLATION REQUIREMENTS

A. Refer to section 270000

B. All installation shall be done in conformance with ANSI/TIA-568 standards, BICSI methods, industry standards and manufacturer's installation guidelines.

1. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.

2. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.

3. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

C. Install cable using techniques, practices, and methods that are consistent with specified data cabling and the installed components and that ensure specified performance levels of completed and linked signal paths, end to end.

1. Pull cables in smooth and regular motions using methods that prevent cable kinking.

2. Pull cables simultaneously if more than one is being installed in the same raceway/pathway.

3. If necessary, use approved cable pulling lubricant

4. Use fish tape, cable, rope, basket weave wire/cable grips, and other tools that will ensure no damage to the media or raceway.
5. Install open cabling parallel and perpendicular to surfaces or structural members following surface contours where possible.
6. Do not bend cable greater than a bend radius of 0'-1".

D. Provide a 10'-0" service loop at the communications room and shall provide a 3'-0" service loop above the access ceiling or cable trays unless specified otherwise.
1. All service loops shall be a minimum of 1'-6" (18") in diameter and be accessible for maintenance.

E. Coordinate loop placement and orientation with the technology consultant.
1. This allows for future changes or expansion without installing new cables.

F. Install cables in continuous "home run" lengths from work station outlet to specified patch panel.
1. No intermediate punch-down blocks or splices may be installed or utilized between the communications rooms and the workstation outlet without written HITS permission.

G. All cable must be handled with care during installation so as not to change performance specifications.
1. Factory twists of each individual pair must be maintained up to the connection points at both ends of the cable.
2. There shall never be more than 0'-½" of unsheathed cable at either the wiring closet or the workstation termination locations.

H. All cabling and associated hardware shall be placed so as to make efficient use of available space.
1. All cabling and associated hardware shall be placed so as not to impair equipment's efficient use of their full capacity.

I. All horizontal UTP data cable runs shall be within the permanent link distance limit of 295-ft. Contractor shall verify the cable run distance before installation and notify A&E team and HITS representative immediately if any of the data cable runs might exceed the distance limit. All exceptions shall be reviewed and approved by HITS representative. The contractor shall be responsible for all mitigation required to bring the cable runs within the distance limit or HITS approved alternative solutions.

3.4 CABLING METHODS

A. The Contractor shall provide cabling in accessible spaces, cable tray, (surface and/or enclosed raceway), conduits, and/or J-Hook cable support system.
1. Within consoles, racks, cabinets, desks, and counters, in accessible ceilings spaces and in gypsum board partitions where open cable method may be used.
2. Use UL or ETL listed plenum rated cable in all spaces.
3. Provide all necessary installation materials, hardware, tools and equipment to perform insulation displacement type terminations at all data outlets, patch panels, and voice termination materials.

B. Conceal raceway and cabling except in unfinished spaces as is practical.

C. Exposed Cable
1. All station cabling shall be installed inside walls or ceiling spaces whenever possible.

2. All cables outside walls below finish ceiling shall be installed in approved communication raceway. Exposed station cable will only be run where indicated on the drawings and will only be allowed when no other options exist.
    a. HITS must approve all exceptions.

D. The Contractor shall utilize conduits/cable tray as indicated on the drawings.

E. All cabling placed above drop ceilings must be supported by cable tray, J-hooks, caddy bags or conduit.

1. The Contractor shall permanently affix cable supports to the building structure or substrates and provide attachment hardware and anchors designed for the structure to which attached and are suitably sized to sustain the weight of the cables to be supported.
    a. Attaching cable to pipes or other mechanical items is not permitted.
    b. Cabling shall not be attached to ceiling grid wires.
2. Multiple cables are to be dressed every 5’-0” to 7’-0”.
    a. Maximum cable sag between cable hooks is 3”-6”.

F. The Contractor shall route data and voice cables separately in a neat and orderly fashion.

1. No cable ties or wraps shall be used to secure the cables in the runway outside of the communications rooms. Cable ties shall be rated for the environment.

G. Keep all items protected before and after installation with dust and moisture proof barrier materials/envelopes.

H. If wiring is terminated on patch panels, data, voice jacks prior to painting, carpet installation, and general finish clean up, these jacks shall be placed in a protective envelope to ensure dust, debris, moisture, and other foreign material do not settle onto jacks’ contacts.

1. Envelope will be removed on final trim out after other trades have completed their finish work.
2. It shall be the Contractor’s responsibility to ensure the integrity of these protective measures throughout the life/installation of the project.
    a. Cable bundles brought into the communications rooms shall be routed and dressed in such a manner that prior to termination the cables are not subject to damage and misuse such as installers walking on the bundles that are on the floor.
    b. Cable pulling force shall not exceed 25 lbs of pulling tension or cable manufacturer’s recommended pulling tensions.
    c. Do not leave cables on the floor unprotected or cable bundles hanging from the ceilings. Coil them up in a temporary manner and protect them from damage.

I. Communications room cables shall be combed and dressed in a manner as to prevent twists, “braiding” and crossed cables in the cable bundle from the communication room entrance to the termination point at the rear of the patch panel.

1. Behind the patch panel, the cable bundle shall be attached to the rear cable support bar, and shall drop out each cable in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.
    a. Use Velcro wraps instead of cables ties for all bundling in the communications rooms.
    b. Plastic/nylon tie-wraps are not allowed to permanently secure cables inside the communications room.

3.5 CABLING SEPARATION

A. Comply with TIA rules for separating unshielded copper communication and data-processing equipment cables from potential EMI sources, including electrical power lines and equipment.

B. Maintain a minimum spacing of 1’-6” (18”) from electrical feeders and/or branch circuit wiring including, but not limited to, light fixtures, sources of heat and EMI sources.

C. Maintain a minimum spacing of 1’-0” from auxiliary systems cabling.

D. Maintain a 1’-0” separation where cables must pass perpendicularly to electrical, plumbing, or other wiring, conduit, or piping systems.

E. Use non-conduit bushings, if necessary to maintain separation, which allow for the addition of a reasonable number of cables in the future.

F. Maintain communications pathways away from electrical apparatus such as motor driven equipment and transformers, minimum separation distance of 10’-0” is recommended.

3.6 CABLING TERMINATION

A. Terminate cables in consistent consecutive order.

B. Terminate cables onto 8P8C modular patch panels without damaging twisted pairs or jacket.

C. Arrange cables on patch panels and voice termination hardware in ascending order of room numbers and outlet numbers within rooms.

D. Provide a 10’-0” service loop for horizontal cables in the communications rooms.

1. Service loop in the communications rooms shall be neatly bundled and placed in cable trays. Cables shall follow the longest route of cable tray along the perimeter of the room inside MDF/IDF rooms to reach the destination patch panels. 10’ service loop is provided in this manner to avoid big service loop bundles. Provide additional cable tray section if required.

E. Provide a 3’ service loop for horizontal cables at work area outlets, and locate the service loop above or below data/voice outlet where vertical cable run transitions to horizontal run.

F. Maintain twists in cable pairs to within 0’-½” of termination.

G. Building Systems Cabling (BAS, FA, elevator line, etc)

1. Coordinate exact placement and connectivity requirements with applicable trade prior to installation.

2. Group all building systems cables in one group.

3. Clearly label cable number and function, in the last positions on the horizontal cabling blocks in each communications room.

H. Limit cable-bending radius to 20X the cable diameter during installation, and 15X the cable diameter after installation.

I. Start numbering at the left of the main door to the room and continue in a clockwise direction around the room.

1. The cables within the room will be terminated starting with the cables located to the left of the main door to the room and continuing around the room in a clockwise direction.

3.7 TERMINATION HARDWARE

A. Station Hardware

1. Flush mount jacks shall be mounted in a faceplate with a back box.

2. Outlets shall not be mounted on temporary, movable, or removable surfaces, doors, or access hatches without prior HITS approval.

3. 8P8C Jack Pin Assignments for work area outlets shall match the T-568B wiring scheme.

B. Patch panels

1. Copper cables shall be terminated in 110 style eight position/eight conductor (8P8C) patch panels.
2. All cable terminations shall match the T-568B wiring scheme.

C. Work Area Outlet

1. 8P8C non-keyed modular outlets for applications up to 10 Gbps and ANSI/TIA-568 compliant for the specified transmission requirements

D. Work Area Outlet Faceplates:

1. Furnish and install blank dust cover in all unused ports.
2. Furnish and install blank plate to cover in all unused outlet boxes.

3.8 SPECIAL CIRCUITS

A. The Contractor shall coordinate with the HITS on the cable termination plan for special circuits, including cables to wireless access point locations, security, elevators, fire alarms, etc.. Terminate Data cables to surface mounted outlet boxes where outlets are located inside the equipment enclosure or devices will be mounted directly above the outlet boxes.

B. Wireless Access Points

1. Enclosures shall be NEMA rated for the environment to which they are exposed.
2. 30’-0” of cable slack shall be coiled and hung on a “J”-hook at the enclosure location.

3.9 IDENTIFICATION AND LABELING

A. Refer to section 270553 for more information.

B. Labeling system shall consist of a hand-held portable printer and labels appropriate to the application. Handwritten labels are not acceptable.

C. Labelling scheme shall meet HITS’s IT cabling standard and industry standards and best practices. Submit the labeling scheme for approval before work to start.

D. Fiber termination hardware (designation strip) shall have a 0’-¾” x 0’-¼” thermal transfer printable label with a permanent acrylic adhesive

E. All labels shall be permanent and shall not fade, peel, or deteriorate due to environment or time.

F. The Contractor shall provide a copy of the finalized plan in writing to the HITS representative and IT Consultant for review and authorization to proceed.

1. Coordinate with HITS for specifications on labeling of all hardware, cabling, and related equipment prior to installation.

G. Labeling requirements:

1. Label cable terminations on designation strips
2. Label all cables at each terminating point.
3. Label each port of the work area outlet.
4. Cable identification numbers shall not be duplicated.
5. Label patch panels in the communications rooms to match those on the corresponding voice and data outlets.

a. The font shall be at least 0’-1/8” in height.

6. Where a wireless access point is installed above an acoustical ceiling, label the ceiling grid frame below the access point, displaying the data port number and, if applicable, the access point identification number. Coordinate labeling of grid with HITS and Architect prior to application of labels.

7. Label each distribution rack, block and other terminating equipment unit and field within that unit within 0’-4” from the block or patch panel termination. Keep labels in a neat and orderly lineup.

8. Label each connector and each discrete unit of cable-terminating and connecting hardware within connector fields, in wiring closets and equipment rooms.

a. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.

9. Post the cable schedule in a prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations.

H. Unique identifiers

1. Segregation and position on equipment rack

2. Port color-coding

3. Unique labeling

I. Documentation

1. Provide electronic copy of final comprehensive schedules for project in software and format selected by HITS.

a. All labels shall correspond to as-built drawings and to final test reports.

2. All cable inventory data documentation shall be submitted in format coordinated with and approved by HITS so that data can be incorporated into existing databases.

3. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.

4. Complete cross connect documentation is required.

3.10 FIELD QUALITY CONTROL

A. Refer to section 270000

3.11 POST-INSTALLATION TESTING

A. Contractor shall test each pair or strand of every cable prior to acceptance. (100% PASS)

B. Contractor shall submit acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved.

C. Standards Compliance and Test Requirements:

1. Cabling shall meet ANSI/TIA-568.2 Category 6A Horizontal cabling requirements.

D. 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.

1. These tests shall be performed in a swept frequency manner from 1 MHz to the highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements.

2. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.

3. Length, propagation delay, and delay skew relative to the relevant limit.
    a. Length, propagation delay, and delay skew shall be tested relative to the relevant limit.
    b. Test shall also include mutual capacitance and characteristic impedance.
        1) Any individual test that fails the relevant performance specification shall be marked as a ‘FAIL”.

E. Cable Test Documentation:

1. Cable test documentation shall be submitted in hard copy and electronic formats.
    a. If proprietary software is used, disk or CD shall contain any necessary software application required to view test results.
    b. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report.
    c. Certificate shall reference traceable circuit numbers that match the electronic record.
2. Each test record shall contain the cable ID as follows:
    a. “MEDIA TYPE – TR Room ID – Cable #”, e.g. CAT6A-201-002.
3. Test results saved within the field-test instrument shall be transferred into an accessible database utility that allows for the maintenance, inspection and archiving of the test records.
    a. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”.
    b. The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
4. Test reports shall include the following information for each cabling element:
    a. Wire map results that indicate that 100% of the cabling has been tested for shorts, opens, miss-wires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
    b. Length, propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
    c. Cable manufacturer, cable model number/type, and NVP
    d. Tester make & model, serial number, hardware version, and software version.
    e. Cable ID and project name
    f. Auto-test specification used
    g. Overall pass/fail indication
    h. Date of test

F. Cable Test Equipment

1. Contractor shall supply all of the required test equipment used to conduct acceptance tests.
2. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.
3. Testing equipment shall be UL-verified to meet Level V accuracy.
    a. The cable installers shall have a copy of this reference in their possession and be familiar with the contents.

4. Testing equipment shall be within the calibration period recommended by the manufacturer.
5. Testing equipment shall have the latest software and firmware installed.
6. Testing equipment of a given type shall be from the same manufacturer, and have compatible electronic results output.
7. Test adapter cables shall be approved by the manufacturer of the test equipment.
    a. Adapter cables from other sources are not acceptable.
    b. Adapter cables must be replaced after 1000 tests to ensure accuracy.
8. Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.
9. Test equipment must be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
10. Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
11. Test equipment must be capable of running individual NEXT, return loss, etc measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
12. Test equipment must include a library of cable types, sorted by major manufacturer.
13. Test equipment must be able to internally group auto tests and cables in project folders for good records management.
    a. Test equipment must store at least 1000 auto tests in internal memory.
14. Test equipment must include DSP technology for support of advanced measurements.
15. Test equipment must make swept frequency measurements in compliance with TIA standards.
16. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector.
17. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
18. Acceptable testers:
    a. Fluke DTX CableAnalyzer
    b. HITS approved equivalent

3.12 CLEANING

A. Refer to section 270000

3.13 ACCEPTANCE AND CLOSEOUT

A. Refer to section 270000

END OF SECTION 271500