PROJECT MANUAL

PARKING ACCESS AND REVENUE CONTROL SYSTEMS (PARCS)

DEMO AND REPLACEMENT

AT

WILLIAM P. HOBBY AIRPORT (HOU)

SOLICITATION NO.: H37-PARCS-2021-021
PROJECT NO. 783A&B

Division 27 – Communications

Issued For Construction JUNE 12, 2020

PREPARED BY

KIMLEY-HORN AND ASSOCIATES, INC.

FERGUSON CONSULTING, INC.

TABLE OF CONTENTS

SECTIONS

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Project overview for the Parking Access and Revenue Control Systems (PARCS) at George Bush Intercontinental Airport and at William P. Hobby Airport.
2. Except as modified in this section, General Conditions, Supplementary Conditions, applicable provisions of Division 1, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 27 – Technology Infrastructure.
3. Each section included in Division 27 incorporates this section by reference and is incomplete without the provisions stated herein.
4. Coordinate work included in other Divisions, which affect the work in this Division.
5. Mobilization for the project.

B. Project Overview:

1. The related components of the telecommunication system include grounding, administration, MEP requirements, architectural requirements.
2. The telecommunications system design will be based on the Electronic Industries Association/ Telecommunications Industries Association (EIA/TIA) standards as well as the Building Industry Consulting Services, Inc. (BICSI) standards. In addition, the design will comply with the Houston Airport System standards.
3. Specific coordination is required with HAS PDC and Properties for the coordination, relocation and uninterrupted services for all, communication and signaling devices owned, operated or leased by FAA, HAS, AT&T, Sprint and other such providers and tenants. The Houston Airport System (HAS) horizontal and backbone cabling and connectors will the meet the HAS IT requirements and construction guidelines document.
4. The scope of work for this project includes construction of an HAS IT ductbank system. The ductbank will include concrete encased ducts and handholes as noted on the contract documents. The intent of this ductbank is to provide telecommunication service for all property tenants. The services may include CATV, Phone, Data, security, etc.

1.2 REFERENCES

A. Section 270510 – Telecommunication Administrative Requirements.

B. Telecommunications Industry Association /Electronic Industries Association (TIA/EIA) 568 Commercial Building Telecommunications Cabling Standard, latest edition.

C. National Electrical Manufacturers Association (NEMA).

D. American Society for Testing Materials (ASTM).

E. National Electric Code (NEC®).

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

G. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS 11801, latest edition.

H. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program.

I. Occupational Safety and Health Administration (OSHA) 29 CFR Part 1910, Permit-Required Confined Spaces for General Industry; Final Rule.

J. HAS IT Infrastructure Standards of Practice

1.3 DEFINITIONS AND ABBREVIATIONS

A. Provide: Where the word "provide" is used, the word is understood to mean, "the Contractor shall furnish and install" the equipment, tests, inspections, etc. referenced.

B. Related Work: The sections referenced under the article RELATED SECTIONS are understood to include provisions which directly affect the work being specified in the section where the RELATED SECTIONS article occurs.

C. Concealed: Where the word "concealed" is used in conjunction with raceways, equipment and the like, the word is understood to mean hidden from sight as in chases, furred spaces or suspended ceilings.

D. Exposed: Where the word "exposed" is used, the word is understood to mean open to view.

E. Above Finished Grade – AFG

F. Above Finished Floor – AFF

G. American Wire Gauge – AWG

H. Air Blown Fiber – ABF

I. Equipment Room – ER

J. Gigabits Per Second – Gbps

K. Intermediate Distribution Frame – IDF

L. Main Cross Connect – MC

M. Main Distribution Frame – MDF

N. Megabits Per Second - Mbps

O. Multimode Fiber Optic Cable – MM

P. Not in Contract – NIC

Q. Optical Fiber – OF

R. Polyvinyl Chloride - PVC

S. Refer to - RE:

T. Singlemode Fiber Optic Cable – SM

U. Structured Cabling System - SCS

V. Telecommunication Closet - TC

W. Telecommunications Room – TR

X. Telecommunications Main Grounding Busbar – TMGB

Y. Typical – TYP

Z. Unless Otherwise Noted – UON

AA. With – w/

1.4 CONTRACT DRAWINGS

A. Drawings are generally diagrammatic and are intended to encompass a system that will not interfere with the structural and architectural design of the building. Coordinate the work to avoid interferences between conduit, equipment, architectural and structural work.

B. Coordinate with architectural features, trim and millwork details, and install equipment in cabinets or other special areas as directed by A/E.

C. Drawings are based on equipment specified as the ‘basis of design’. Make adjustments, modifications or changes required, due to use of other equipment, at no additional compensation.

1.5 QUALITY ASSURANCE

A. Submit written proof that the requirements outline in Section 270510 – Telecommunication Administrative Requirements are being met.

1.6 MATERIALS AND WORKMANSHIP

A. Provide new materials and equipment of a domestic manufacturer by those regularly engaged in the production and manufacture of specified materials and equipment. Where Underwriter's Laboratories or other agency has established standards for materials, provide materials, which are listed and labeled accordingly. 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. Perform work by workmen skilled in the trade required for the work. Install all materials and equipment to present a neat appearance when completed and in accordance with the approved recommendations of the manufacturer and the best practices of the trade and in conformance with the Contract Documents.

C. Provide all labor, materials, apparatus, and appliances essential to the complete functioning of the systems described or indicated herein, or which may be reasonably implied as essential whether mentioned in the Contract Documents or not.

D. In cases of doubt as to the Work intended or in the event of need for explanation thereof, make written request for supplementary instructions to A/E.

E. Since manufacturing methods vary, reasonable minor variations are expected; however, performance and material requirements are the minimum standards acceptable. The right to judge the quality of equipment that deviates from the Contract Documents remains solely with A/E.

F. Exterior and interior raceway systems may be installed by a licensed electrical contractor.

G. Cable terminations and testing shall be performed only by the channel solution manufacturers Certified Contractor.

H. If a part number shown in this document has been discontinued or is no longer in production, then the manufacturer's replacement part number shall be used. If there is no replacement part number, then the contractor shall notify the engineer in writing requesting instructions for an approval replacement part number.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Follow the manufacturer's directions completely in the delivery, storage, and handling of equipment and materials.

B. Store equipment in a clean, dry place, protected from other construction. While stored, maintain factory wrappings or tightly cover and protect equipment against dirt, water, construction debris, chemical, physical or weather damage, traffic and theft.

C. Adequately brace and package equipment to prevent breakage and distortion while in transit.

1.8 OPERATING INSTRUCTIONS

A. Provide the services of competent representatives of the manufacturer capable of certifying that the equipment is installed according to the manufacturer's recommendations, is operating properly, and to instruct the Owner's operating personnel during start-up and operating tests of the complete telecommunication system. Prove the operation of equipment to the satisfaction of A/E. Give at least seven days' notice to A/E prior to beginning equipment start-up.

B. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

C. Perform all tests outlined in Division 27.

1.9 SERVICE

A. Remove all excess material and debris. Place all telecommunication systems in complete working order before request for final review. Broom clean all areas.

B. Clean and polish all fixtures, equipment, and materials thoroughly, and return to "as new" condition.

1.10 FINAL REVIEW

A. Prior to requesting final payment, submit final approved operation and maintenance manuals including approved submittals, test reports and "AS-BUILT" drawings. Delivery of operation and maintenance manuals is a condition of final acceptance.

1.11 GUARANTEE

A. Guarantee materials, parts and labor for all work for one year from the date of issuance of occupancy permit. During that period make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship with no additional compensation and to the complete satisfaction of A/E.

B. Refer to 270510 – Telecommunication Administrative Requirements for additional requirements.

1.12 SAFETY

A. The contractor shall follow the safety procedures.

1. The contractors shall be responsible for training all personnel under their employ in areas concerning safe work habits and construction safety. The contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.

1.13 PROJECT/SITE CONDITIONS

A. Site Visitation: Visit the site of the proposed construction to thoroughly become familiar with all details of the work and working conditions, verify all dimensions in the field, and advise A/E of any discrepancy before performing any work.

B. Space Requirements:

1. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.
2. Make changes in equipment location of up to 5 feet, to allow for field conditions prior to actual installation, at no additional compensation, as directed by A/E.
3. Install all equipment requiring service so that it is easily accessible.
4. Compare the equipment sizes with the space allotted for installation before installation and make written notice of possible conflict. Disassemble large equipment to permit installation through normal room openings when required. Should written notice not be made in a timely manner, make adjustments and modifications necessary without additional compensation.
5. Timely place all equipment too large to fit through finished openings, stairways, etc.

C. Site Obstructions

1. The drawings indicate certain information pertaining to surface and subsurface obstructions, which has been taken from available drawings. Such information is not guaranteed; however, as to the accuracy of location or the completeness of the information.
2. Before any cutting or trenching operations are begun verify with A/E, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown. If damaged, repair the lines at no additional compensation.

D. Cutting and Patching

1. Submit a written request to A/E in advance of cutting or alterations.
2. Execute cutting and demolition by methods, which will prevent damages to other work and will provide proper surfaces to receive installation of repairs.
3. Restore work which has been cut or removed; install new products complying with specified products, functions, tolerances and finishes as stated in the contract documents. Provide heavy chrome-plated or nickel-plated escutcheon plates of approved pattern for penetrations of finished surface. Approved escutcheon plates are B&C No. 10 with concealed hinges.
4. Fit work airtight to conduit, sleeves and other penetrations through surfaces. For fire-rated penetrations, provide in accordance with UL 1479 and ASTM E-814 assemblies utilizing products and materials equal to the rating of all surfaces penetrated.

E. Outages: All outages to existing on-line systems shall be coordinated and approved in writing by the owner prior to outage.

F. The contractor may have to perform some work after hours such as new cable pulls through active manhole systems, outage of existing services and such.

G. The contractor shall provide and install all cross-connect cabling, connectors, coupling panels. Couplers and any other materials necessary for a complete system installation when working in existing areas to extend active circuits.

1.14 IDENTIFICATION

A. Refer to Section 270553 – Identification and Labeling of Communication Infrastructure and the following.

B. Backbone Conduit Pullbox: Install nameplate to cover of pullbox

C. Conduit: Label conduits with appropriate color-coded tape.

1. Install tie wrap label tag on each conduit end point that terminates in ER, MDF, TR, or stubbed through floor, ceiling or wall without pullbox.
2. Hand-letter with permanent black ink, in block type letters with clear, legible letters.
3. Match label information to information in nearest J-Box label that conduit leads to.
4. Provide all conduits greater than 1" with a label which includes the TO/FROM destination. Label to be located on each end of conduit and at 100' intervals. Label shall be white with black letters. Face label downward where visible and clear from below. Label to consists of the following font sizes:
   a. 1.25" – 2"conduit: ¼" Block letters with max 2 rows of text
   b. 2.25' – 3" conduit: ½" Block letters with max 2 rows of text
   c. Over 3" conduit: ¾" Block letters with max 2 rows of text

1.15 MOBILIZATION

A. The work covered under this item consists of preparatory work and operations, including but not limited to those necessary for the movement of personnel, equipment, supplies, and incidentals to the Project site; for the establishment of all offices, buildings, and other facilities necessary for work on the Project and for all other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

B. The Contractor shall demobilize within 30 days after substantial completion of the work.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION 270500

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 270510 - TELECOMMUNICATION ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following Telecommunications Administrative Requirements, including, but not limited to:

1. Contractor qualifications
2. Submittals
3. Substitution requirements
4. Labeling requirements
5. Testing and Identification
6. As-built documentation requirements.
7. Each section included in Division 27 incorporates this section by reference and is incomplete without the provisions stated herein.

B. Related Sections include the following:

1. Section 270500: Common Work Results for Communications
2. All division 27 Specification Sections.

1.2 REFERENCES

A. Telecommunications Industry Association /Electronic Industries Association (TIA/EIA) 568-Commercial Building Telecommunications Wiring Standards, latest edition.

B. National Electrical Manufacturers Association (NEMA).

C. American Society for Testing Materials (ASTM).

D. National Electric Code (NEC®).

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

F. 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.

1.3 CONFLICTS

A. Between referenced requirements: Comply with the one establishing the more stringent requirements.

B. Between referenced requirements and contract documents: Comply with the one establishing the

more stringent requirements.

1.4 SUBMITTALS

A. Submittal Package

1. All submittal packages must be furnished with, but not limited to, a cover page detailing what specification (number and name) the submittal is referencing, what company is furnishing the submittal, a consecutively assigned submittal number, submittal date, etc.
2. If furnished electronically, each submittal must be bound into 1 PDF file by specification or logical grouping.
3. Resubmittals must reference the original submittal number suffixed with a letter (A, B, C etc..) or R1, R2, R3, etc.

B. Contractor qualifications: Furnish evidence of meeting the requirements for contractor qualifications specified in this section.

C. Shop drawings indicating the intended cable layout and pulling plan prior to beginning cable pulling.

D. Manufacturers' data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment.

E. Shop Drawings to be submitted and approved before implementation is started.

F. Record Drawings.

1. Furnish CAD drawings. Refer to Section 270500 for labeling conventions.

G. Submit installation plan indicating:

1. Equipment and personnel
2. Materials and staging area
3. Start and completion dates
4. Locations, including floor, room and building

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

C. Maintain temperature of between 64 degrees Fahrenheit and 75 degrees Fahrenheit and between 30 and 55 percent humidity in areas of active electronic system work.

1.6 QUALITY ASSURANCE

A. Submit written proof that the following experience requirements are being met.

1. Contractor Qualifications
   a. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last eight years.
2. Perform work in accordance with the latest editions, revisions, amendments or supplements of applicable statutes, ordinances, codes or regulations of Federal, State and Local Authorities having jurisdiction in effect on the date bids are received.
3. Where approval standards have been established by OSHA, Underwriter's Laboratories, ASME, AGA, AMCA, ANSI, ARI, NFPA 70, State Fire Insurance Regulatory Body, and FM, these standards shall be followed whether or not indicated on the Contract Drawings and Specifications. Include the cost of all work required to comply with the requirements of these authorities in the original proposal. Comply with ANSI C2 where applicable.
4. 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 plans or specifications shall be made without full consent in writing of the Engineer.
5. Monitor and maintain quality control over manufacturers, suppliers, subcontractors, work force, site conditions, products, and services to ensure Work is of specified quality.
6. Provide all materials, equipment, and installation in compliance with the latest applicable standards from ANSI, FCC, ASTM, EIA/TIA, IEEE, NEC, NFPA, NEMA, REA, and UL.
7. Requirements in reference specifications and standards are minimum for all equipment, material and work. In instances where capacities, size or other features of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
8. Resolve any code violation discovered in contract documents with the A/E prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional compensation.
9. Arrange with local and state authorities and utility companies for permits, fees and service connections, verifying locations and arrangement, and pay all charges including inspections.

B. Standard products:

1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer’s latest standard design in satisfactory use for at least one year prior to bid opening.
2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

1.7 CONTRACTOR’S DUTIES

A. The Contractor shall provide all calculations and analysis to support design and engineering decisions as specified in the Submittals section.

B. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services/programming to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.

C. Secure and pay for plan check fees, permits, fees, and licenses necessary for the execution of Work as applicable for the project.

D. Give required notices, i.e., no work shall commence in an existing MDF/IDF or other equipment room without providing a minimum notice of 30 days to all tenants occupying the applicable space.

E. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.8 MAINTENANCE AND SUPPORT

A. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568, latest edition, or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty-year period.

B. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty period.

1.9 DELIVERY AND STORAGE

A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.

B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.

C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost HAS.

PART 2 - PRODUCTS

2.1 LABELS AND LABELING SYSTEMS

A. Follow Section 270500 – Common Work Results for Communications and Section 270553 – Identification and Labeling for Communications Infrastructure.

2.2 AS-BUILT DOCUMENTATION

A. Upon completion of the installation, Contractor shall prepare as-built documentation of the entire SCS. This documentation shall include:

1. As-Built Drawings

a. Contractor to furnish a full size or half-size laminated as-built showing the Equipment Room floor plan and equipment rack elevations.
b. All drawings shall be provided on disk in a form compatible with AutoCAD 2013. A complete set of project plans will be provided to the Contractor on disk. The Contractor shall modify the drawings by placing the cable information on a separate layer. All of the requested drawings shall be placed on these plans so that all cable routes are to scale and provide accurate information for use in the future when changes are made and the exact location of cables are required to avoid service interruptions.
c. A complete diagram of all cable tray, conduits and conduit sleeves.

2. Documentation
   a. All cable inventory data documentation shall be submitted in designated Microsoft Excel 2007 format, or ASCII, comma delimited files with fields in identical order so that data can be incorporated into existing databases. Follow Section 270553 for additional requirements.
   b. Documentation on horizontal cable shall include cable number and length of cable.
   c. Documentation on riser cable and inter-building cable shall include cable number, source and destination, type of cable, length of cable and number of pairs or fibers.
   d. Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.
3. As-built Drawings and Documentation shall be reviewed, approved and stamped by the Contractor.

PART 3 - EXECUTION

3.1 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted and approved, and Owner Engineer is satisfied that all work is in accordance with contract documents, the Owner's Engineer will notify Contractor in writing of formal acceptance of the system.

END OF SECTION 270510

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 270526 - TELECOMMUNICATIONS GROUNDING & BONDING
(REV. 01-14-2020-TAB)

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

A. The scope of work includes providing communication design services for the Parking Access and Revenue Control Systems (PARCS) for George Bush Intercontinental Airport and for William P. Hobby Airport.

1.2 SECTION INCLUDES

A. Grounding electrodes and conductors.

B. Equipment grounding conductors.

C. Bonding.

D. Communication system grounding.

E. Electrical equipment and raceway grounding and bonding.

F. Control equipment grounding.

1.3 REFERENCES

A. Related Specification Sections

1. Section 270500 Common Work Results for Communications
2. Section 270510 Telecommunication Administration Requirements
3. Section 270553 Identification and Labeling of Communication Infrastructure
4. Section 271100 Communication Cabinets and Equipment Rooms
5. Section 271300 Backbone and Riser Media Infrastructure
6. Section 271500 Horizontal Media Infrastructure
7. Section 272100 Data Communication Network Equipment

B. American Society for Testing and Materials (ASTM):

1. B 3 Soft or Annealed Copper Wires
2. B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
3. B 33 Tinned Soft or Annealed Copper Wire for Electrical Purposes

C. Institute of Electrical and Electronics Engineers (IEEE):

1. 142-82 Recommended Practice for Grounding of Industrial and Commercial Power Systems
2. 383-2.5 IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.

3. 1100 IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems.

D. Underwriters' Laboratories (UL):

1. 83 Thermoplastic Insulated Wire and Cables
2. 96 Lightning Protection Components
3. 96A System Installation
4. 467 Grounding and Bonding Equipment

E. National Fire Protection Association (NFPA):

1. 780 Lightning Protection Code
2. 70 National Electrical Code (NEC)
   a. NEC Article No. 250 - Grounding

F. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance (ANSI/TIA/EIA):

1. J-STD-607-B Commercial Building Grounding and Bonding Requirements.
2. Telcordia – Network Equipment Building Systems (NEBS) GR-1275.

G. Building Industry Consulting Services International (BICSI):

1. Telecommunications Distribution Methods Manual (Latest Issue)
2. Customer Owned Outside Plant Design Manual (Latest Issue)
3. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

H. Local, county, state and federal regulations and codes in effect as of date of “notice to proceed” shall be complied with.

I. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components which may be of foreign manufacture, if any, and the country of origin.

J. Reference attached Figure 1 for general grounding infrastructure layout and connectivity.

K. Conflicts:

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.4 DESIGN REQUIREMENTS

A. Design grounding system following ANSI J-STD 607-B – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, BICSI Telecommunications Distribution Methods Manual, NECA/BICSI 607-2011, NEC Article No. 250 - Grounding, IEEE 1100 – Recommended Practices for Powering and Grounding Sensitive Electronic Equipment,

and IEEE 142-82 - Recommended Practice for Grounding of Industrial and Commercial Power Systems, by a firm acceptable to Owner's insurance underwriter. All labeling shall follow standards set forth by ANSI/TIA/EIA-606 and Houston Airport System's Information Technology (HAS-IT) requirements.

B. Design Standards:

1. Completely protect above-surface structures and equipment.
2. Calculate system on the basis of existing soil resistivity.
3. If cathodic protection for underground sewer pipe is installed (see applicable Division 2 Sections), ensure the pipe is not connected to the general grounding system, either directly through grounding cable or indirectly through grounded electrical devices connected to the pipe. Electrically isolate electrical devices from sewer pipe.

C. Radio Equipment

1. All Radio equipment/systems shall be grounded per Motorola Standard R56.

1.5 SUBMITTALS

A. Follow Section 013300 & 270510, for the following:

B. Product Data:

1. Manufacturers catalog data and applicable special fabrication and installation details.
2. Installation, terminating and splicing procedures.
3. Instructions for handling and storage.
4. Dimensions and weights.
5. Conformance Certificate and Quality Assurance Release: Signed by QAP Manager. Specifically identify products and include purchase order number, supplements, and item number where applicable. Indicate that requirements are met and identify approved deviations.
6. Include spares list to be approved by HAS IT Project Manager, whichever is applicable, for approval.

1.6 QUALITY ASSURANCE

A. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.

B. Tests for Insulated Cable: Pass vertical tray flame test following IEEE 383-2.5.

C. HAS and/or the Owner retains the right to inspect all work during the entire duration of the project and any items that do not adhere to the reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

1.7 SHIPPING AND HANDLING

A. Ship on manufacturer's standard reel sizes of one continuous length. Where cut lengths are specified, mark reel quantity accordingly.

B. Protect wire wood lagging or suitable barrier across the traverse of reels. Provide heat-shrink self-sealing end caps on cable.

C. Equipment shall be delivered in original packages with labels intact and identification clearly marked. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other containments. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owners.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cable Manufacturers/Suppliers:

1. Houston Wire and Cable Company
2. Okonite Company
3. Anixter
4. Graybar
5. CSC (Communication Supply Company)
6. Cablec Continental Cables Company
7. Pirelli Cable Corporation
8. Triangle Wire and Cable, Inc.

B. Ground Rod and Connector Manufacturers:

1. Copperweld
2. Thomas & Betts
3. Blackburn

C. Exothermic Connector Manufacturers:

1. Erico Products (Cadweld)
2. Burndy Corporation (Therm-O-Weld)
3. OZ Gedney

D. Grounding Connector Manufacturers:

1. Thomas & Betts
2. Burndy Corporation
3. O.Z. Gedney
4. Panduit

E. Telecommunications Busbars:

1. Erico Products
2. Cooper B-Line
3. CPI Chatsworth
4. Panduit

2.2 MATERIALS

A. Grounding Conductors: Bare or insulated copper AWG wire following ASTM-B3, ASTM-B8 and ASTM-B33, of following sizes:

1. A minimum of 6 AWG, stranded, insulated (green) copper conductor shall be used for communications since this accommodates different code requirements and allows for future changes.
2. Metallic cable shield shall NOT be used as a Telecommunication Bonding Backbone (TBB).
3. A minimum of #1/0 AWG shall be used for the TBB up to 50'. A minimum of #3/0AWG shall be used for a TBB greater than 50'. Route the TBB in conduit between equipment rooms. Size conduit per NEC requirements for 40% fill.
4. Interior water piping system shall NOT be used as a TBB

B. Grounding Connectors: It is recommended that connectors should be one of the following:

1. Tin-plated copper.
2. Copper.
3. Copper alloy.

C. Ground Rods: A minimum of 10 feet long, 3/4-inch diameter, copper-clad steel.

D. Where single conductor insulated grounding conductors is required, furnish green color (or tape marking) insulation rated for 600 volts.

E. Telecommunications Main Grounding Busbar (TMGB):
1. HAS
   a. The TMGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two holed lugs must be attached to busbar)
   b. The TMGB shall be sized for the immediate requirements and allow for100% growth.
   c. The minimum busbar dimensions are .25” thick x 4” wide x 20” long.
   d. The busbar shall be electrotin plated for reduced contact resistance.

F. Telecommunications Grounding Busbar (TGB):

1. The TGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two holed lugs must be attached to busbar)
2. The TGB shall be sized for the immediate requirements and allow for 100% growth.
3. The minimum busbar dimensions are .25” thick x 2” wide x 12” long.
4. The busbar shall be electrotin plated for reduced contact resistance.
5. Furnish with plexiglass cover.

G. Rack-Mounted Grounding Busbar (RMGB):
1. HAS
   a. The RMGB shall be a predrilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two holed lugs must be attached to busbar)

b. The TGB shall be sized for the immediate requirements and allow for 100% growth.
c. The minimum busbar dimensions are 3/16” thick x 19” wide x 3/4” long.
d. The busbar shall be electrotin plated for reduced contact resistance.

H. Busbar Insulators for TMGB and TGB

1. The insulators shall be manufactured of rugged polyamide reinforced with glass fiber meeting requirements of UL94 VO for self-extinguishing materials.
2. Minimum height is 2”.

I. Busbar Brackets for TMGB and TGB

1. The wall mounting brackets shall be minimum 1/8” thick type 304 stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Complete site preparation and soil compaction before trenching and driving ground rods for underground use.

B. Verify exact location of stub-up points for grounding of equipment, fences and building or steel structures.

C. Verify wiring for lighting systems is single conductor cable in conduit and each conduit contains a green-color insulated equipment-grounding conductor connected to lighting system. If no ground conductor is present, install conductors as required.

D. Copper and copper alloy connections should be cleaned prior to connection.

E. In new construction, the electrical contractor must provide accessible means to a direct electrical service ground, which is one of the best points for grounding communications systems. NEC Section 250.94 and 800.100 requires an intersystem bonding connection accessible at the electrical service equipment, such as:

1. Approved external connection on the power service panel. The NEC allows direct connection to a provided minimum 6 AWG copper conductor. See Chart 1
2. Exposed metallic service raceway (using an approved bonding connector).
3. Grounding electrode conductor.
4. For connectivity between buildings and rooms, all bonding conductors are to be placed in conduit end to end and conduit should be properly grounded. 3/0 conductor to be placed in 2 inch conduit and minimum 6 AWG to be placed in a 1 inch conduit run.

TBB Conductor Size vs. Length		
TBB/GE Linear Length	TBB/GE Size	Conduit Size
Feet (m)	(AWG)	Inch
Less than 13' (4) 6	6	1”
14–20' (4 -6)	4	1”

TBB Conductor Size vs. Length		
21–26' (6–8)	3	1”
27–33' (8–10)	2	1”
34–41' (10–13)	1	1”
42–52' (13–16)	1/0	1”
53–66' (16–20)	2/0	1”
37–84' (20–26)	3/0	1.5”
85–105' (26–32)	4/0	1.5”
106-125’	250	1.5”
126-150’	300	1.5”
151-175’	350	1.5”
176-250’	500	2”
257-300’	600	2”
>301’	750	2”
*Reference ANSI-J-STD-607-B for more information.		

3.2 INSTALLATION

A. Install work following drawings, manufacturer’s instructions and approved submittal data.

B. Bonding conductors shall be routed with minimum bends or changes in direction and should be made directly to the points being bonded, and shall be one continuous run NO splices.

C. Bonding connections shall be made by using:

1. Double crimp connectors only for all horizontal runs (cabinets trays etc.). Use listed hardware that has been laboratory tested. For double crimp connectors use 2 hole type connector.
2. Exothermic welding (per NEC) within the ground electrode system, for parts of a grounding system that are subject to corrosion or that must carry high currents reliably, or for locations that require minimum maintenance. Exothermic-weld to be used on the Telecommunications Bonding Backbone (TBB) conductor for all connections.

D. Install main ground loop minimum 18” (inches) below ground surface.

E. Drive grounding rods vertically, so at least 8 feet of rod is in contact with the soil. All connections shall be exothermic-weld. Install additional ground rods as required to pass resistance test.

F. Make connections only to dry surfaces with paint, rust, oxidation, scales, grease, dirt or other foreign material is removed. Ensure proper conductivity.

G. Make above-grade grounding connections with Exothermic-weld.

1. Ground small groups of isolated equipment with No. 3/0 minimum insulated conductor connected to the main loop.

H. Equipment Grounding:

1. Make grounding connections to electrical equipment, vessels, mechanical equipment, equipment enclosure, relay racks, and ground rods in accordance with NEC.
2. Make grounding connections to tanks and vessels to integral structural supports or to existing grounding lugs or pads, and not to the body of the tank or vessel.
3. All equipment grounding conductors must have green insulated jacket.

I. Telecommunications Raceway and Support Systems Grounding:

1. Bond and ground raceway, cable rack or tray and conduit together and permanently ground to the equipment grounding busbar. Connection to conduit may be with grounding bushing.
2. Connect ladder-type cable tray to grounding electrode system. Telecommunications cable tray that is located in the same room, as the TGB shall be connected to the TMGB.
3. Bond and ground raceway at low voltage motor control centers or other low voltage control equipment, except conduit which is effectively grounded to sheet metal enclosure by bonding bushing or hubs need not be otherwise bonded.
4. Where only grounding conductor is installed in a metal conduit, bond both ends of conduit to grounding conductors.
5. Provide flexible "jumpers" around raceway expansion joints and across cable tray joints parted to allow for expansion and hinged cable tray connections. Provide copper bonding straps for steel conduit.
6. For any painted surface with ground connections, thoroughly remove paint prior to connecting ground.
7. Provide copper bonding straps for steel conduit.

J. Telecommunications Grounding and Bonding Infrastructure:

1. Install the TMGB in the Telecommunications Entrance Facility (TEF) or Main Distribution Frame (MDF) as close to the panel-board as possible. The TMGB shall also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
2. If a panel-board is not installed in the TEF or MDF, locate the TMGB near the backbone cabling and terminations.
3. The TMGB shall be insulated from its support with a recommended separation of 2 inches.
4. Connect the TMGB to the electrical service ground and telecommunications primary protectors.
5. The minimum Telecommunications Bonding Backbone (TBB) conductor size shall be No. 2 AWG. The TBB originates at the TMGB and extends throughout the building using the telecommunications backbone pathways, and connects to the TGB(s) in all telecommunication closets and equipment rooms.
6. Install the TGBs in the telecommunications closets and equipment rooms as close to the panel-board as possible. The TGB shall also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
7. The TGB shall be insulated from its support with a recommended separation of 2 inches.
8. Properly bond and ground all communications cabinets, equipment racks, raceway, cable rack or tray, and conduit directly to TMGB or TGB. Daisy chaining of equipment is not permitted
9. Refer to the Telecom Grounding diagram in the design documentation (see figure 1).

10. Preparation: Copper and copper alloy connections shall be cleaned prior to connecting.
11. Bonding conductors shall be routed with minimum bends or changes in direction and shall be made directly to the point being bonded. Change of direction shall be taken over as wide a radius as possible with a minimum radius of one foot.
12. Make connections only to dry surfaces with paint, rust, oxides, scales, grease and dirt removed. Ensure proper conductivity.
13. Grounding conductors, by gauge, shall be continuous, with splices, from a larger gauge feeder to the last frame or component served by the grounding lead (ex. 750 KCM to 500 KCM to 1/0, etc.).
14. C-Taps from Aisle equalizer to a frame can be the same gauge (ex. E.g., 6 AWG to 6 AWG).
15. Cable to Cable taps shall be made with exothermic weld, or listed compression connectors.
16. No aluminum conductors or connectors shall be used in any bonding and grounding system.
17. Ground bars not supplied as part of a standard assembly shall be copper or tinned copper.
18. Refer Telecommunications Grounding drawings for additional information.
19. Both ends of the grounding conductors shall be equipped with a printed destination label recording the far end termination. The label shall be applied within 6 inches of the termination and be visible from the floor.
20. All metallic items that interact electro-magnetically with Network/Telecommunications equipment shall have their framework bonded and grounded to the Telecommunications grounding system with a minimum #6 AWG grounding conductor. Example includes switch frames, power plants frames, battery stands, storage cabinets and other metallic objects, etc. “Daisy Chaining” or frame to frame connecting of these conductors is NOT permitted.
21. TMGB and TGB shall be furnished with stand-off plexiglass cover and shall be stenciled and labeled per HAS requirements.
22. Locate all TMGB and TGB at 6’-0” AFF unless otherwise noted. Do not locate lower than 54” AFF.
23. All ground cables must be labeled on each end. Label shall include TO and FROM designators and shall be wrapped around cable jacket and heat shrunk.

K. Fences and Gates in the equipment rooms:

1. Ground fences, fence posts and gates to nearest TMGB or TGB.

L. Telecommunications Cable Armored and/or Shielded:

1. Terminate and ground shield of shielded control cable at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables. Maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes or other splice points.
2. Connect ground wire in power cable assemblies at each terminal point to a ground bus, if available, or to the equipment enclosure. Do not extend these ground wires through "doughnut" CTs used for ground fault relaying, but do extend ground leads from stress cones. Ground power cable armor and shield at each terminal point.
3. Bond and ground exposed cable shields and metallic sheaths according to the manufacturer’s guidelines. They shall also be grounded as close as possible to the point of entrance.
4. Intra-building telecommunications cabling that is armored or has a metallic shield be bonded to the building grounding system at each end.

3.3 TESTING

A. Follow Section 270510 – Telecommunication Administrative Requirements.

B. Test grounding system before grid trenches are back-filled. Test for ground resistance after installation of underground grid and grounding connections.

C. Install ground access test wells at locations as required for testing, using a pipe surrounding the rod and connections with a cover placed on top at grade level.

D. Test system resistance at each test well using "Fall of Potential" method Per IEEE Standard No. 81-1983) with a maximum resistance of 5 ohms.

E. Upon completion of the electrical system, including all grounding, the Electrical Contractor shall test the system for stray currents, ground shorts, etc. Approved instruments, apparatus, service, and qualified personnel shall be utilized. If stray currents, shorts, etc., are detected, eliminate or correct as required. The test procedure shall be as follows:

1. Open all main disconnects for the system being tested.
2. Disconnect the system neutral from the service entrance or step-down transformer neutral connection.
3. Connect a DC ohmmeter across the system neutral and equipment ground.
4. Submit all ground tests to engineer for review and approval.
5. An ohmmeter reading in excess of 100 ohms shall indicate that the system neutral and equipment ground are properly isolated.
6. An ohmmeter reading less than 100 ohms shall indicate that the system contains ground shorts (stray currents) at some point along the system neutral.
7. Grounded neutrals may be identified by disconnecting individual neutral conductors from the system, one at a time, while monitoring the ohmmeter.
8. The systems shall be re-tested after correction of all ground shorts is complete.

END OF SECTION 270526

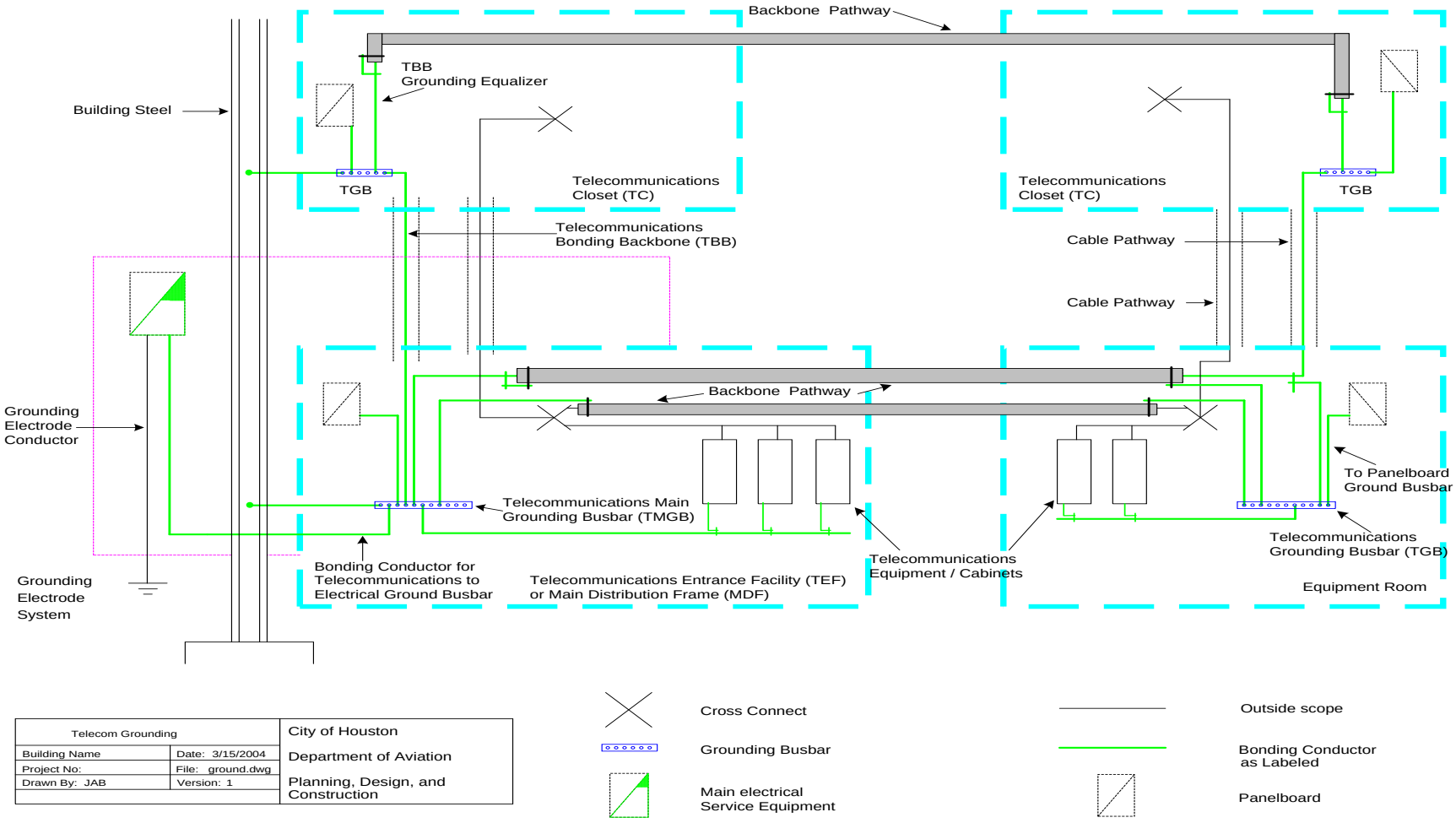

Backbone Pathway
TBB
Grounding Equalizer
Building Steel
TGB
Telecommunications
Closet (TC)
Telecommunications
Bonding Backbone (TBB)
Telecommunications
Closet (TC)
TGB
Cable Pathway
Cable Pathway
Backbone Pathway
Grounding
Electrode
Conductor
To Panelboard
Ground Busbar
Telecommunications Main
Grounding Busbar (TMGB)
Telecommunications
Grounding Busbar (TGB)
Bonding Conductor for
Telecommunications to
Electrical Ground Busbar
Telecommunications Entrance Facility (TEF)
or Main Distribution Frame (MDF)
Telecommunications
Equipment / Cabinets
Equipment Room
Grounding
Electrode
System
Telecom Grounding
City of Houston
Building Name
Date: 3/15/2004
Department of Aviation
Project No:
File: ground.dwg
Drawn By: JAB
Version: 1
Planning, Design, and
Construction
Cross Connect
Outside scope
Grounding Busbar
Bonding Conductor
as Labeled
Main electrical
Service Equipment
Panelboard

Figure 1

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 270528 - INTERIOR COMMUNICATION PATHWAYS (REV.01-23-2020-SJS)

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

A. The scope of work includes providing communication design services for Parking Access and Revenue Control Systems (PARCS) at George Bush Intercontinental Airport and at William P. Hobby Airport.

1.2 SECTIONS INCLUDES

A. This section includes specifications for the installation of interior communications pathways.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.

C. Interior Communication Pathways are defined to include, but are not limited to innerduct, flexible multi-cell innerduct, conduit, pull boxes, cable/j-hooks, cable trays, supports, accessories, associated hardware and fire stopping materials.

1.3 REFERENCES

A. Related Sections:

1. Section 270500: Common Work Results for Communications
2. Section 270510: Telecommunication Administrative Requirements
3. Section 270526: Telecommunication Grounding and Bonding
4. Section 270553: Identification and Labeling of Communication Infrastructure
5. Section 271100: Communication Cabinets and Equipment Rooms
6. Section 271300: Backbone and Riser Media Infrastructure
7. Section 271500: Horizontal Media Infrastructure
8. Section 272100: Data Communication Network Equipment

B. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance (ANSI/TIA/EIA): Most current standard revision

1. 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
2. 568-D, Commercial Building Telecommunications Cabling Standard

C. American National Standards Institute (ANSI):

1. C80.1 Rigid Steel Conduit - Zinc Coated
2. C80.4 Fittings for Rigid Metal Conduit

D. Federal Specifications (FS):

1. W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron
2. W-C-1094 Conduit and Conduit Fittings Rigid

3. WW-C-581D Coatings on Steel Conduit

E. Building Industry Consulting Services International (BICSI):

1. Telecommunications Distribution Methods Manual(latest issue)
2. Customer Owned Outside Plant Design Manual (latest issue)

F. National Electrical Manufacturers Association (NEMA).

1. VE 1-1998 - Metallic Cable Tray Systems
2. VE 2-2000 - Cable Tray Installation Guidelines
3. RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
4. TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
5. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing

G. Underwriters laboratories (UL) Cable Certification and Follow Up program

1. UL 6: Rigid Metal Electrical Conduit.
2. UL 514B: Fittings for Conduit and Outlet Boxes.
3. UL 651: Schedule 40 and 80 Rigid PVC Conduit.
4. UL 651A: Type EB and A Rigid PVC Conduit and High Density PolyEthylene (HDPE) Conduit.
5. UL 886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

H. American Society for Testing Materials (ASTM).

1. ASTM B633 – specification for Electro-Deposit Coating of Zinc on iron and Steel.
2. ASTM A653 – Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process.
3. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability (Formerly ASTM A570 &A607)
5. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A611)

I. National Electrical Code (NEC latest issue).

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

K. Systimax generic specifications: Fiber Optic Outside Plant Cable, Latest issue.

L. Sumitomo FutureFLEX Cabling System Specification, Latest Issue

M. International Standards Organization/International

N. Specification 270528 – Interior Communication Pathways and the Houston Airport System Standards and Specifications located at

https://www.fly2houston.com/biz/resources/building-standards-and-permits/.

O. Electromechanical Commission (ISO/IEC) DIS 11801

P. Conflicts:

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.4 SUBMITTALS

A. Submit Shop Drawings to include but not limited to plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited to:

1. Room penetration plan.
2. Communication pathway extension plan.
3. Riser conduit anchoring plan.
4. Conduit chase plan.
5. Communication pathway labeling plan.
6. Junction box, gutter and pull-box labeling plan.

B. Shop Drawings shall be submitted and approved before implementation is started. Shop Drawings shall be submitted in accordance with Specification 013300 & 270510.

C. Submit prototype test reports for all vault covers verifying conformance to the specification requirements in this document and HAS.

D. Submit catalog data sheets of conduit, innerduct, raceway, cable tray, cable hook and associated hardware. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

E. Test Reports: Submit certified test reports indicating compliance with material reference standard indicated for material performance characteristics and physical properties of fire stopping materials

F. Certificates: Submit product certificates, signed by manufacturer certifying materials comply with specified performance characteristics and physical properties of fire stopping materials.

G. Copy of Building Industry Consulting Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor’s on-site RCDD supervisor. RCDD shall supervise all parts of communications installation at all times.

1.5 QUALITY ASSURANCE

A. Verify conduit, raceway, cable tray runs, etc. shall not interfere with existing or new systems within each facility.

B. Fire stopping: Manufacturer trained and approved installer to perform fire stopping work who

has specialized in the installation of work similar to that required for this project.

C. Communication Pathway Minimum Clearances:

1. Motors or transformers: 4 feet
2. Power cables and conduits: 1 foot parallel, 3 inches crossover
3. Fluorescent lights: 5 inches
4. Above ceiling tiles: 3 inches
5. Access above cable tray: 12 inches
6. Hot Flues, Steam pipes, Hot water pipes and other hot surfaces: at least 6”

D. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.

E. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

F. All installed materials and accessories shall be new from the manufacture. No used components shall be accepted by HAS.

G. All Documentation submittals shall be reviewed by the supervising RCDD and stamped prior to submittal.

H. Contractor Qualifications:

1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
2. A BICSI RCDD shall supervise ALL work. Must demonstrate knowledge and compliance with all BICSI, ANSI/TIA/EIA, UL, and NEC standards and codes.

I. HAS retains the right to have access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at NO cost to HAS.

J. All communication media will be installed in conduit or cable tray unless alternate method has been approved by HAS/IT.

1. Exception: MATV/CATV horizontal media must be installed in conduit from faceplate to MDF/IDF.

2. Exception: PA System Cables where amplification occurs must be installed in conduit or cabletrays (not shared with other horizontal media) from device to equipment room termination panel.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where conduit, pull boxes, cable tray and other raceway sizes are not specifically shown on contract drawings. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC. No conduit shall be less than 1".

B. All raceways exposed to the elements or possible physical damage or installed below 8 feet shall be Rigid Metal Conduit.

C. Raceway exposed to elements, not exposed to physical damage and above 8 feet shall be Intermediate Metal Conduit.

D. Raceways installed in stud walls or above suspended ceilings shall be Electrical Metallic Tubing.

E. All exposed raceways must be painted to match adjacent surfaces.

F. Install PVC coated metal conduits in outdoor above-ground locations, inside valve vaults and we wells, and in corrosive and wet environments.

G. All backbone and riser conduits installed shall be populated with MaxCell flexible innerduct. Cable fill ratio not to exceed 40%.

2.2 CONDUIT AND ACCESSORIES

A. Manufacturers:

1. Allied
2. Triangle
3. Wheatland

B. Rigid Steel Conduit shall pass all bending, ductility, and thickness of zinc coating in ANSI C80.1 and UL 6. Conduit shall be galvanized have threaded end with 1” minimum size and 4” maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.

C. Intermediate Metal Conduit (IMC) shall be manufactured in accordance with UL 1242. Conduit shall be low carbon, hot-dipped galvanized inside and out, with threaded ends, 1” minimum size, and 4 inch maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.

D. Electrical Metallic Tubing (EMT) shall be manufactured in accordance with UL 797 and ANSI C80.3. EMT shall be high-strength, zinc-coated, 1 inch minimum size. EMT may be used for sizes greater than 2" where physically protected. EMT shall not be utilized for service entrance conductors. Fittings shall be of same finish and material as tubing. Fittings shall be compression type with insulated throat and screw on bushings.

E. Expansion Joint Fittings: OZ type AX or Appleton type XJB, watertight, permitting two-way movement up to 4 inches, equipped with bonding jumpers around or through each fitting.

F. Thruwall Sealing Fittings: Type WSK by O-Z Gedney Company.

G. Fire-Seal Fittings: Type CFSI by O-Z Gedney Company.

H. Sealing Material for Sealing Fittings: Chico X Fiberdam, and Chico A sealing compound, or Chico A-P interpak by Crouse-Hinds or Apelco sealing cement and fiber filler by Appleton.

I. Insulated Bushings: Type B or SBT, as applicable, by O-Z Gedney or series B1900, series BU500 or series TC700, as applicable, by Steel City.

J. Provide a measured pull tape in each empty conduit, empty innerduct for backbone and riser pathways.

K. Provide a pull string for all horizontal conduits with a minimum pulling tension of 200 pounds.

L. Thread lubricant/sealant shall be Crouse-Hinds type STL or T & B Kopr-Shield except, when required on joints for heat producing elements such as lighting fixtures, it shall be Crouse-Hinds type HTL.

M. PVC Conduit shall not be used in intercommunication pathways. Except when encased in concrete. Provide label on all conduit stubs inside room, each conduit end and all box or junction structures. Label to include To/From destination. Labels shall be clearly visible with maximum of two lines of text. Size text equivalent to ¼ of the conduit diameter. I.E.: use ¼" text for 1"C; use 1" text for 4"C.

2.3 FLEXIBLE MULTI-CELL INNERDUCT

A. Manufacturers:

1. MaxCell
2. Or HAS approved equivalent

B. Flexible Innerduct

1. Flexible innerduct is the HAS standard for multi-path applications within conduit.
2. All riser/backbone fiber shall be installed in flexible innerduct.
3. Flexible Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024A.
4. All flexible innerduct shall be installed per manufacture requirements.
5. Only manufacturer's fittings, transition adapters, terminators, accessories and installation kits shall be used.
6. All flexible innerduct will be populated with a measured pull tape.
7. All interior flexible innerduct shall be plenum rated.
8. Flexible innerduct shall only be used when installed in conduit and shall consist of a different color for the Maxcell.

MaxCell 4" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 4" 3 Cell	1	3	1.34"	1500'	2000'
4"	MaxCell 4" 3 Cell	2	6	1.34"	1500'	2500"
5"	MaxCell 4" 3 Cell	3	9	1.34"	1500'	2500'
6"	MaxCell 4" 3 Cell	4	12	1.34"	1500'	2500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

MaxCell 3" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 3" 3 Cell	2	6	1.03"	1200'	2000'
4"	MaxCell 3" 3 Cell	3	9	1.03"	1500'	2500"
5"	MaxCell 3" 3 Cell	4	12	1.03"	1500'	2500'
6"	MaxCell 3" 3 Cell	5	15	1.03"	1500'	2500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

MaxCell 2" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
2"	MaxCell 2" 3 Cell	1	3	.70"	800'	1500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

2.4 INNERDUCT

A. Manufacturers:

1. Carlon
2. Pyramid
3. Or HAS approved equivalent

B. Innerduct

1. All fiber placed in cable tray shall be installed in corrugated innerduct.
2. Interior innerduct shall be orange for multimode fiber and yellow for singlemode fiber.
3. One-inch corrugated, non-metallic innerduct.
4. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.
5. Only manufacturer's fittings, transition adapters, terminators and fixed bends shall be used.
6. All empty innerduct will be populated with a measured pull tape.
7. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color from end to end (ex. Orange, Blue, Black and White). Do not couple innerduct of different colors without HAS approval.
8. All interior innerduct shall be plenum rated, unless installed in conduit.
9. Label all innerduct at ends, upon entering a room at wall or floor sleeves and in all boxes or junction structures. Label to include To/From designation and associated fiber cable id.

2.5 SUMITOMO TUBE CABLES AND HARDWARE

A. Indoor Tube Cable

1. All indoor tube cables shall be composed of dielectric materials and properly rated (i.e. – plenum/riser/general purpose) per application. (TCxxTRX-Riser, and/or TCxxTP2 –

Plenum) To be installed per Sumitomo Recommended Procedure SP F-04-008 Tube Cable Installation Procedures.

2. During installation, tube cable ends are to be completely sealed per manufacturer's recommended procedures to prevent ingress of contaminants. SP F-04-019 – Tube & Tube Cable Sealing Procedures.
3. The minimum bend radius shall be 20 times the cable diameter during installation and 10 times the cable diameter after installation.
4. Upon completion of tube cable installation, all tubes shall pass the Standard Pressure and Obstruction Tests per the Sumitomo Electric's Recommended Procedures. (SP F-04-003 – Tube Pressure Testing Procedure and SP F-04-004 – Tube Obstruction Testing Procedure).
5. After fiber installation all unoccupied tubes shall be plugged on both ends per manufacturer's specifications. (SP F-04-019 – Tube & Tube Cable Sealing Procedures.
6. All Fiber Tube Distribution Units (NEMA rated per application); Tube-Splice Enclosures, Splice Cases, and Cold-Shrink Enclosures shall be installed per applicable manufacturer's recommendations. (SP F-04-008 – Tube Cable Installation Procedures, SP F-04-011 – Restoration Procedures – Dielectric Tube Cables & Tube Cable Splice Kits, SP F-04-012 – Restoration Procedures – Metallic Tube Cables & Splice Case Kits, SP F-04-015 – Splice Case Kit Installation Procedures, SP F-04-016 – Tube Cable Splice Kit Installation Procedure, SP F-04-019 – Tube & Tube Cable Sealing Procedures (for applications outside of classified areas), SP F-04-029 – Plenum Rated Jacketed Tube Cable TCxxTP2 Installation Procedure, SP F-04-030 – Grounding & Bonding Metallic Tube Cable Procedure, SP F-04-031 – Tube Cable Splicing Procedure.)

B. Fiber Tube Distribution Units (TDU'S)

1. A NEMA-rated enclosure, suitable for the site environmental conditions (i.e. a generic NEMA rated box for indoor use) shall be provided for tube distribution, routing, and termination
2. TDUs shall be installed as shown in the drawings, wherever several Tube Cables enter the same location or where Tube Cable type transitions take place.
3. The contractor is responsible for selecting the TDU hardware to meet site conditions.
4. Coordinate TDU size with the manufacturer prior to construction. The size is based on the number of tubes to enter the unit and Sumitomo recommended Procedure SP F-04-005 – Indoor, Wall Mount TDU Installation Procedure. Only 7"D enclosures are approved for use.
5. TDUs shall be mounted to provide the best geometry for distribution.
6. Furnish all TDU's with tube brackets and strain relief.
7. Furnish all TDU's with a lock.

~~2.5~~2.6 CABLE TRAYS

A. Manufacturers:

1. B-Line
2. Cope
3. Panduit

B. Cable Tray

1. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
2. Materials and Finish: Material and finish specifications for each tray type are as follows:
   a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
   b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties in accordance with ASTM A653 SS.
   c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray.
   d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.
   e. Rigid PVC (Channel), ABS (Fittings) with the Flammability rating 94V-0, UL listed to 2024A Optical Fiber Cable Routing Assemblies Compliant with the applicable tests in Telcordia GR-63-CORE Network Equipment Building Systems Level 3.

~~2.6~~2.7 TYPE OF TRAY SYSTEMS

A. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 or 12 inches on center. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.

B. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4 inch rectangular holes punched along the width of the bottom.

C. Wire Basket Tray shall consist of steel wire (ASTM A510) with black powder coat finish and shall be UL listed as an equipment grounding conductor. Remove finish at splice contact points for grounding compliance. Use the manufacturer recommended quantity of splices to connect sections and at places where tray is cut. The top edge of the wire mesh tray shall be smooth. All mesh wires shall have rounded ends. Use splice bar with minimum of 3 washers on each tray side at all cabletray splice locations. Use manufacturers recommended materials and installation methods. Use only radius turns. Where interior bend is 90 degrees due to nature of mesh tray, provide additional manufacturer components as required to maintain a smooth radius (radius shield, cable rollers, etc).” Install wirebasket tray cable tray bottom

inserts when tray is installed inside a telecommunication equipment room (MDF/BDF/IDF, etc).

D. All tray sizes and types shall have a minimum of 4 inch usable load depth.

E. All straight sections shall be supplied in standard 10 foot length, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.

F. Tray widths shall be noted on contract documents.

G. All fittings must have a minimum radius of 12 inches.

H. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.

1. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1.
2. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.

I. Cable Tray Support shall be placed so that the support spans do not exceed maximum span indicated on drawings or by the manufacturer. Supports shall be Trapeze style support. Cable trays installed adjacent to walls shall be supported on wall mounted brackets as specified by the manufacturer.

J. Trapeze hangers shall be supported by 3/8 inch (minimum) diameter all thread rods.

K. Accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, waterfall plates, barriers, etc.

L. All cable tray components and accessories will be from the same manufacturer. Parts from different manufacturer will not be intermixed.

M. All cabletrays, ladder racks and wire basket trays shall be grounded following manufacturer recommendations, ANSI/EIA/TIA-606 specifications and NEC. Install minimum #6 AWG copper cable with green jacket from tray to TGB/TMGB.

~~2.7~~2.8 CABLE HOOK SYSTEMS (J-Hooks)

A. Cable hooks must be pre approved by HAS/IT prior to installation.

B. Cable hooks shall have a flat bottom and provide a minimum of 1-5/8 inch cable bearing surface.

C. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.

D. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.

E. Cable hooks shall have a cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.

F. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.

G. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.

H. Cable hooks for corrosive areas shall be stainless steel, AMERICAN IRON STEEL INSTITUTE Type 304.

I. All Cable Hooks shall be supported with minimum ¼" all thread with the appropriate fasteners.

~~2.8~~2.9 FIRESTOPPING MATERIALS

A. Manufacturers:

1. Johns Manville
2. Hilti
3. 3M
4. Unique

B. Description:

1. Performance requirements: Provide firestopping systems that are produced and installed to resist spread of fire according to requirement indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.
   a. F-Rated Systems: in accordance with ASTM E 814
   b. T-Rated Systems: in accordance with ASTM E 814
2. Fire stopping flame spread performance requirements: Provide products with flame-spread ratings of less than 25 and smoke development ratings of less than 50 as determined in accordance with ASTM E 84.
3. Fire Stopping UL performance requirements: Provide products with UL ratings specified for assembly indicated as determined in accordance with UL listings.
4. Use only Hilti CP 653 wall sleeves or a submitted and approved equivalent. All wall sleeves must be mechanically attached to wall per NEC requirements.

~~2.9~~2.10 JUNCTION BOXES/PULL BOXES

A. All pull boxes shall be constructed with a minimum of 14 gauge galvanized steel with an ANSI 61 grey polyester powder finish inside and out over phosphatized surfaces or galvanizes steel unless otherwise specified.

B. All pull boxes shall have flat, removable covers fastened with plated steel screws with unique keyhole screw slots in the cover to permit removal of the cover without extracting screws unless otherwise specified.

1. All removable box covers shall be connected to box with a safety strap or chain for all boxes 8 X 8 or larger.

C. All pull boxes shall provide the appropriate provisioning for grounding.

D. All pull boxes shall be NEMA Type 1 and sized according to the table below unless otherwise specified.

Maximum Trade Size of Conduit (inches)	Minimum Box Size (inches)			For Each Additional Conduit Increase Width (Inches)
	Width	Length	Depth	
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

~~2.10~~2.11 WALL BACKBOARD

A. Reference Specification 271100.

PART 3 - EXECUTION

3.1 GENERAL

A. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded per NEC.

B. The routing and location of all conduits, cable tray, cable hooks and other raceways shall be coordinated with other trades prior to and during building construction to avoid delays and conflicts.

C. Where raceways pass through walls, partitions and floors, seal penetrations to provide a neat installation which will maintain the integrity of the waterproofing or fireproofing, as applicable, of the structure. Coordinate installation requirements with roofing installer where conduits pass through the roof.

D. All raceways entering a building from underground shall be sealed to prevent water, moisture, gas, or any other foreign matter from entering the building. Service conduits shall be sealed in accordance with NEC 230-8.

E. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and records drawings.

F. Do NOT route communication pathways under HVAC condensing units.

G. Expansion Fittings:

1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit funs where necessary. Provide bonding jumpers across fittings in metal raceways systems

H. Where a raceway is exposed, either interior or exterior, it shall be primed and then painted with a minimum of two (2) coats of paint to match adjacent surface color.

3.2 CONDUIT INSTALLATION

A. Rigid and IMC shall be installed with threaded fittings and couplings.

B. The contractor shall consolidate all parallel conduit runs by using one (1) larger size conduit in lieu of multiple small diameter conduits. All conduits shall be sized following Table 9 of the EIA/TIA and shall be based on the installed cables allowing minimum 20% spare capacity.

C. All metallic couplings, connectors and fittings shall be malleable iron or steel and finished with zinc plating or by galvanizing.

D. All conduits shall be plugged immediately upon installation to prevent the entrance of construction dirt and debris. All conduits shall be swabbed and cleaned before wires are pulled.

E. Expansion fittings shall be utilized in all cases where conduits pass through building expansion joints. Fittings shall be of an approved weatherproof telescopic type permitting a movement of up to four inches and shall be provided with approved bonding jumpers around or through the fitting.

F. Connection of Conduit to pull / junction Boxes and Enclosures:

1. Connection to NEMA 1 type boxes and enclosures:
   a. Rigid: Install insulated bushings and double locknuts.
   b. IMC: Install insulated bushings and double locknuts.
   c. EMT: Shall be installed with compression box connectors, insulated throats and bushings.
2. Connection to NEMA 3R, 4, 4X, and 12 type boxes: Install insulated bushings and sealing locknuts or hubs.
3. When conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.
4. Install sealing bushing within all conduits which have entered a building from outside, whether from above or below grade.

G. No section of conduit shall be longer than 30m (100ft) or contain more than two 90 degree bends between pull points, pull boxes, or reverse bends. Offset is considered to be 2 equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bend less than 90 degrees and is not associated with the offset as described herein is considered a 90 degree bend.

H. The inside radius of bends in conduit shall be:

1. 6 times the internal diameter for 2" or less.
2. 10 times the internal diameter for greater than 2".

I. With prior HAS/IT APPROVAL. For Backbone and riser conduit runs ONLY (2" to 4") a special LBD condulet (Crouse-Hinds or approved equal) may be used for CMU penetration where a swept 90 will not work. LBD condulets are designed for communications cable installation to maintain bend radius requirements.

J. A measured pull tape shall be placed in all installed conduit with pull strength of 200 pounds.

K. Any single conduit run extending from a Telecommunication Room shall not serve more than one outlets.

L. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) with the origination and destination location.

Example: **IDF.AMDF>CAM.1023**

M. Conduit shall be reamed to eliminate sharp edges and terminated with an insulated throat bushing along with a screw on bushing and/or grounding bushing.

N. Conduit protruding through the floor shall be terminated at a minimum of 3 inches above the floor surface and a maximum of 5" AFF. All conduits shall stop uniformly while allowing enough space between conduits for installation of a bushing (2" minimum).

O. All stubbed conduit ends shall be provided with a ground bushing.

P. All conduit penetrations shall be provided with the proper conduit sleeves.

1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
2. Sleeves shall be installed in the communications room floor or ceiling a minimum of six inches on center from the wall.
3. Conduit floor sleeves shall be spaced to allow space for insulted ground bushing for cable protection.
4. Shall be installed in a single tier or row from left to right horizontally. If two tiers or rows are required the conduits shall be staggered minimum of 2 inches between tiers.
5. Cable support anchors shall be installed 18 to 24 inches above the sleeves.

Q. All cable (horizontal, riser or backbone) wall or ceiling penetrations shall be provided with the proper conduit sleeves.

1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
2. Sleeves shall be installed in the floor or ceiling a minimum of two to four inches on center from the wall.
3. Sleeves shall be installed in the walls at a minimum of two inches extended on each side of the wall.

4. Cable floor, ceiling and wall sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
5. Shall be installed in a single tier or row from left to right horizontally.
6. If two tiers or rows are required the conduits shall be staggered minimum of 2 inches between tiers.
7. Cable support anchors shall be installed 18 to 24 inches above the sleeves.

R. All conduit and cabinet entrances shall be sealed with an approved, re-enterable sealant material to prevent ingress of water, dust or other foreign materials.

S. Conduit shall not be embedded in the required fire protective covering of a structural member that is to be individually encased in accordance with Building Officials and Code Administrators International, Inc. (BOCA).

T. Install all exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.

U. ALL Conduit Sizing and supports:

1. Support conduit 2 inches and larger at 10 feet on center maximum, and conduit less than 2 inches {1½ inch and smaller}at eight feet on center maximum.
2. Fasten 1½ inch and smaller conduit to concrete, masonry or steel with either one-hole malleable iron conduit straps, or "Korn" clamps, or U-bolts; for larger diameters, use two-hole straps. Use "clamp backs" for strapping conduits to planar surfaces.
3. Multiple runs shall be supported on channel adequately secured to walls or hung from structure above with conduits fastened to channel with clamps designed for the purpose.
4. When installation requires trapeze/rack support minimum 3/8 inch all thread shall be used.
5. When installation requires a single 1 inch conduit ¼ inch all thread shall be used. No hanger wire for any installation.
6. When installation requires single conduit greater than 1 inch, 3/8 inch all-thread shall be used.
7. Cable fill rates should not exceed 40% of the cross sectional area of the installed conduit.

V. Horizontal Conduit Routes:

1. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.
2. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, terminating equipment or cable tray, as indicated in Drawings.
3. Each single horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90 degree bends between pull points, pull boxes, or reverse bends. Offset is considered to be 2 equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with the offset as described herein is considered a 90 degree bend.
4. Each dual horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90 degree bends between pull points, pull boxes, or

reverse bends. Offset is considered two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bend less than 90 degrees and is not associated with an offset as described herein is considered a 90 degree bend. The quantity of conduits entering the junction or pull box shall equal the number of conduits exiting the junction or pull box.

5. Each terminating (outlet end) conduit connection shall be provided with the proper connecting insulated bushing or fitting.
6. Each originating end (communications room end) shall be provided with the proper connecting insulated ground bushing and properly bonded to ground.
7. If flexible conduit is required install must not be longer than 7 feet and must have HAS/IT approval prior to installation.

W. Horizontal conduit entrance in communications rooms – wall entry

1. Horizontal conduits shall enter the communications room wall 12 to 18 inches above the top of the cable tray. Maintain cable bend radius with supporting device as required.
2. Conduit wall stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.
3. All conduit wall stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
4. Conduit crossovers are not permitted.

X. Horizontal conduit entrance in communications rooms – ceiling entry

1. Horizontal conduits shall enter or be extended from the equipment room ceiling 12 to 18 inches above the top of the cable tray.
2. Ceiling conduit stubs shall be spaced in increments equal to the conduit OD from each other.
3. All ceiling conduit stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
4. Conduit crossovers are not permitted.

Y. Horizontal conduit entrance in communications rooms – floor entry

1. Horizontal conduits shall enter the communications room floor two inches to four inches on center from the wall and shall be stubbed 4 inches AFF.
2. Conduit floor stubs shall be spaced in increments equal to the conduit OD from each other.
3. Conduit crossovers are not permitted.

Z. Horizontal conduit to cable tray

1. No horizontal conduits runs shall be attached to the cable tray in any fashion.
2. Conduit terminating end shall be self supporting above the cable tray side rail. Not attached. Minimum of 6 inches above the cable tray and not to exceed 12 inches above the cable tray.

AA. Horizontal Junction/Outlet Boxes

1. Each horizontal conduit shall be terminated into an outlet box.

2. Each outlet box shall be a deep four-inch square junction box with a minimum of two one-inch knockouts on each of the sides.
3. Each conduit home run shall be provided with a deep 4- 11/16" inch square junction box (w/cover) at 100-foot intervals and six inches above each ceiling and wall intersection.

BB. Backbone/Riser conduit entrance in communications rooms – wall entry

1. BB/Riser conduits shall enter the communications room wall a minimum of 24 inches above the top of the cable tray.
2. Conduit wall stubs shall be spaced in increments to equal the conduit OD from each other.
3. BB/Riser conduits shall be installed in a single tier or row from left to right horizontally.
   a. If two tiers or rows are required the conduits shall be staggered between tiers.
   b. No more than two tiers or rows are permitted.
4. All conduit wall stubs shall be extended to and over the cable tray to access cable tray pathway.
5. All BB/riser conduit stubs shall be provided with the proper universal drop-out/ waterfall cable exit runway, which shall be supported by and mounted to channel strut.
6. Conduit crossovers are not permitted.

CC. Backbone/Riser conduit entrance in communications rooms – floor entry

1. BB/Riser conduits shall enter the communications room floor two inches to four inches on center from the wall and shall stub up six inches AFF.
2. Conduit floor stubs shall be spaced in increments to equal the conduit OD from each other.
3. BB/Riser conduits shall be installed in a single tier or row from left to right horizontally.
   a. If two tiers or rows are required the conduits shall be staggered between tiers.
   b. No more than two tiers or rows are permitted.
4. Exiting cable shall be extended to the bottom of the cable tray and be provided with cable support anchors and secured with supporting hardware every six inches above the conduit bushings.
5. Conduit floor stubs shall be extended 6 inches from wall on center and 6 inches above AFF.
6. The BB/riser cable shall be extended in the cable tray to the terminating equipment, as noted in the Drawings.
7. Conduit crossovers are not permitted.
8. Provide ladder tray on wall at all backbone conduit stub up locations to overhead cabletray system to support routing of cables. Ladder tray to be same width and conduit stub up area with minimum 8" width.

3.3 TUBE CABLE INSTALLATION

A. Indoor Tube Cable

1. During installation, tube cable ends are to be completely sealed per manufacturer's recommended procedures to prevent ingress of contaminants. SP F-04-019 – Tube & Tube Cable Sealing Procedures.
2. The minimum bend radius shall be 20 times the cable diameter during installation and 10 times the cable diameter after installation.

3. Upon completion of tube cable installation, all tubes shall pass the Standard Pressure and Obstruction Tests per the Sumitomo Electric's Recommended Procedures. (SP F-04-003 – Tube Pressure Testing Procedure and SP F-04-004 – Tube Obstruction Testing Procedure)
4. After Fiber Installation all unoccupied tubes shall be plugged on both ends per manufacturer's specifications. (SP F-04-019 – Tube & Tube Cable Sealing Procedures.
5. All Fiber Tube Distribution Units (NEMA rated per application); Tube-Splice Enclosures, Splice Cases, and Cold-Shrink Enclosures shall be installed per applicable manufacturer's recommendations. (SP F-04-008 – Tube Cable Installation Procedures, SP F-04-011 – Restoration Procedures – Dielectric Tube Cables & Tube Cable Splice Kits, SP F-04-012 – Restoration Procedures – Metallic Tube Cables & Splice Case Kits, SP F-04-015 – Splice Case Kit Installation Procedures, SP F-04-016 – Tube Cable Splice Kit Installation Procedure, SP F-04-019 – Tube & Tube Cable Sealing Procedures (for applications outside of classified areas), SP F-04-029 – Plenum Rated Jacketed Tube Cable TCxxTP2 Installation Procedure, SP F-04-030 – Grounding & Bonding Metallic Tube Cable Procedure, SP F-04-031 – Tube Cable Splicing Procedure.)
6. Contractor shall furnish all required installation tools to facilitate Tube Cable installation without damage to the cable jacket. Such equipment is to include, but not be limited to, sheaves, winches, cable reels, cable reel jackets, duct entrance funnels, pulling tension gauges, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices that may move or wear in a manner to pose a hazard to the cable or employees shall not be used.
7. Tube Cable pulling shall be done in accordance with cable manufacturer's recommended procedures (SP F-04-008 – Tube Cable Installation Procedures, SP F-04-029 – Plenum Rated, Jacketed Tube Cable TCxxTP2 Installation Procedures) and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and minimum bending radii shall not be exceeded. Any tube cable bent or kinked to a radius less than recommended shall not be installed.
8. During tube cable pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.
9. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable material used. Lubricant shall not harden or become adhesive with age. (i.e.- Polywater)
10. Avoid abrasion and other damage to cables during installation.
11. Tube Cable slack is required for thermal expansion/contraction per manufacturer's recommendations. (See SP F-04-008 – Tube Cable Installation Procedures)
12. Tube cable shall be riser or plenum-rated if required by the installation environment.
13. Where not installed in a continuous length, tube cable segments shall be spliced using tube couplings designed for that purpose and housed within a properly rated TDU (tube distribution unit), splice case, or cold shrink boot per manufacturer's specifications and labeled appropriately.
14. Where multiple TDU's are installed, provide (2) 3" conduit pathways between the units.
15. Where a TDU is installed in an equipment room (ER, MDF, IDF, BDF, TR), provide a 3" knock-out with rubber grommet in the TDU enclosure for individual clear tube routing from the TDU to the equipment rack. All tubes inside the TDU and from the TDU to the equipment rack shall be individual clear tubes.
16. Furnish all TDU enclosures with perf panel kits for neat organization and management of tube cables.

~~9.~~17. All TDU, Tube Cables and Tubes shall be clearly labeled with origin, destination, component ID, and associated fiber cable ID, etc. Labels for tube cables shall be located at all accessible locations and at 35' intervals. Labels for TDU enclosures shall be permanent nameplates (3-layer engraved adhesive plates).

~~3.3~~3.4 CABLE TRAY INSTALLATION

A. Cable tray shall be supported as follows:

1. Where tray is suspended above equipment cabinets it shall be supported by a Trapeze type hanger and per manufacture instructions. In all other applications, uni-strut trapeze type hangers affixed to the structure above via minimum 3/8-inch threaded rod shall support the tray.
2. Threaded rod shall be fitted with a 6-inch long tube where it resides in cable tray to protect cables.
3. Minimum of 12 inches of vertical clearance above all cable tray.

B. Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.

C. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.

D. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2-2006 guidelines, or in accordance with manufacturer's instructions.

E. A support must be place within 24 inches on each side of a connection or fitting.

F. Maintain a minimum of 12 inches of clearance above cable tray for cable installation. Maintain a minimum of 3 inches between ceiling tile and bottom of cable tray support.

G. Cable tray installation will be completed in one continuous run with no separations between sections.

H. Vertical cable or ladder racks shall be used to route cable up and down the wall.

I. Dropout/Water Fall of the same make and size of the cable tray shall be used to route cables in or out of the tray.

J. Matted "T" and elbows shall be used of the same make and size for all interchanges and directional changes.

K. All cabletray and ladder racks shall be of aluminum construction. Where the term 'cabletray' is used, it refers to a ladder type tray with depth. Where the term 'ladder rack' is used, it refers to a ladder type tray with approximate 1.5" side rails.

~~3.4~~3.5 JUNCTION BOX/PULL BOX INSTALLATION

A. Pull boxes shall be installed in sections of conduit that are 100 feet in length, or that contain more than two 90 degree bends.

B. A pull box shall NOT be used in lieu of a conduit bends.

C. All pull boxes shall be installed in an easily accessible location with unobstructed entry to the pull box access panel.

D. Pull boxes 6x6 or larger shall be supported on all four corners in such a manner that the cable running through does not support the pull box or conduit attached to the pull box.

~~3.5~~3.6 OUTLET BOX INSTALLATION

A. Outlet boxes shall be installed plumb and level. When installed adjacent to electrical outlets, they shall be plumb and level with same orientation as the electrical outlet.

B. Size all outlet boxes as needed for containing slack cable if so noted on the contract drawings. Do not, in any case without prior written approval, use low depth outlet boxes.

C. Install deep recessed boxes where needed for timeclocks.

~~3.6~~3.7 CABLE HOOK INSTALLATION (J-HOOKS)

A. Cable hook systems must be pre approved by HAS/IT prior to installation.

B. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.

C. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

D. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of 3 where extra strength is required.

E. Cable Hook spacing maximum four feet on center.

F. Maintain maximum cable sag between cable hooks of 12 inches.

G. Do not fill cable hook greater than manufacturer recommended guidelines.

~~3.7~~3.8 FIRESTOPPING MATERIAL INSTALLATION

A. Comply with manufacturer’s product data, including product technical bulletins, product catalog installation instruction, and product carton instruction for installation.

B. Verify substrate conditions are acceptable for product installation in accordance with manufacturer’s instructions.

C. Install fire stopping to comply with performance requirements specified herein.

D. Install fire stopping to comply with listed fire rated assemblies in accordance with ASTM and UL requirements

E. Installer shall be trained and approved by the manufacturer

F. Protect installed products from damage during construction operations until final completions.

G. Inspection: Code official or building inspectors to review proper installation using manufacturer guidelines.

END OF SECTION 270528

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 270543 - EXTERIOR COMMUNICATION PATHWAY (REV. 01-23-2020-SJS)

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

A. This section shall include the furnishing and installing of exterior communication pathways, including, but not limited to, the following items:

1. Communication ductbanks
2. Duct spacers and hardware
3. Caution tape and measuring pulltape
4. Trenching, boring and backfilling
5. Manholes, handholes, pullboxes and associated covers
6. Concrete encasement
7. Innerduct

1.2 SECTIONS INCLUDES

A. This section includes specifications for the installation of exterior communications pathways.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.

C. Exterior Communication Pathways are defined to include, but are not limited to innerduct, flexible multi-cell innerduct, conduit, manholes, handholes, concrete encased ductbanks racking material, manhole and handhole lids.

1.3 REFERENCES

A. Related Sections: Use these Specifications for all related work not specifically covered in this specification.

1. Section 270500: Common Work Results for Communications
2. Section 270510: Telecommunication Administrative Requirements
3. Section 270553: Identification and Labeling of Communication Infrastructure

B. Building Industry Consulting Services International (BICSI):

1. Telecommunications Distribution Methods Manual (Latest Issue)
2. Customer Owned Outside Plant Design Manual (Latest Issue)

C. HS20 (AASHTO) highway Fatigue Loading

D. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Association (ANSI/TIA/EIA):

1. 569 Commercial Building Standard for Telecommunications Pathways and Spaces
2. 758 Customer-Owned Outside Plant Telecommunications Cabling Standard

E. Houston Airport System Standards and Specifications located at http://www.houstonairports.biz/TIP.

F. Conflicts:

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.4 SUBMITTALS

A. Submit plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited:

1. Room penetration plan.
2. Communication pathway extension plan.
3. Conduit chase plan.
4. Duct bank pathway
5. Handhole/Manhole Details
6. Handhole/Manhole Lids

B. Shop Drawings shall be submitted and approved before implementation is started. Shop Drawings shall be submitted in accordance with Specification 013300.

C. Submit calculations associated with sizing and arrangements of ducts and cables.

D. Manufacturers' data: To include but not limited to part numbers, data sheets and detailed descriptions, for ALL proposed equipment and material.

E. Submit a schematic with the COMM Vault/MH/HH duct bank layout showing the wall-to-wall, center to center and a MH butterfly detail down to individual flexible innerduct and hard innerduct assignments in AutoCAD.

F. Submit plan and section drawings detailing proposed vault specifications.

G. Copy of Building Industry Consulting Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor's on-site RCDD supervisor. RCDD shall always supervise all parts of communications installation.

1.5 QUALITY ASSURANCE

A. Verify duct banks do not interfere with existing or new underground facilities.

B. Follow Appendix B of National Electrical Code.

C. Assure that the "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

D. Contractor Qualifications:

1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
2. ALL work shall be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC standards and codes.

E. Owner retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

1.6 SHIPPING AND HANDLING

A. Follow Section 01450.

B. Clearly mark containers "For Communication Material Only".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Conduit Measuring Tape:

1. Neptco
2. Greenlee
3. Garvin Industries

B. Caution Tape:

1. Reef Industries
2. Repnet
3. Panduit

C. Maintenance/Hand Hole Covers

1. Dabico Inc.
2. Ejco
3. Locke Solutions
4. Neehan Foundry
5. Oldcastle

D. Flexible Multi-cell Innerduct

1. MaxCell
2. Or HAS approved equivalent

E. Plastic Innerduct: HAS-IT approval required before installation.

1. Carlon
2. Pyramid
3. Or HAS approved equivalent

2.2 MATERIALS

A. Ducts: Schedule 40 rigid PVC following this section, with non-magnetic universal interlocking type spacers for both horizontal and vertical duct arrangements. Duct bank will be encased in concrete with orange color dye.

B. Duct Spacers and Hardware: On all conduit arrays, the contractor shall furnish and install a conduit spacer system as required to maintain uniform conduit spacing. The system shall consist of plastic spacers that interlock vertically and horizontally. A spacer assembly shall consist of base spacers, intermediate spacers and top spacers to provide a completely enclosed and locked in conduit assembly. Install spacers per manufacturer's instructions and provide at 5-foot intervals.

C. Plastic conduit and fittings shall conform to the requirements of Fed. Spec. W-C-1094 and shall be rigid PVC Schedule 40, with non-magnetic universal interlocking type spacers for both horizontal and vertical duct arrangements.

D. Maintenance Hole (MH) shall be a minimum 144" x 72" x 84" and shall be designed as needed.

E. Hand Hole (HH) shall be minimum 48" x 48" x 48" constructed with a minimum 5 inch thick concrete (or HAS approved equivalent).

1. HH shall be pre-formed
2. Include a minimum 12" sump drain
3. Include a stainless steel bonding ribbon and/or 1" knockout for ground stainless steel rod connection
4. Fitted with pulling irons at each end.
5. All HH internal components such as racking and ground strips shall be field installable and shall meet the requirements of ANSI/TIA/EIA, NEC, and HAS requirements.
6. All walls shall have a minimum of 2- 3 x 3" saddle Throat openings cable rack supports, yellow in color (3SR3N).
7. All walls shall include 4" duct terminators minimum of 2 wide x 2 height terminators verses a 24" x 24" x 4' thin wall K.O. window on each wall.

F. HH cover: Shall require a maximum 35-lb lift to open and close

1. Cover and service lettering shall be abrasion, corrosion, chemical resistant and slip resistant surface.
2. Door shall use a non-load bearing, internally mounted spring hinge mechanism and shall have a high visibility warning label affixed to the underside
3. The cover shall be removable from the cover frame assembly with a minimum opening clearance size of 36" x 36" (see attached figure 1 part number 8197)
4. A prototype test report for each cover style to be installed shall be submitted. The testing shall be conducted by an independent testing company and shall conform to the following:
   a. Carry a proof load of 29,250 lbs applied at 150 psi without deformation or injury to the cover
   b. Carry a maximum HS20 service load, applied at 100 psi for a minimum of 525,000 cycles without losing its service life

c. Carry a maximum HS20 service load applied continuously at 100 psi for twelve continuous hours without exhibiting an increase in residual deflection, as measured at the center of the cover, of more than 0.4% (0.004)
d. Covers have a modulus of elasticity of, at least, 3,500,000 psi, a flexural strength of 53,000 psi, and a compressive strength of 62,000 psi.

5. AOA covers to meet or exceed FAA loading standards.
6. All HH covers shall include the following (see attached figure 1):
   a. Slip Resistant surface
   b. Four (4) ½-13 x 2 ¼" Hex bolts with Stainless Steel washers
   c. "HOUSTON AIRPORT SYSTEM' shall be casted on the lid ½" FLAT FACE GOTHIC. (see attached figure 1)
   d. "HAS COMMUNICATIONS" shall be casted on lid ¼" FLAT FACE GOTHIC. (See attached figure 1).
   e. "TELECOM" shall be cast on lid 2" FLAT FACE GOTHIC(See attached figure 1).
   f. Submit proof for approval prior to customizing covers.
   g. Obtain permanent HH number from HAS IT. Field punch or weld MH number at time of installation.
   h. Submit cross reference table with construction MH number and permanent MH number.
   i. All cover and hinge hardware shall be stainless steel.
   j. All covers shall have a Security camlock and MPIC multi-tool pick bar.
   k. Ram-Nek shall be installed in between the manhole, frame, and cover.
   l. All covers shall a self-engaging safety bar and a stainless steel mechanical spring strut for lift assist. Cover shall open to 105 degrees, safety catch and removal at 90 degrees.

G. AOA HH will be 48" x 48" x 48" and constructed of 8 inch thick concrete covered with 250 psi, aircraft rated cover plates containing an approved locking device with a 35 pound lift to open and close. All HH covers shall include the following:

1. Slip Resistant Surface
2. Four (4) ½-13 x 2 ¼" Hex bolts with SS washers
3. "HOUSTON AIRPORT SYSTEM' shall be casted on the lid 1/2" FLAT FACE GOTHIC "HAS COMMUNICATIONS" shall be casted on lid ¼" FLAT FACE GOTHIC. (See attached figure 1).
4. "TELECOM" shall be cast on lid 2" FLAT FACE GOTHIC(See attached figure 1).
5. Submit proof for approval prior to customizing covers.
6. Obtain permanent HH number from HAS IT. Field punch or weld MH number at time of installation.
7. Submit cross reference table with construction MH number and permanent HH number.
8. All cover and hinge hardware shall be stainless steel.
9. All covers shall have a security camlock and MPIC multi-tool pick bar.
10. Ram-Nek shall be installed in between the manhole, frame, and cover.
11. All covers shall a self-engaging safety bar and a stainless steel mechanical spring strut for lift assist. Cover shall open to 105 degrees, safety catch and removal at 90 degrees

H. Concrete and Reinforcing Steel for Encasement: Furnish products following Section 01610 and Division 3 except strengths as follows:

1. Compressive Strength: 2500 psi at 28 days, class A.

2. Flexural Strength: 500 psi at 28 days.
3. Dye concrete encasement "ORANGE" to identify Communication Duct banks.

I. Flexible Innerduct:

1. Flexible innerduct is the HAS standard for multi-path applications within conduit.
2. All backbone fiber shall be installed in flexible innerduct.
3. All backbone copper cable 1 inch and smaller will be installed in flexible innerduct.
4. All flexible innerduct shall be installed per manufacture requirements.
5. Only manufacturer's fittings, transition adapters, terminators, accessories, and installation kits shall be used.
6. All flexible innerduct cells will be populated with a measured pull tape.
7. All flexible innerduct shall be OSP rated.
8. Flexible innerduct shall only be used when installed in conduit

MaxCell 4" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 4" 3 Cell	1	3	1.34"	1500'	2000'
4"	MaxCell 4" 3 Cell	2	6	1.34"	1500'	2500"
5"	MaxCell 4" 3 Cell	3	9	1.34"	1500'	2500'
6"	MaxCell 4" 3 Cell	4	12	1.34"	1500'	2500'

*Use of OFNR cable may result in reduced pulling lengths

MaxCell 3" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 3" 3 Cell	2	6	1.03"	1200'	2000'
4"	MaxCell 3" 3 Cell	3	9	1.03"	1500'	2500"
5"	MaxCell 3" 3 Cell	4	12	1.03"	1500'	2500'
6"	MaxCell 3" 3 Cell	5	15	1.03"	1500'	2500'

*Use of OFNR cable may result in reduced pulling lengths

MaxCell 2" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
2"	MaxCell 2" 3 Cell	1	3	.70"	800'	1500'

*Use of OFNR cable may result in reduced pulling lengths

9. All Plastic innerduct must be approved by HAS before installation.

2.3 ACCESSORIES

A. Continuous Tape for Underground Conduit: orange warning ribbon, PVC tape (detectable, i.e., containing metallic tracings), minimum 5 mils thick and 3 inches wide, permanently imprinted with "CAUTION--BURIED COMMUNICATIONS LINE BELOW" in black letters, minimum 1-inch high.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify materials are on site in proper condition and of sufficient quantity.

B. Verify proper excavation depth; verify width route and support of work. (Division 2). Ducts shall be installed so that the tops of all ducts are at least 36 inches below the finished grade. Verify proper location of hand holes and MH (maximum every 600 feet). Communications facilities must be placed in separate MH/HH from electrical facilities.

C. Trenches greater than or equal to 5 feet deep:

1. Shall be shored to prevent cave-in.
2. Shall have 2 feet clearance from the dirt pile.

D. Directional boring (HAS IT prior approval required) is a suitable substitute when trenching is impractical or impossible. Bore logs shall be submitted as deliverables along with the GPS/GIS data information to include but not limited to, depth every 10-12 feet, x and y coordinates. Refer spec section 270553 for the GIS data collocation deliverable. A 6-gauge trace wire shall be installed with the conduit. Locating existing underground utilities is crucial when directional boring is planned because of the potential for the drilling unit to encounter high voltages. Although directional boring machines are manufactured with electrical strike sensing capabilities, which can warn the operator of any contact with a high voltage source, accidents may still occur.

1. Operators of directional boring machines require special protection due to the potential for exposure to high voltage. Therefore, operators shall always have a ground mat grid underfoot as insulation protection. In addition, operators shall wear insulating boots and gloves, along with hard hats and safety glasses.
2. Casings shall be installed when boring conduits under streets, roadways, runways and or taxiways.

E. Minimum electrical/communications underground cable separation:

1. Concrete: 3 inches
2. Masonry: 4 inches
3. Well-tamped earth: 12 inches
4. Electrical: 12 inches

F. Before encasement, verify ducts are free of debris and properly installed in support and spacer system, are properly fitted together and hold-down hardware is properly installed.

3.2 INSTALLATION

A. Prior to installation, the contractor shall comply with Specification 270553 referencing GIS GPS requirements during the installation of all manholes / handholes and duct banks.

B. Install all work following drawings, manufacturer's instructions and approved submittal data.

C. Install conduit in excavations following Drawings. If directional boring is utilized, cable or flexible conduits can be attached to the unit and pulled back to the origination point (after the drilling unit reaches its destination).

D. HH shall be 48" x 48" x 48" and shall be constructed of min two-inch thick concrete covered with 3/8 inch steel plate. The hand hole or MH shall rest on a 4-inch blanket of 2 sack stabilized sand, and 4 inches around the side walls shall be filled with 2 sack stabilized sand. Refer to Division 02321.

E. Each MH/HH that contains a pedestal will have four bollards installed 18 inches diagonally from each corner, with a cross member welded at 30 inches connecting the Four Corners. These barriers will be constructed of 4 inch ridged conduit filled with concrete, driven four feet in the ground and extending 36 inches above the protective cover.

F. Install watertight penetrations through foundation, HH, and MH walls. Wherever a hand hole is used to simply pass through, the conduit entrances and exits will be situated at opposite ends of the hand hole instead of 90-degree angles.

G. Assemble duct banks with non-magnetic saddles, spacers and separators. Position separators for 2-inch minimum concrete separation between outer surfaces of adjacent ducts.

1. Make uniform required bends with a minimum of 24-inch radius for conduits less than 3-inch diameter, and a 48-inch radius for conduits 3 inches and larger.
2. Maintain vertical or horizontal separations of 12 inches of well-packed topsoil from any electrical service conduit run parallel to Communications conduits.

H. Install reinforcing. Install concrete encasement surrounding reinforcing steel and ducts. Follow Section 03315 using one-inch maximum size course aggregate concrete.

1. Unless otherwise noted on the drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at maximum parallel spacing of 12 inches o.c., and No. 3 tie-bars transversely placed at 12 inches o.c. maximum longitudinal. Maintain maximum clearance of 2 inches from bars to edge of forms and ducts.
2. Sprinkle ORANGE colorants on top of concrete.
   a. ORANGE: For Telecommunications.
3. Place concrete with minimum 3 inch cover surrounding ducts and reinforcement.
4. Maintain ducts in proper place during concrete placement.

I. Transition from non-metallic to PVC coated metallic conduit where duct banks enter structures or turn upward for continuation above grade.

1. With prior HAS IT APPROVAL. For conduit runs (1" to 4") a special LBD condulet (Crouse-Hinds or approved equal) may be used for exterior wall penetration where a swept 90 will not

work. LBD condulets are designed for communications cable installation to maintain bend radius requirements.

J. Where ducts enter structures such as HH, MH, pull boxes, or buildings, terminate ducts in proper end bells, provide insulated L-bushings, and grout walls at the conduit entrance points. Terminators or bells shall be installed at the wall for a flush installation. All ducts shall be sealed with Meyers hubs or couplings on steel conduits l ducts and/or sealed with watertight mechanical plugs with a max back Air Pressure 17 PSI, Max Back Pressure 40 ft of Head.

K. Extend below grade conduits to 4 inches above the finished floor inside a building.

L. Tag conduits entering pull boxes with stamped stainless steel tags following cable and conduit schedule.

M. Install continuous, orange warning ribbon, PVC tape (detectable, i.e., containing metallic tracings), 3 inches wide, permanently imprinted with "CAUTION - BURIED COMMUNICATIONS LINE BELOW" in black letters, approximately 12 inches below finished grade following line of duct banks.

N. Expansion Fittings:

1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit funs where necessary. Provide bonding jumpers across fittings in metal raceways systems

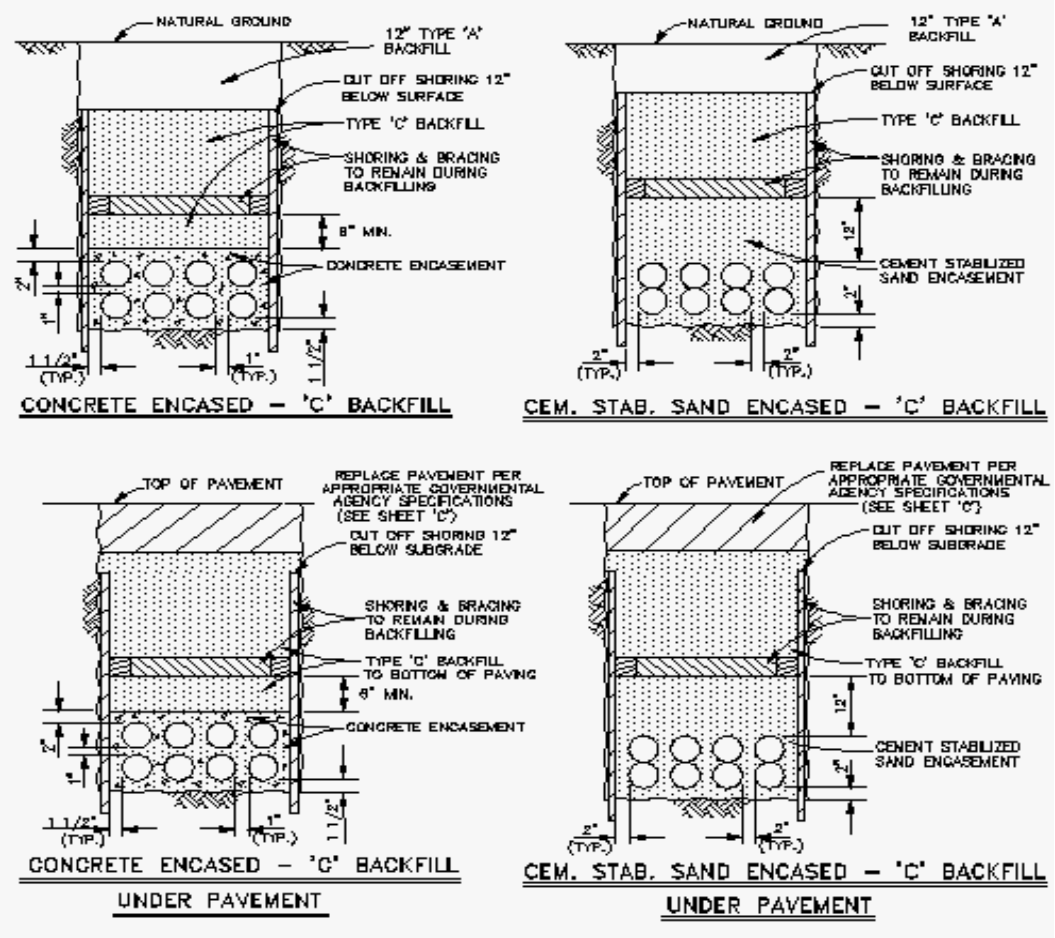
3.3 BACKFILLING

A. Backfill following Section 02320 after concrete cures 24 hours. After concrete encased ducts have been properly installed, and the concrete has had time to set, the trench shall be backfilled in at least two layers with excavated material, not larger than four inches in diameter, thoroughly tamped, and compacted to at least the density of the surrounding undisturbed soil. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required. Trenches shall not be excessively wet and shall not contain pools of water during backfill operations. The trench shall be completely backfilled and compacted level with the adjacent surface. Any excess excavated material shall be removed and disposed of offsite at the contractor’s expense.

B. Type ‘C’ Backfill Cement Stabilized Sand

1. Two (2) sack stabilized sand is authorized only with HAS IT Infrastructures prior approval. Compact 2 sack stabilized sand in 6” to 8” lifts to a 95% of maximum density as determined in accordance with ASTM D558, ASTM D698 and ASTM D1633, unless otherwise specified in spec section 02321.

2. Perform and complete compaction of 2 sack stabilize cement mixture within 4 hours from the load delivery receipt.



C. If trench is in a grassy area: sod and pin to match the original condition.

3.4 MAINTENANCE HOLES / HANDHOLES

A. Installation shall be in accordance with the manufacturer's requirements. Top of MH/HH cover shall be set ¼ inch above finished pavement or one inch above finished grade.

B. MH/HH shall be bedded on four inches of 2 sack stabilized sand with ¾ inch gradation.

C. Have ducts stubbed into the MH/HH, which shall terminate in end bells cast in concrete flush with the inside walls. Ducts shall enter the MH/HH at the lowest knockout window available.

D. MH/HH shall be fitted on each wall with cable racks and struts. Each rack shall be provided with a minimum of four rack type arms. Rack arms shall be made of non-flammable polymer.

E. MH shall be provided with a pulling eye on each end and a drainage sump in the bottom.

F. HH shall be provided with a pulling eye on each end and a drainage sump in the bottom.

G. MH/HH shall be provided with a ¾ inch by 10-foot stainless steel ground rod in each MH. See Section 270526 for ground rod specification. Do not install the ground rod through the drain sump. Install through a prepared opening and grout fill after installation.

H. All vacant ducts, shall be sealed with an HAS and Industry approved water-tight and gas-tight mechanical plugs with max back Air Pressure 17 PSI, Max Back Pressure 40 ft of Head.

I. All flexible innerducts and plastic innerducts shall be sealed with an HAS and Industry approved watertight and gas-tight plugs.

J. All occupied ducts shall be sealed with Triplex duct plugs, Quadplex duct plugs or HAS and Industry approved water-tight and gas-tight plugs.

K. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color (ex. Orange, Blue, Black and White). HAS-IT approval required before installation.

L. When populating duct bank with plastic innerduct the following apply: HAS-IT approval required before installation.

1. Innerduct to be OSP rated
2. 4” duct to be populated with no less than 3-1.25 inch innerducts
3. 4” duct to be populated with no less than 4-1 inch innerducts

M. All fiber cables shall be placed in flexible innerduct and comply with 271300 guidelines.

N. All copper cables 100 pairs or less shall be placed in flexible innerduct.

O. A 12 inch long mandrel shall be swabbed through all ducts to remove debris, until shown clean (1/4 inch smaller than duct diameter).

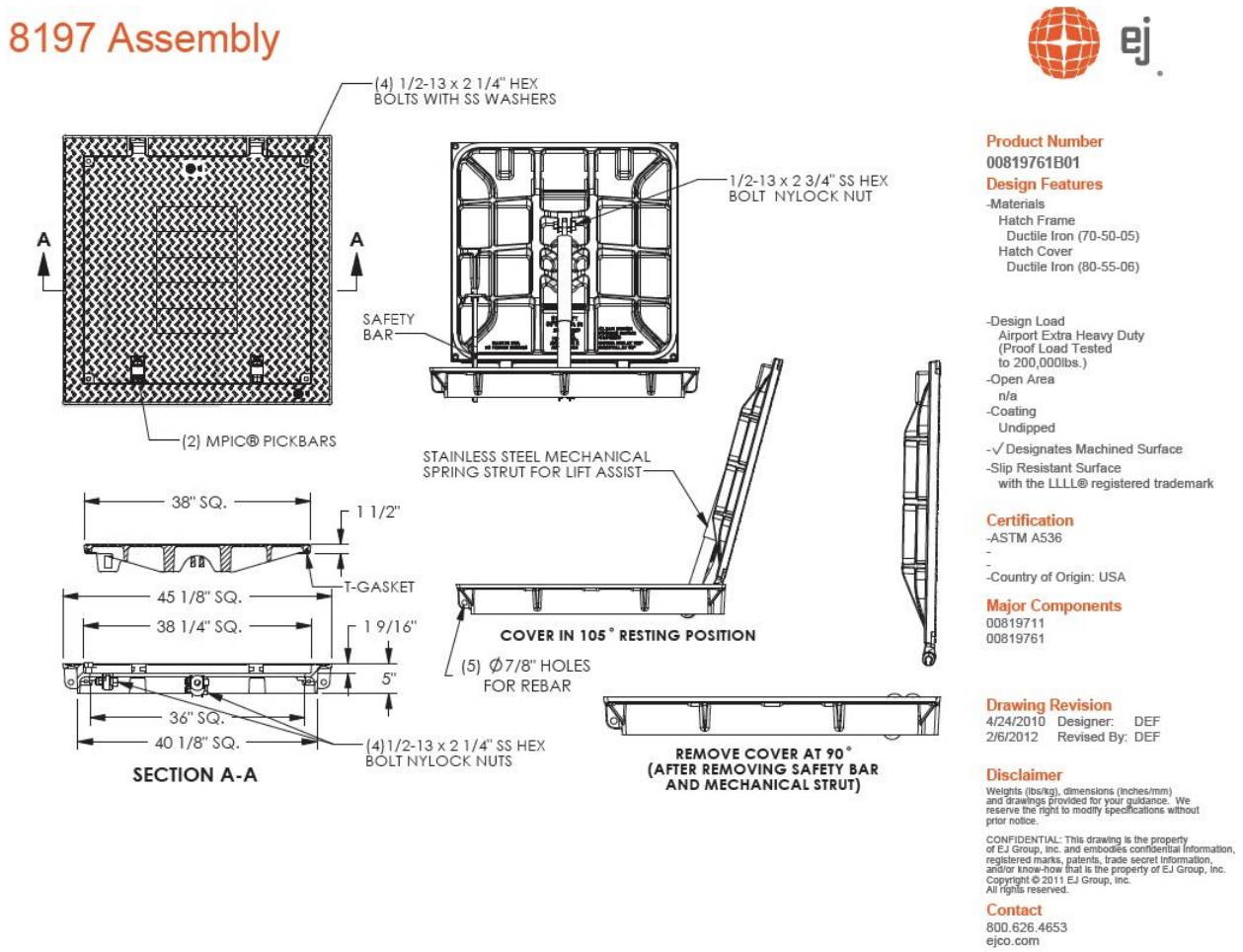
P. Provide a conduit measuring tape, with a minimum test rating of 1250 pounds of pulling tension in all underground conduits, flexible innerducts and plastic innerduct when applicable. Label each end of the duct bank in every MH to ensure continuity per specification 270553.

3.5 IDENTIFIERS, LABELS AND LABELING SYSTEM

A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. **Any deviation from the specification must be approved by HAS IT prior to installation.**

END OF SECTION 270543

Figure 1


8197 Assembly
(4) 1/2-13 x 2 1/4" HEX BOLTS WITH SS WASHERS
1/2-13 x 2 3/4" SS HEX BOLT NYLOCK NUT
A
A
SAFETY BAR
(2) MPIC® PICKBARS
STAINLESS STEEL MECHANICAL SPRING STRUT FOR LIFT ASSIST
38" SQ.
1 1/2"
T-GASKET
45 1/8" SQ.
38 1/4" SQ.
1 9/16"
5"
36" SQ.
40 1/8" SQ.
(4)1/2-13 x 2 1/4" SS HEX BOLT NYLOCK NUTS
SECTION A-A
COVER IN 105° RESTING POSITION
(5) Ø7/8" HOLES FOR REBAR
REMOVE COVER AT 90° (AFTER REMOVING SAFETY BAR AND MECHANICAL STRUT)
ej
Product Number
00819761B01
Design Features
-Materials
Hatch Frame
Ductile Iron (70-50-05)
Hatch Cover
Ductile Iron (80-55-06)
-Design Load
Airport Extra Heavy Duty
(Proof Load Tested
to 200,000lbs.)
-Open Area
n/a
-Coating
Undipped
-√ Designates Machined Surface
-Slip Resistant Surface
with the LLLL® registered trademark
Certification
-ASTM A536
-
-
-Country of Origin: USA
Major Components
00819711
00819761
Drawing Revision
4/24/2010 Designer: DEF
2/6/2012 Revised By: DEF
Disclaimer
Weights (lbs/kg), dimensions (inches/mm) and drawings provided for your guidance. We reserve the right to modify specifications without prior notice.
CONFIDENTIAL: This drawing is the property of EJ Group, Inc. and embodies confidential information, registered marks, patents, trade secret information, and/or know-how that is the property of EJ Group, Inc.
Copyright © 2011 EJ Group, Inc.
All rights reserved.
Contact
800.626.4653
ejco.com

Ductile Iron Hinged Hatch Access Assembly

Ductile iron access hatches have been designed for improved ergonomics, and are available in heavy duty and airport extra heavy duty applications.
On a cover that can weigh as much as 550 lbs, the lifting force required to open the cover is less than 35 lbs due to the uniquely designed mechanical strut.
The self-engaging safety bar provides added protection while the underground infrastructure is accessed, and safety grates can be specified for added fall through protection.

Features
- Ductile iron frame and cover
- Cover opens to 105°, safety catch and removal at 90°
- Self-engaging safety bar
- EON LOCK®
- MPIC® multi-tool pick bar
- Bolting

Options
- Mechanical lift assist (standard feature for airport rated models)
- Top and bottom flange designs
- Safety grate
- INFRA-RISER® adjustment riser
- Forming skirt

8197 grate option
36" x 36"

Wide Availability of Sizes
Shown below are just a sample of the various cover openings and sizes. See the table below for the full range of available clear opening sizes and load ratings.

8192 hinged hatch
24" x 36"

8198 hinged hatch with dual lift assist
48" x 48"

8218 double assembly
48" x 48"

8196 double assembly
30" x 62"

Ductile Hinged Hatch Clear Opening Options

Clear Opening Size	Airport Extra Heavy Duty Series No.	Heavy Duty Series No.
24 x 24	8195	8215
24 x 36	8192	8212
30 x 30	8196	8216
30 x 62	8196—Double	8216—Double
36 x 36	8197	8217
36 x 74	—	8217—Double
48 x 48	8198	—
48 x 48	—	8218—Double

Note: All dimensions are in inches.

ejco.com 800 626 4653

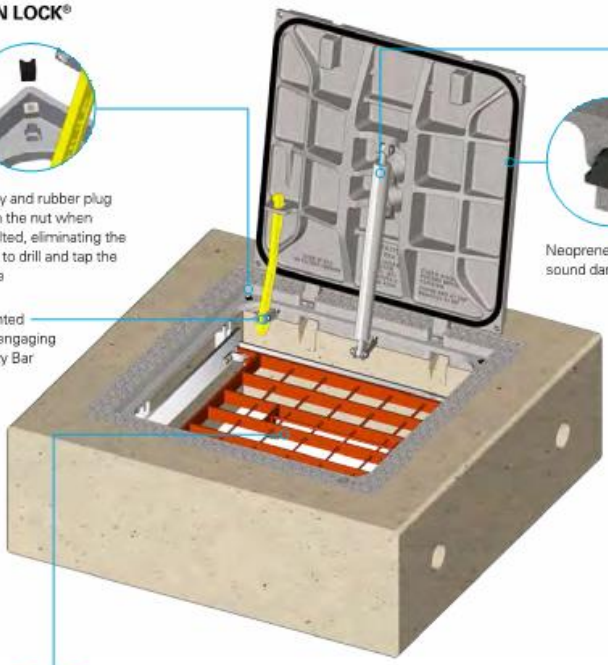
DIHH SS USA 0516

Ductile Iron Hinged Hatch Access Assembly

EON LOCK®

Cavity and rubber plug retain the nut when unbolted, eliminating the need to drill and tap the frame

Patented Self-engaging Safety Bar



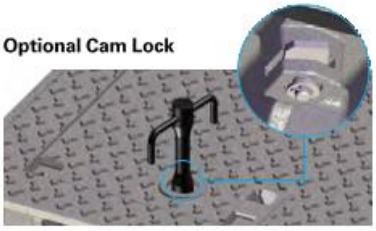
Neoprene gasket for sound dampening

Lift Assist

Lift Assist is a corrosion-resistant stainless steel mechanical spring strut. The rugged design is clean and maintenance free. The strut takes up less space in the clear opening than a traditional spring assist. It is fully self-contained, protecting coils from exposure to the elements.

Made without internal gases or seals, the struts have an effective operating temperature range of -30° F to 400° F. The durability has been tested at over 150,000 cycles.

Optional Cam Lock



Security cam lock and wrench shown. Wrench is only removable when cover is in the locked position.

Optional Safety Grate

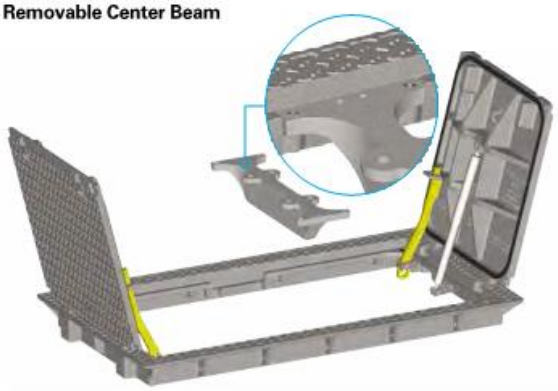
Provides additional safety features

- Doors cannot be closed unless the fall through protection has been put back in place (protecting the next operator).
- Visual inspections and limited maintenance can be done while safety grate is left in place.
- Orange safety grates create a visual barrier around the pit; an orange epoxy coating promotes an awareness of the hazard and provides a durable finish.
- Grate can be locked independently of the hatch, adding another level of security when needed.

Optional Forming Skirt

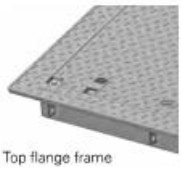
Available forming skirt simplifies precasting the hatch in concrete—no need for added forming to protect the inner hatch. The leave-in-place aluminum skirt can be made to fit any concrete slab thickness. (Image showing hatch upside down with forming skirt.)

Removable Center Beam

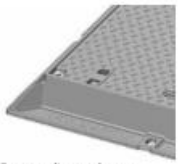


Removable center beam provides a much greater clear opening access on several double hatch models. Removal/replacement is simple with 4 bolts securing the beam to the frame.

Frame Options



Top flange frame



Bottom flange frame

Visit our YouTube Channel for videos on this and other products at www.youtube.com/AccessInfrastructure

ej

ejco.com 800 626 4653

SECTION 270553 - IDENTIFICATION AND LABELING OF COMMUNICATION INFRASTRUCTURE (REV. 01-31-2020-BW)

PART 1 - INTRODUCTION

1.1 GENERAL

A. As the Houston Airport System (HAS) continues to develop both its private and commercial interests, it is essential that an effective telecommunications infrastructure be developed and maintained to ensure the support of any and all services which rely on the electronic transport of information. To effectively administer these assets requires a disciplined effort that begins with a systematic practice and procedure for capturing useful data regarding inventories that might be conducted at any point during the lifecycle of a project.

1.2 OBJECTIVE

A. The objective and intent of this standard is to provide uniform GIS inventory and documentation practices/guidelines for any person or party directly involved with data collection, administration and/or accountability of the HAS IT telecommunications infrastructure or related systems.

1.3 INTENDED USE

A. Any designer, consultant or engineering entity contracting with the Houston Airport System to inventory/document the telecommunications physical and network configurations will need to refer to this document for clarification regarding standard operating procedures. The guidelines given here provide for effective documentation of the HAS telecommunications network. The result of following this standard will be a telecommunications infrastructure that is well documented and easily managed by the administrator.

Note: For specific criteria concerning the GIS/GPS datum, refer to the OASIS Standards document maintained by direction under the HAS Planning Design and Construction department. Said datum is not specific to the Information Technology department and thus will be not replicated here.

1.4 LIFE OF THE STANDARD

A. This standard is a living document. The criteria contained in this standard are subject to revision without notice, as warranted by advances in administration techniques related to telecommunications technology.

B. This manual is the property of the Houston Airport System. The contents of this manual are proprietary and should not be copied or disclosed without prior written permission of the Houston Airport System. Any variation from the standards in this manual should be addressed by the Houston Airport System IT GIS contact listed below for approval prior to implementation on a project.

Brandon Williams
IT Project Manager
Technology Infrastructure
Houston Airport System
(281)233-1394

Jay Kabouni
Systems Consultant
Technology Infrastructure
Houston Airport System
(281) 233-1660

Li Sun
Senior GIS Analyst
Technology Infrastructure
Houston Airport System
281-233-1169

brandon.williams@houstontx.gov jay.kabouni@houstontx.gov li.Sun@houstontx.gov

PART 2 - GENERAL

2.1 SCOPE

A. This standard specifies the GIS inventory and documentation requirements for the Houston Airport System IT Telecommunications Infrastructure, Network Engineer and associated information databases. Areas of the infrastructure and/or databases to be inventoried, administered, monitored or maintained include:

1. terminations for the telecommunications media located in work areas, telecommunications closets, equipment rooms, and entrance facilities;
2. equipment/devices hosting physical terminations;
3. telecommunications media (cable) between terminations;
4. pathways (spans) between terminations that contain the media;
5. spaces (structures) where terminations are located;
6. bonding/grounding as it applies to telecommunications;
7. geophysical plant networks i.e., manhole, handhole, pullbox, cabinet, pedestal, building access points;
8. splice enclosures.

NOTE: Whereas this document provides an outline and overview of the GIS documentation process, the following Telecommunications Infrastructure Specifications for the Houston Airport System should be referenced for detailed administrative requirements

2.2 This standard also specifies requirements for the collection, organization, and presentation of as-built data.

2.3 In addition to providing requirements and guidelines for a traditional paper-based documentation system, this standard will serve as the reference for all associated computer-based administration tools.

Contracting parties, by this standard, are required to attend an HAS-IT coordination meeting prior to commencement of any documentation effort; the scope of work and project expectations will be discussed at length. You will be given additional direction as required and any useful maps, diagrams, numerical sequences, etc. will be provided to you at this time.

PART 3 - REFERENCES

3.1 The latest published version at the date of contract applies to all references. Related Documents include all Drawings and General Provisions of the Contract. In Conflict between contract documents, the most stringent will be applied.

3.2 Related Specifications: Use these Specifications for all related work not specifically covered in this specification

1. Section 270526: Telecommunication Grounding and Bonding
2. Section 270528: Interior Communication Pathways
3. Section 270543: Exterior Communication Pathways

4. Section 270553: Identification and Labeling of Communication Infrastructure
5. Section 271100: Communication Cabinets and Equipment Rooms
6. Section 271300: Backbone and Riser Media Infrastructure
7. Section 271500: Horizontal Media Infrastructure
8. Section 272100: Data Communication Network Equipment
9. Section 272200: PC, Laptop, Servers and Equipment
10. Section 275113: Audio Communication system
11. Section 281300: Access Control System
12. Section 232313: Video Surveillance Control and Management System

PART 4 - DEFINITIONS

4.1 GENERAL

A. This section contains definitions of terms, acronyms, abbreviations, and formats that have special technical meaning or that are unique to the technical content of this standard.

4.2 DEFINITIONS

A. For the purposes of this standard, the following definitions apply:

1. assignment
   a. A unique designation assigned to a person who is expected to use the circuit, equipment, service, etc., serving a particular work area. Examples of an assignment: telephone number, a name, a circuit number or a logical address.
2. backbone
   a. Network of copper and fiber connections between termination panels/switches.
3. cable
   a. An assembly of one or more copper conductors or optical fibers within an enveloping sheath, constructed so as to permit use of the conductors singly or in groups.
4. campus
   a. The buildings and grounds have legal contiguous interconnection. (TIA)
5. equipment
   a. Generally, an endpoint for cable lengths; any hardware device/component. Used to terminate cable for cross-connection or interconnection to other cables or devices.
6. grounding electrode conductor
   a. The conductor used to connect the grounding electrode to the equipment grounding conductor and/or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system.
7. handhole (HH)
   a. A structure similar to a small maintenance hole in which cable can be pulled, but not large enough for a person to fully enter to perform work.
8. identifier
   a. An item of information that links a specific element of the telecommunications infrastructure with its corresponding record. (TIA)
9. linkage
   a. A connection between a record and an identifier or between records.(TIA)
10. location
    a. A position occupied or available for occupancy within a site or infrastructure network.

11. manhole (MH)
    a. A vault located in the ground or earth as part of an underground duct system and used to facilitate placing, establishing connections, and maintenance of cables as well as placing associated equipment, in which it is expected that a person will enter to perform work. (TIA).
12. outlet box (telecommunications)
    a. A metallic or nonmetallic box mounted within a floor, wall or ceiling and used to hold telecommunications outlet/connectors or transition device. (TIA)
13. outlet / connector (telecommunications)
    a. A connecting device in the work area on which horizontal cable or outlet cables terminates. (TIA)
14. Pathways
    a. A raceway, conduit, sleeve, or exposed location, for the placing of telecommunications cable that links telecommunications spaces together
15. record
    a. The permanent documentation of installed telecommunications infrastructure obtained from as-builts.
16. record drawing (as-built)
    a. The documentation of measurements, location, and quantities of material work performed. May be in the form of marked up documents or other work order forms.
17. report
    a. A presentation of a collection of information from various records.
18. site
    a. Spatial location of an actual or planned structure or set of structures.
19. span
20. A raceway, conduit, sleeve, or exposed location, for the placing of telecommunications cable that links telecommunications spaces together.
21. splice
    a. A joining of conductors meant to be permanent. (TIA)
22. splice box
    a. A box, located in a pathway run, intended to house a cable splice.(TIA)
23. splice enclosure
    a. A device used to protect a cable or wire splice.(TIA)
24. structure
25. Generally an endpoint for span lengths; i.e., manhole, handhole, cabinet, junction box, pedestal, building access point, communications rooms, work areas.
26. structure unit
    a. A component of the structure; usually housing equipment i.e., cabinet, rack.
27. telecommunications
    a. Any transmission, emission, or reception of signs, signals, writings, images, and sounds; that is, information of any nature by cable, radio, optical or other electromagnetic systems. (TIA)
28. telecommunications infrastructure
    a. The components (telecommunications spaces, cable pathways, grounding, wiring and termination hardware) that together provide the basic support for the distribution of all telecommunications information.
29. telecommunications media
    a. Wire, cable, or conductor used for telecommunications.

30. telecommunications space
    a. Areas used for the installation and termination of telecommunications equipment and cable, e.g., telecommunications closets, work areas, false ceilings, and manholes/handholes.
31. termination position
    a. A discrete element of termination hardware where telecommunications conductors are terminated.
32. work area; work station
    a. A building space where the occupants interact with telecommunications equipment.(TIA)

PART 5 - DOCUMENTATION CONCEPTS

5.1 GENERAL

A. This section describes the concepts of identifiers, records, linkages among records, and presentation of information necessary to administer infrastructure cable, spans and structures.

5.2 IDENTIFIERS

A. An identifier is assigned to an element of the telecommunications infrastructure to link it to its corresponding record. Identifiers shall be marked at the elements to be administered.

B. Identifiers used to access record sets of the same type shall be unique. For example, each identifier for each one of the set of cable records shall be unique. Unique identifiers across all types of telecommunications records are mandatory. For example, no cable record identifier should be identical to any pathway record identifier.

C. Labeling is the marking of an element of the telecommunications infrastructure with an identifier and (optionally) other relevant information. Labeling shall be accomplished in either of two ways: separate labels may be securely affixed to the element to be administered, or the element itself may be marked.

5.3 RECORDS

A. A record is a collection of information about or related to a specific element of the telecommunications infrastructure.

B. Elements identified as required information and required linkages shall constitute the minimum requirements for these records. Specific information and other linkages suggest additional elements that may be useful to the administrative system, such as cable length.

C. Telecommunications records are typically used in conjunction with other records. For example, a user record or assignment may contain an identifier to the record of the cable that serves an individual’s workspace. Conversely, a cable record may also contain an identifier for a user record or assignment.

D. By this standard, the Houston Airport System utilizes AutoCAD and ArcGIS as the software platforms by which all telecommunications infrastructure records and linkages are recorded and maintained.

5.4 RELATIONSHIPS

A. Relationships are the logical connections between identifiers and records. The records for infrastructure elements shall be interlinked. For example, in a cable record, termination port identifiers point to specific termination port records that contain additional information about each of the cable termination ports.

5.5 ASSIGNMENT

A. An “assignment” is a specific term of reference that allows the association of the end location, cable pairing record or termination port record with additional information. For example, an assignment such as a telephone number or circuit number can associate a user with elements of the telecommunications infrastructure. This aids in troubleshooting by identifying both the physical and logical connectivity from a single circuit assignment.

5.6 PRESENTATION OF INFORMATION

A. A typical documentation system includes labels, records, reports, drawings, and work orders. Reports compile and present information found in the records. Graphical information regarding the relationship of the telecommunications infrastructure to other infrastructures within the campus or site is presented in drawing format. Work orders document the operations needed to implement changes affecting the telecommunications infrastructure.

B. Reports present information selected from the various telecommunications infrastructure records. Reports may be generated from a single set of records or from several sets of interlinked records.

C. Drawings are used to illustrate different stages of telecommunications infrastructure planning and development. Generally, conceptual and installation drawings supply input to the record drawings that graphically document the telecommunications infrastructure. These record drawings as well as some equipment schedules and installation drawings (i.e., rack layouts) become part of the administration system documentation.

D. Conceptual drawings (i.e., one-line or riser diagrams) are used to illustrate the proposed design intent. They do not typically include all telecommunications infrastructure elements or identifiers and do not necessarily become part of the administration documentation.

E. Installation or bid drawings are used to document (graphically) the telecommunications infrastructure to be installed. They should illustrate relevant infrastructure elements and may also describe the means of installation. Identifiers may or may not be included on the drawings.

F. Record drawings (as-builts) graphically document the installed telecommunications infrastructure through floor plans, elevation, and detail drawings. These drawings may differ from installation drawings because of changes and specific site conditions. Key elements of the telecommunications infrastructure shall have identifiers assigned. The span/structure and wiring portions of the infrastructure each may have separate drawings if warranted by the complexity of the installation or the scale of the drawings.

G. ESRI (ArcGIS) formatted feature class and feature class layers graphically depict data in a spatial environment and are linked via physical relationship protocols established by the administrator through the utilization of software engineered towards GIS applications.

5.7 WORK ORDERS (SYMANTEC)

A. Work orders document the actions needed to implement changes affecting the telecommunications infrastructure as it was actually installed. The changes may involve several telecommunications components as well as other related systems. The Documentation Team utilizes Symantec software as its change-management notification platform. Typical Symantec tickets document actions such as moving a patch cord, installing a conduit, cross-connect or relocating an outlet box. A Symantec ticket may involve structures, spans, cable, splices, terminations, or grounding, either individually or in combination. A Symantec ticket should list both the personnel responsible for the physical action and those responsible for updating various portions of the documentation to assure its accuracy. *Prior to commencement of an action that would result in a change to any telecommunications infrastructure component or related system; a Symantec ticket should be submitted in accordance with departmental and operational requirements.*

5.8 SUMMARY

A. This section has presented basic concepts of documentation for the Houston Airport System Telecommunications Infrastructure. The sections that follow specify the administration of each of the components of the infrastructure in greater detail.

PART 6 - HAS IT INFRASTRUCTURE STANDARDS FOR DOCUMENTATION

6.1 DATA COLLECTION AND ADMINISTRATION CONCEPTS

A. This section describes the documentation of assets within the administrative jurisdiction of the Houston Airport System - Public Safety and Information Technology department. As changes are made to the assets, affected labels, records, reports and drawings shall be updated or revised.

The following outline assumes that the contracting parties understand the GIS/GPS datum specifications and requirements as provided in the OASIS standards. Further, that the equipment to be used towards gathering the data has been configured accordingly.

6.2 STRUCTURES

A. Applies to the following structures:

1. Manhole
2. Handhole
3. Pullbox
4. Cabinet (Pole Mounted, Pedestal)
5. Building Access
6. Dog House
7. Remote Location
8. Entrance Facility
9. Workspace
10. Main Distribution Frame (MDF)
11. Building Distribution Frame (BDF)
12. Intermediate Distribution Frame (IDF)
13. Point of Presence (POP)

14. Pathway Transition
15. Aerial Pole)

B. *Identification*

1. Each **Structure** has been assigned a unique GIS databse identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All structure identifiers follow a specific schema; new structures must be identified accordingly. In the event that a determination cannot be made regarding the identification of a structure, please contact an HAS IT GIS representative prior to documenting.
3. All structures are identified through a numerical range with prefix characters specific to its respective airport campus, technology asset designation and feature-category:
4. *Airport Campus Characters:*
   a. IAH: I
   b. HOU: H
   c. EFD: E
5. *Asset Designation Character:*
   a. Technology: T
6. *Feature-Category Characters:*
   a. Structure: S
   b. Pathway: P
   c. Equipment: E
   d. Cable: C
7. *Numerical Range:*
   a. 0000 – 9999
8. *Example:*
   a. **ITS0054** (IAH Structure), **HTS0054** (HOU Structure), **ETS0054** (EFD Structure) Manhole Numerical Range:

Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

9. Labeling
   a. Labeling should follow the identification schema and further be accomplished via an approved chisel/stamp device or other approved method.
   b. Newly constructed structures (manhole, handhole, pullbox, cabinet) will require that their identifiers be etched onto the lid or affixed with an appropriate label material. Manholes and handholes should be stamped on the lid itself, as well as the metal ring/material surrounding the opening; or the concrete foundation (topside). Utilize an appropriate chisel or stamp or labeling device to accomplish the task.
   c. The Technology Infrastructure group does not maintain the specification for labeling newly con-structed structures (dog house, remote location, entrance facility, workspace, MDF, BDF, IDF, POP, Pole). These should be placarded according to current **HAS Infrastructure** specification. The Technology Infrastructure GIS identifiers (described in the previous paragraphs) relevant to these spaces and locations are preserved for GIS database record keeping purposes only. Contact an HAS Infrastructure representative for clarification on physical labels for architectural spaces.
10. Required Fields
    a. Each structure requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.

TELECOM_ID
COORD_X
COORD_Y
COORD_Z
AIRPORT
AGENCY
LID_TYPE
DEPTH_INCH
SPLICE_CLOSURE
SLACK_LOOP
GROUNDING
COMMENTS
BUILDING_NAME
LEGACY_ID
STRUCTURE_TYPE
STRUCTURE_SUBTYPE
HAS_LEVEL
LID_SIZE
PROJECT
COLLECTION_DATE
LID_SHAPE
LID_MATERIAL
PROJECT_CLASS

11. GPS
    a. Each manhole should be recorded as follows:
        1) Single shots; taken on-center. Offset shots are acceptable for manholes not available to satellite coverage but these shots must be coordinated with an HAS-IT GIS contact prior to.
12. Supporting Documentation Deliverables
    a. Additional documentation records are required to support GPS data. The documentation is as follows:
        1) Manholes and Handholes only
            a) Digital photos – top (north to top of photo), north wall, west wall, south wall, east wall; for manholes not true to cardinal compass points adjust call-outs as necessary.
            b) AutoCAD – butterfly diagram of manhole depicting pathway orientation, conduit layout, innerduct configurations, cabling locations, and cabling counts for each manhole unit in both .dwg; 2010 or higher and .pdf formats; (See manhole AutoCAD butterfly exhibit; see also the OASIS standards for IT specific AutoCAD layering).
            c) Video – 360 degree imagery of interior; .mpg format.
        2) Communication Rooms
            a) AutoCAD – floorplan (where applicable) layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit).
13. Spatial Data Deliverables
    a. The entire manhole inventory should be delivered separately in ArcGIS feature class (version 10) format along with any records outlined in the *'Supporting Documentation"* paragraph. This feature class (STRUCTURE) should contain the attribute values from the 'Required Fields' paragraph.

14. Special Instructions
    a. None.

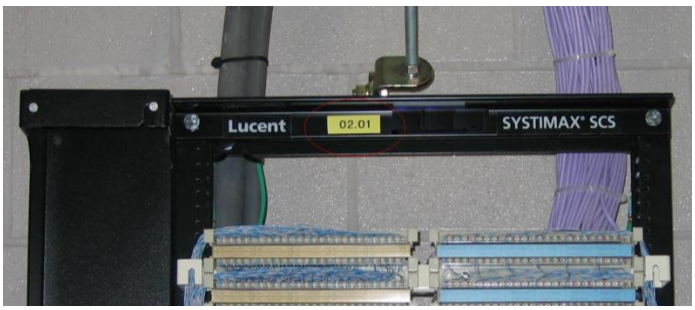
C. Cabinets/Racks:

1. Identification
    a. Each cabinet/rack has been assigned a unique campus identifier. All structure identifiers follow some specific schema; new structures must be identified accordingly. In the event that a determination cannot be made regarding the identity of the structure, please contact the HAS IT GIS representative prior to documenting.
    b. All cabinets are identified through a numerical range specific to its respective campus and should be prefixed with 'PC' (pedestal cabinet) or 'PM' (pole mounted cabinet). The ranges are as follows:
2. Example:
    a. ITS0054.BB01
        1) Translation: Cabinet or Rack in Room (Structure) ITS0054, row 02, column or position 01.
    b. ITS0054.BB01
        1) Translation: Backboard (plywood) 01 in Room (Structure) S103.1

    Note: Backboards tend to be randomly arranged within the structure and are usually not numbered according to wall orientation. Different identifiers are however assigned to each. Any one backboard could host a wide assortment of equipment; see EQUIPMENT for identifier schemas.

    Note: Future expansion of rows should be a major consideration during identifier/labeling phase; numbering from low to high in the direction of any available space.
3. Labeling
    a. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
    b. DYMO RhinoPRO 5000 Industrial Label Maker
    c. ¾" Flexible Industrial Strength Nylon label tape - yellow
    d. Labels should be affixed to the cabinet housing.
    e. Labels should be affixed to top-center of identified structure unit. For labeling purposes only, the structure identifier can be omitted from the structure unit identifier to minimize space required for the label. It will be assumed that all structure units located in the same structure will carry the same structure identifier.

    Note: this is for labeling purposes only; data collection records/tables must use complete identifier including telecom structure identifier.



4. Required Fields
    a. No Action Required

5. GPS
   a. No Action Required
6. Supporting Documentation Deliverables
   a. AutoCAD – floorplan and rackface layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit).
7. Spatial Data Deliverables
   a. No action required.
8. Special Instructions
   a. Structure units are visibly marked with a reference tag identifying its column and row. The telecom structure (ITS, HTS, ETS) is omitted from the reference tag but should be included in the structure unit tables. Newly placed structure units will require that their identifiers be affixed to the cabinet face or rack frame. Utilize specified labeling device to accomplish the task.

6.3 PATHWAYS

A. Applies to the following pathways:

1. Ductbank
2. Trench
3. Direct Buried
4. Cable Tray

B. Identification

1. Each **Pathway** has been assigned a unique GIS database identifier. . This identifier serves as a primary key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All pathway identifiers follow a specific schema; new pathways must be identified accordingly. In the event that a determination cannot be made regarding the identification of a pathway, please contact an HAS IT GIS representative prior to documenting.
3. All pathways are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
4. *Airport Campus Characters:*
   a. IAH: I
   b. HOU: H
   c. EFD: E
5. *Asset Designation Character:*
   a. Technology: T
6. *Feature-Category Characters:*
   a. Structure: S
   b. Pathway: P
   c. Equipment: E
   d. Cable: C
7. *Numerical Range:*
   a. 0000 – 9999
8. *Example:*
   a. **ITP0054** (IAH Pathway), **HTP0054** (HOU Pathway), **ETP0054** (EFD Pathway)
9. Labeling

a. Pathways are identified for the purposes of GIS referencing and are linked to structure inventories but are not physically labeled per current guidelines.

10. Required Fields
    a. Each pathway requires that specific data be collected per unit. GPS equipment should be formatted to account for this information. From the PATH data dictionary matrix (See Data Dictionary exhibit), the following fields and their respective values are required:

CONDUIT_SIZE	END2_Z_COORDINATE
COMMENTS	HAS_LEVEL
AIRPORT	COLLECTION_DATE
HAS_ENCASEMENT	PROJECT
AGENCY	TICKET
CONDUIT_QTY	LEGACY_ID
PATH _ID	PATHWAY_MATERIAL
PATH_NUMBER	FROM_TELECOM_ID
PATH_TYPE	TO_TELECOM_ID
END1_COORD_X	TELECOM_ID
END1_COORD_Y	PROJECT_CLASS
END1_COORD_Z	DEPTH_END1
END2_COORD_X	DEPTH_END2
END2_COORD_Y	

11. GPS
    a. Each pathway must be recorded as follows:
    b. Care should be taken to accurately locate the pathways prior to commencing with documentation.
    c. Continuous-line shots; taken on center. Line-shots should begin and end on-center of endpoint (structure) locations.
12. Supporting Documentation Deliverables
    a. No action required
13. Spatial Data Deliverables
    a. The entire pathway inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the ‘Supporting Documentation’ paragraph. This feature class (PATHWAY) should contain the attribute values from the ‘Required Fields’ paragraph.
14. Special Instructions
    a. No action required

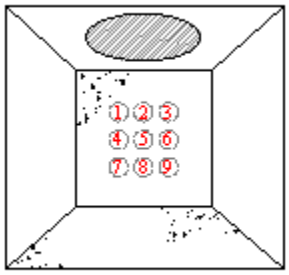
C. Cable Tray

1. Identification no requirements per current guidelines
2. Required Fields no requirements per current guidelines
3. GPS no requirements per current guidelines
4. Supporting Documentation Deliverables no requirements per current guidelines
5. Spatial Data Deliverables no requirements per current guidelines
6. Special Instructions no requirements per current guidelines

6.4 PATHWAY UNITS

A. Conduits:

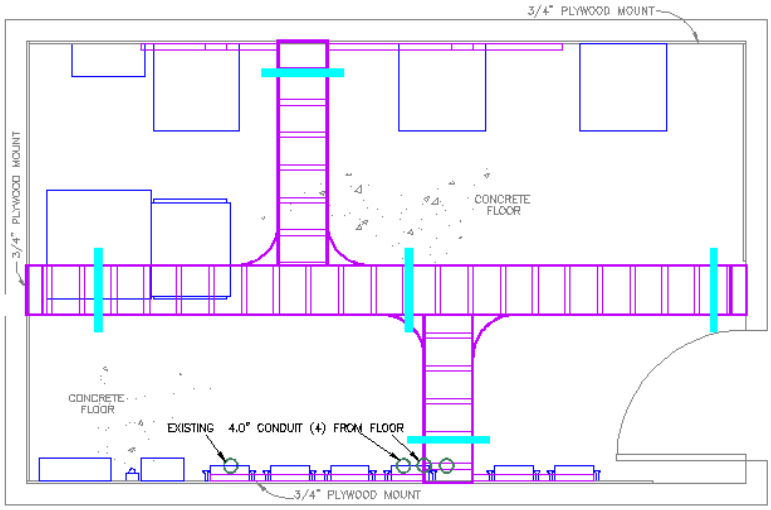
1. Identification
   a. For deliverable purposes conduits are only being depicted via AutoCAD formats; i.e. butterfly diagrams or floorplans (see Exhibits: Communication Room Exhibit, Rackface Exhibit).
   b. In the outside plant environment, conduits should be identified where applicable by size, location and position respective to their endpoints (structures) i.e. handhole wall, building access point, etc.
   c. Further, on manhole / handhole butterfly diagrams, OSP conduits are depicted relevant to their size, position and orientation. As a general rule, conduits are identified left-to-right and top-to-bottom as you're facing the wall to be inventoried and should be prefixed with 'CD' on the AutoCAD documents.



MANHOLE

   d. For the purposes of illustration and to be included as part of the manhole butterfly diagram draft document, each wall should identify the following:
      1) Ductbank (Telecom Pathway Identifier for each respective manhole / handhole wall face)
      2) Conduits (Count, Orientation)
      3) Cabling (Telecom Cable Identifier, Cable Type, Cable Count, location within respective conduit)
      4) In the inside plant environment, conduits should be identified where applicable by position and location respective to their endpoints (telecom structures) i.e. communications rooms, vaults
      5) ISP conduits are depicted on communication-room AutoCAD layouts as to their position and orientation; and are not numbered.

e. Example:



2. Labeling
   a. Not physically labeled per current guidelines.
3. Required Fields
   a. Conduit counts and size as prescribed in the pathway sub-topic
4. GPS
   a. No action required
5. Supporting Documentation Deliverables
   a. AutoCAD manhole/handhole butterfly diagrams for OSP conduits and communication-room layouts for ISP conduits; (See manhole/handhole AutoCAD butterfly exhibit).
6. Spatial Data Deliverables
   a. No action required
7. Special Instructions
   a. See note regarding annotation above.

6.5 CABLE

A. Applies to the following cable types:

1. Inside Plant Copper
2. Inside Plant Fiber (Single-Mode, Multi-Mode)
3. Outside Plant Copper
4. Outside Plant Fiber (Single-Mode, Multi-Mode)
5. Inside Plant Copper Coax
6. Outside Plant Copper Coax
7. Inside Plant Hybrid
8. Outside Plant Hybrid

B. Identification

1. Each **Cable** has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All cable identifiers follow a specific schema; new cable must be identified accordingly. In the event that a determination cannot be made regarding the identification of a cable-run, please contact an HAS IT GIS representative prior to documenting.
3. All cables are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
4. Airport Campus Characters:
   a. IAH: I
   b. HOU: H
   c. EFD: E
5. Asset Designation Character:
   a. Technology: T
6. Feature-Category Characters:
   a. Structure: S
   b. Pathway: P
   c. Equipment: E
   d. Cable: C
7. Numerical Range:
   a. 0000 – 9999
8. *Example:*
   a. **ITC0054** (IAH Cable), **HTC0054** (HOU Cable), **ETC0054** (EFD Cable)

Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

9. Labeling
   a. Labels should be affixed to all connection ends of identified cable and on any visible length at key access points, i.e. manhole, handhole cable ladder runs.
   b. "All adhesive inside/outside plant cable labels for horizontal and backbone cables shall be covered with clear heat shrink tubing"
10. Required Fields
    a. Each cable requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.:

TELECOM_ID	FROM_EQUIPMENT_ID
LEGACY_ID	TO_EQUIPMENT_ID
AIRPORT	HAS_LEVEL
AGENCY	PROJECT
CABLE_TYPE	PROJECT_CLASS
CABLE_COUNT	COLLECTION_DATE
FROM_TELECOM_ID	SYMANTEC_TICKET
TO_TELECOM_ID	COMMENTS
FROM_STRUCTURE_UNIT_ID	
TO_STRUCTURE_UNIT_ID	

11. GPS
    a. Each cable should be recorded as follows:
       1) OSP – continuous GPS shot between identified structures

2) ISP – conventional GPS services are unavailable inside-plant; therefore inside-plant cabling will need to be digitized and included in the ArcGIS CABLE feature class spatial data deliverable.

12. Supporting Documentation Deliverables
    a. ISP Horizontal cabling (see Exhibits – iPatch SOP.pdf).
    b. Cable testing records; .pdf format (see Exhibits – C_Cable Test Exhibit, F_Cable Test Exhibit.pdf)
    c. Butterfly diagrams (OSP) AutoCAD format; (See AutoCAD manhole/handhole butterfly exhibit).
13. Spatial Data Deliverables
    a. The entire OSP cable inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the 'Supporting Documentation' paragraph. This feature class (CABLE) should contain the attribute values from the 'Required Fields' paragraph.
    b. No Spatial Data required for ISP inventory.
14. Special Instructions
    a. No cable testing should be conducted on any live circuit. Ensure that necessary precautions are observed to guarantee existing network integrity and no active circuits are impacted.

C. Jumper Cables / Patch Cords / Cross-Connects:

1. Identification
    a. No action required
2. Labeling
    a. No action required
3. Required Fields
    a. Refer to iPatch SOP (see Exhibits - iPatch SOP.pdf)
4. GPS
    a. No action required
5. Supporting Documentation Deliverables
    a. ISP cabling (see Exhibits - iPatch SOP.pdf)
6. Spatial Data Deliverables
    a. No action required
7. Special Instructions
    a. No cable testing should be conducted on any live circuit. Ensure that necessary precautions are observed to guarantee existing network integrity and no active circuits are impacted.
    b. As iPatch is the administration application for these assets - all project managers, inspectors and consultants overseeing 'new-build' infrastructure configurations must strictly adhere to guidelines specified in the iPatch SOP (see Exhibits - iPatch SOP.pdf). Further, you must contact an iPatch database administrator directly to coordinate the data collection and documentation-deliverable evolution.
    c. Bulk import of key iPatch modeling components can be facilitated by utilization of a specifically formatted spreadsheet (see Exhibits - iPatch Bulk Import.xls).
    d. Updates/changes to fiber patching can be facilitated by utilization of a specifically formatted cut-sheet (see Exhibits – Fiber Patching Cut Sheets.xls).

6.6 EQUIPMENT

A. Applies to the following equipment types:

1. Termination Point
2. Patch Panel
3. Network Switch
4. 110 Block
5. Splice Enclosure
6. Cable Transition
7. EFSO Button
8. Copper Modem
9. Tap
10. Camera

B. Identification
   1. All **Equipment** has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
   2. All equipment identifiers follow a specific schema; new equipment must be identified accordingly. In the event that a determination cannot be made regarding the identification of a piece of equipment, please contact an HAS IT GIS representative prior to documenting.
   3. All equipment is identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
   4. Airport Campus Characters:
      a. IAH: I
      b. HOU: H
      c. EFD: E
   5. Asset Designation Character:
      a. Technology: T
   6. Feature-Category Characters:
      a. Structure: S
      b. Pathway: P
      c. Equipment: E
      d. Cable: C
   7. Numerical Range:
      a. 0000 – 9999
   8. *Example:*
      a. **ITE0054** (IAH Equipment), **HTE0054** (HOU Equipment), **ETE0054** (EFD Equipment)
   9. Labeling
      a. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
      b. DYMO RhinoPRO 5000 Industrial Label Maker
      c. ¾" Flexible Industrial Strength Nylon label tape – yellow
      d. Labels should be affixed to the splice enclosure housing.
      e. Label placement should be affixed to or as near to equipment as possible
   10. Required Fields
      a. All equipment requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.

EQUIPMENT_ID TELECOM_ID

SYMANTEC_TICKET
CABLE_ID
TELECOM_CABLE_ID
LEGACY_CABLE_ID
AIRPORT
AGENCY
PROJECT_CLASS
COLLECTION_DATE
COMMENTS
LEGACY_ID
EQUIPMENT_TYPE
HAS_LEVEL

PROJECT

11. GPS
    a. No action required for ISP equipment
    b. Each splice enclosure (OSP) should be recorded as follows:
        1) Single shots; taken on-center. Offset shots or other means of location are acceptable for splice enclosures not available to satellite coverage but these shots or options must be coordinated with an HAS-IT GIS contact prior to.
12. Supporting Documentation Deliverables
    a. AutoCAD – one-line diagram of ACCESSIBLE splice enclosures depicting cable identifiers, connections and cable counts for each splice enclosure in both .dwg 2010 or higher and .pdf formats; (See AutoCAD splice enclosure exhibit).
    b. AutoCAD – rackface layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit).
13. Spatial Data Deliverables
    a. The entire equipment inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the 'Supporting Documentation" paragraph. This feature class (EQUIPMENT) should contain the attribute values from the 'Required Fields' paragraph.
14. Special Instructions
    a. Do not attempt to open a splice enclosure that appears to be in a fragile state or does not provide for ready access (sealed). Note in 'comments' field that the enclosure was inaccessible.
    b. Do not move, adjust 'live' equipment in order to identify or label. Ask for assistance from qualified HAS Technology Infrastructure personnel.
    c. Do not disconnect cabling in order to identify or label. Ask for assistance from qualified HAS Technology Infrastructure personnel.

C. Outlets:

1. Identification
    a. Each outlet-faceplate is identified specific to its servicing IDF; regardless of the number of outlets within a given location. All outlet-faceplate ports are labeled to correspond with the servicing IDF panel port. ***NOTE: These space identifiers are architectural identifiers, and are designated by reference to the HAS Infrastructure schema for identifying building spaces. This is not a GIS Technology Infrastructure database identifier.***
    b. Example Outlet-Faceplate Identifier:
        S103.1
        Translation: Outlet serviced by IDF S103.1
    c. In the event that a determination cannot be made regarding the identity of the outlet, please contact the HAS IT GIS representative prior to documenting.
    Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This

action will account for all identifiers previously assigned and prevent duplications or omissions.

2. Labeling
   a. Outlet label placement 2-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right.

   b. Outlet label placement 3-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right.

   c. Outlet label placement 4-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Follow 3-port example.

d. Outlet label placement 6-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Any mid-faceplate ports will require an adhesive label - servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. These types of outlets are 'Non-Standard'.

3. Required Fields
   a. No action required
4. GPS
   a. OSP – No GPS action required
   b. ISP – No GPS action required
5. Supporting Documentation Deliverables
   a. Additional documentation records are required to support iPatch data. The documentation is as follows:
   b. AutoCAD – floorplan (where applicable) depicting outlet locations; (See AutoCAD communications room exhibit).
6. Spatial Data Deliverables
   a. No action required
7. Special Instructions
   a. Outlets are visibly marked with a reference tag indicating the outlet identifier. Additionally any port associated to the outlet is identified with a port number related specifically back to its respective servicing equipment. Newly placed outlets will require that their identifiers be affixed to the outlet face. Utilize specified labeling device to accomplish the task.

D. Door Contacts:

1. Identification
   a. Each door-contact sensor (without card-reader) is identified by an alpha-numeric sequence specific to its location. All door-contact identifiers are coded with building or complex character, followed by level character, followed by numerical sequence character, followed by 'CCM' designation. "CCM' is an acronym for 'Control Contact Monitoring.'
   b. Example Outlet-Faceplate Identifier:

      B-2057CCM

      Translation:

B	*(building/complex character)*	*Terminal B*
2	*(level character)*	*Level 2*
057	*(numerical sequence character)*	*Contact # 057*
CCM	*(CCM designation)*	*Control Contact Monitoring*

   c. In the event that a determination cannot be made regarding the identity of a door contact, please contact the HAS IT Project Manager prior to documenting.
   Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT Project Manager prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.
2. Labeling

a. Door-contacts (without card-reader) require identifier plates per 'Special Instruction' specification below

3. Required Fields
   a. TBD
4. GPS
   a. OSP – No GPS action required
   b. ISP – No GPS action required
5. Supporting Documentation Deliverables
   a. AutoCAD floorplans indicating door contact location including label plate identifier annotation
6. Spatial Data Deliverables
   a. No action required
7. Special Instructions
   a. Install Black Lexan Label Plate: sized 1 ½" X 4", black background, white lettering and Door Alarm Identifier engraved (i.e. B-2057CCM). Locate plate on door frame above contact. Clean door frame prior to placement. Affix with 3M double-sided tape.
   b. Provide paper and electronic copies (.pdf format) of all Electronic Lock Permits and Submittal Documents for any door requiring City of Houston door lock permit to the HAS IT Project Manager prior to Acceptance Testing.

E. Card Readers:

1. Identification
   a. Each electronic lock is identified by an alpha-numeric sequence specific to its location. All electronic lock identifiers are coded with building or complex character, followed by level character, followed by numerical sequence character.
   b. Example Outlet-Faceplate Identifier:

      C-1015

      Translation:

C	*(building/complex character)*	*Terminal C*
1	*(level character)*	*Level 1*
015	*(numerical sequence character)*	*Lock # 015*

   c. In the event that a determination cannot be made regarding the identity of a door contact, please contact the HAS IT Project Manager prior to documenting.
   Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT Project Manager prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.
2. Labeling
   a. Electronic locks require identifier plates per 'Special Instruction' specification below
3. Required Fields
   a. TBD
4. GPS
   a. OSP – No GPS action required
   b. ISP – No GPS action required
5. Supporting Documentation Deliverables
   a. AutoCAD floorplans indicating card reader location including label plate identifier annotation

6. Spatial Data Deliverables
   a. No action required
7. Special Instructions
   a. Install Black Lexan Label Plate: sized approximately 3 ¼" X 5 ½", black background, white lettering and Card Reader Identifier engraved (i.e. C-1015). Affix plate to single-gang cabinet with 5/32" screws.
   b. Provide paper and electronic copies (.pdf format) of all Electronic Lock Permits and Submittal Documents for any door requiring City of Houston door lock permit to the HAS IT Project Manager prior to Acceptance Testing.

6.7 CONNECTIONS

A. Ports:

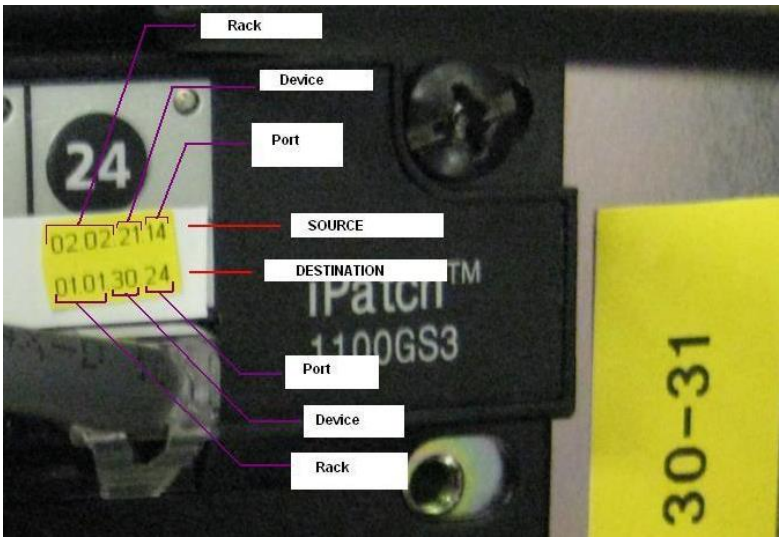
1. Identification
   a. Each port has been assigned an identifier; combined with the equipment identifier, the sequence becomes unique. Therefore port identifiers may be replicated on separate pieces of equipment because again, the true and complete port ID is coupled to the equipment ID.
   b. Example:

100.20.01.02.35-39 (equipment ID) + FP03 = 100.20.01.02.35-39 FP03

100.25.01.01.12-17 (equipment ID) + FP03 = 100.25.01.01.12-17 FP03

Fiber port 03 is replicated on two different pieces of equipment. Coupling it to the equipment ID makes the string unique

   c. All ports are identified through a numerical range specific to its respective equipment. Ports may be prefixed with 'FP' (fiber port) or 'CP' (copper port) as is pertinent to the cable category and space allows on the equipment.
   d. Regarding service outlets: ports are identified via reference to IDF and IDF equipment (see Outlet). This data should be recorded in the Excel data record tables.
   e. Regarding termination panels: ports are identified according to equipment port capacity.
   f. Regarding patch panels: ports are identified in sequence and may be prefixed with structure identifier references.
   g. Regarding switches: ports are identified in sequence and may be prefixed according to cable compatibility; i.e. 'FP' or 'CP'. The port sequence should follow left-to-right and top-to-bottom.
   h. Regarding devices housing multiple blades: ports are identified in sequence as related to respective blades and may be prefixed according to cable compatibility; i.e. 'FP' or 'CP'. The port sequence should follow left-to-right and top-to-bottom.
   i. Regarding SYSTIMAX (iPatch) 'equipment panels': ports are identified with a source-over-destination, (panel-to-panel) schema and inclusive of rack/cabinet (structure-unit) identifiers.
   j. Regarding SYSTIMAX (iPatch) 'service panels': ports are identified in sequence and may be prefixed with structure identifier references.



k. All port identifiers follow some specific schema; new ports must be identified accordingly. In the event that a determination cannot be made regarding the identity of the port, please contact the iPatch database administrator prior to documenting.
Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

2. Labeling

a. Regarding switches: generally space does not allow for switch port labeling; ports must be identified however in order to correlate circuit connectivity to/from/through the device.
b. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
c. DYMO RhinoPRO 5000 Industrial Label Maker
d. ¾" Flexible Industrial Strength Nylon label tape – yellow
e. Labels should be affixed to applicable port locations. Not all ports allow for label placement but these ports should be identified and recorded as part of iPatch SOP; respective to cable or equipment.

3. Required Fields
   a. Each port requires that its relationship be established between cable and equipment via use of the iPatch cut sheet (see Exhibits – iPatch SOP.pdf).
4. GPS
   a. No action required
5. Supporting Documentation Deliverables
   a. ISP cabling/port configurations (see Exhibits – iPatch SOP.pdf)
6. Spatial Data Deliverables
   a. No action required

7. Special Instructions
   a. Careful attention should be given to accurately accounting for and recording relationships established between ports – cable, and ports – equipment.

PART 7 - STANDARD OPERATING PROCEDURES – BEST PRACTICES

A. Data Collection Methodology

1. This section includes a general outline of procedures that can be utilized towards the collection and processing of HAS' IT physical data requirements. The outline establishes some of the recommended methods which have proven to be most successful during previous data collection cycles.
2. This guide does not mandate adherence to these methods provided that the contracting party can determine a like process to produce the intended results. Said process must however provide for the specific formatting of all aforementioned physical data deliverables including data record tables, .DWF / .DWG, .PDF, feature class, feature class, and photo imagery.

Note: Safety is paramount and discussions with regard to OSHA and other regulatory or governing authorities including Airport Operations must be coordinated with the HAS IT representatives prior to commencement of any project scope.

B. Outside Plant

1. Identify outside plant network locations as defined by project scope of work including all structures, pathways, cable and equipment. This requires extensive communication and coordination with HAS airport campus authorities before and during the evolution. Contracting parties will be provided with respective contact information prior to commencement of data collection effort.
2. Coordinate with HAS IT representative to determine existing network identifiers and to specify any new network identifiers that must be incorporated into data deliverables.
3. If applicable to the GPS equipment that will be utilized to collect data, format custom projections to campus, format code-list.
4. GPS locate structures; ensure all attribute fields are populated. For MH, HH produce field sketch - butterfly layout depicting pathway unit counts orientation; cable types / counts, location. These field sketches should be used to create AutoCAD .DWF / .DWG deliverables.
5. Produce photo imagery
6. GPS locate all splice enclosures, slack loops.
7. Label all end-equipment, splice enclosures, slack loops, cable, pullboxes, cabinets, pedestals. Stamp all MH, HH per guidelines.
8. GPS locate pathways; ensure all attribute fields are populated.
9. Physically locate outside plant associated equipment; ensure all attribute fields are populated.
10. Building Access Points can be approximated where the PATHWAY intersects the building face for purposes of GPS data collection; single-shot.
11. GPS locate cable routing; ensure all attribute fields are populated including end-equipment identifiers.
12. QA/ QC to ensure that all data relationships have been established; i.e. equipment-structure, structure-pathways, pathway-cable and that all attribute fields have been populated.

13. Finalize, format deliverables

C. Inside Plant

1. Identify inside plant network locations as defined by project scope of work including all structures, cable and equipment. This requires extensive communication and coordination with HAS airport campus authorities before and during the evolution. Contracting parties will be provided with respective contact information prior to commencement of data collection effort.
2. Coordinate with iPatch database administrator to determine existing network identifiers and to specify any new network identifiers that must be incorporated into data deliverables.
3. Prepare field sketch (floorplan, rackface) of interior space and equipment. Document and dimension structure space and contents required to generate layouts for the floorplan, cable ladder, conduit, room details, and Install details. Rackface layouts should be created in a separate document. These field sketches should be used to create AutoCAD .DWF / .DWG deliverables.
4. Label all structure units, cable and equipment per guidelines.
5. Record information specific to iPatch SOP for structure units, equipment, cable; this process will be covered in depth at the coordination meeting held prior to commencement of data collection effort. This information establishes infrastructure relationships that will be used to model the communications environment.
6. Test Cable.
7. QA/ QC to ensure that all data relationships have been established; i.e. structure – structure, structure – structure units, structure units – equipment, equipment – ports, ports – cable.
8. Finalize, format deliverables.

END OF SECTION 270553

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 271100 - COMMUNICATIONS CABINETS AND EQUIPMENT ROOMS
(Rev 01-14-2020 TAB)

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the specifications for constructing and building out of Telecommunications Equipment Rooms (MDF/IDFs) to be used for supporting telecommunications and other special systems.

B. Upon completion of the installation, a third party field verification firm will independently verify the installation for compliance to the TIA/EIA-568 standard and/or additional requirements as stated in this specification. Contractor shall be responsible for fully rectifying all indicated faults by the third party field verification firm in accordance with the approved project schedule

1.2 RELATED SECTIONS:

A. Specification 270500: Common Work Results for Communications

B. Specification 270510: Telecommunication Administrative Requirements

C. Specification 270526: Telecommunications Grounding and Bonding

D. Specification 270553: Identification and Labeling of Communication Infrastructure

E. Specification 271300: Backbone/Riser Media Infrastructure

F. Specification 271500: Horizontal Media Infrastructure

G. Specification 272100 Data Communication Network Equipment

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. 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 270510 - Telecommunication Administrative Requirements.

D. Telecommunications Industry Association /Electronic Industries Association (TIA/EIA) 568-Commercial Building Telecommunications Wiring Standards (latest issue)

E. TIA/EIA-569-Commercial Building Standard for Telecommunications Pathways and Spaces (latest issue)

F. ANSI/TIA/EIA 607-Commercial Building Grounding and Bonding Requirements (latest issue).

G. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program.

H. National Electrical Manufacturers Association (NEMA).

I. National Electric Code (NEC®).

J. UL Testing Bulletin.

K. Houston Airport System Standards and Specifications

1.4 DEFINITIONS AND ABBREVIATIONS

A. Asynchronous Transfer Mode - ATM

B. American Wire Gauge – AWG

C. Computer Aided Drafting - CAD

D. Polyvinyl Chloride – PVC

E. Megabits per second - Mbps

F. Main Distribution Frame – MDF

G. Intermediate Distribution Frame - IDF

1.5 SUBMITTALS

A. Refer to Section 270510 - Telecommunication Administrative Requirements and the following

B. Contractor shall submit the proposed layout for each communications room in the airport. This should be in accordance with the drawings in for a “typical” room layout and is required for every room.

C. The contractor will need to submit proposed layout and as-build drawings that depict the complete layout of each communications room prior to implementation. Drawings must be entered into the ECN process

D. Shop Drawings and Systems cutover schedules for all services to be submitted and approved before implementation is started. Shop Drawings to be submitted in accordance with Specification 013300 and 270510.

E. Record Drawings: Refer to Section 270510 - Telecommunication Administrative Requirements.

1.6 QUALITY ASSURANCE

A. Refer to Section 270510 - Telecommunication Administrative Requirements and the following.

B. Furnish, erect, install, connect, clean, adjust, test and condition all manufactured articles, materials, and equipment, and place in service in accordance with the manufacturer’s directions

and recommendations except as otherwise indicated in the contract documents.

C. Contractor Qualifications - Refer to Section 270510 - Telecommunication Administrative Requirements.

D. Hardware manufacturer's experience - Refer to Section 270510 - Telecommunication Administrative Requirements.

E. See Appendix A – MDF/IDF Readiness Checklist

F. See Appendix B – Typical Inspector Checklist

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. MDF space allocation shall be a minimum of 1000 sqft.

B. IDF space allocation shall be a minimum of 250 sqft.

C. The manufacturers and specific part numbers listed in this section are provided as an aid in the RFP process and are not meant to preclude other manufacturers that may be qualified to provide communications components. Other manufacturers with comparable qualifications may be proposed but shall be subject to review as an approved equivalent.

D. Substitutions for any product identified in the design drawings or Sections must follow the substitution process as described in Section 270510 - Telecommunication Administrative Requirements.

2.2 RELAY RACKS

A. Manufacturer: Chatsworth or submitted and owner-approved equivalent.

B. HAS

1. Seven-foot double-sided, high cable density style relay rack shall comply with following specifications:

a. 19" rack width
b. Double-sided universal mounting spacing
c. #12-24 panel mounting holes
d. Conformance to EIA-310-D
a. Self squaring with tapped assembly holes
b. Material: aluminum extrusion
c. Provide Horizontal and Vertical wire management
d. Finish: Black Finish
e. Part number: 55053-703
f. Isolation kit for mounting
g. Power Strip –Chatsworth or owner approved equivalent QTY (2) Horizontal Metered Power Strip (Part #13239-755) Input NEMA 5-20P; and Output (12) Nema

5-20R

h. All Cabinets/Rack are to have a 24 port standard RJ45 patch panel installed with 12 ports cabled back to the Horizontal cable cabinet on an approved panel

2.3 FREESTANDING VERTICAL EQUIPMENT CABINETS

A. Manufacturer: Chatsworth F Series Gen 3 cabinets or submitted and owner-approved equivalent.

B. General

1. The work covered here consists of the furnishing of all necessary labor, supervision, materials, accessories, parts, equipment, and services to provide and install a complete freestanding equipment cabinet.
2. The standard freestanding equipment cabinets are defined to include, but not limited to, cabinet frames, cabinet front and rear doors, top and side panels.
3. All internal cabinetry hardware shall be 19-inch rack mountable.
4. Provide and install freestanding vertical cabinets, with hinge placement as indicated in the Drawings.
5. Provide vertical and horizontal wire management for all cabinets
6. All cabinets once installed must have padlock eyes installed on front and back cabinet doors.
7. All Cabinets/Rack are to have a 24 port standard RJ45 patch panel installed with 12 ports cabled back to the Horizontal cable cabinet on a iPatch panel

C. Standard Network cabinet:

1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
   a. Chatsworth part # TS1023813 – 45RU; 800mm W; 1075mm D; F Series Gen 3
      1) 12-24 Tapped sliding rails / 2-pair
      2) Single perforated metal front door with swing latch w/padlock feature
      3) Double perforated metal rear door with swing latch w/padlock feature
      4) Network / One-piece / 4 cable openings
      5) Two solid two piece side panels
      6) 6-slide
      7) (4) Vertical Ring cable managers installed one on each corner (39087-E02)
      8) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)
      9) Glacier white
   b. All Network cabinets to have 24 iPatch panel installed. See Specification 271500
   c. PDU Power Strips:
      1) Core Switch Cabinet QTY (2) Chatsworth Vertical eConnect Monitored Pro PDUs (Part # P4-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s. And (1) Horizontal Metered Power Strip (Part # 13239-755) Input Nema 5-20P; Output (12) Nema 5-20R
      2) All other Cabinets QTY (2) Chatsworth Vertical eConnect Monitored Pro PDUs (Part # P4-1D0A5) L5-30P input; output (24) 5-20Rs.
2. Grounding Bus Bar:
   a. Provide Rack-Mounted Ground Bar. See Specification 270526

D. Standard Server Cabinet:

1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
   a. Chatsworth part # TS1023812 – 45RU; 600mm W; 1200mm D; F Series Gen 3
      1) Square-punched rails / 2-pair
      2) Single perforated metal front door with swing latch w/padlock feature
      3) Double perforated metal rear door with swing latch w/padlock feature
      4) Server / Two -piece / 4 cable openings
      5) Two solid two piece side panels
      6) 6-slide
      7) (4) Vertical Ring cable managers installed one on each corner (39087-E02)
      8) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)
      9) Glacier white
   b. All Server cabinets to have 24 patch panel installed. See Specification 271500 PDU
   c. PDU Power Strips:
      1) Server Cabinet QTY (4) Chatsworth Vertical eConnect Switched Pro PDUs (Part # P6-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s.
2. Grounding Bus Bar:
   a. Provide Rack-Mounted Ground Bar. See Specification 270526

E. Data Center Network cabinet:

1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
   a. Chatsworth part # TS1023649 – 45RU; 800mm W; 1200mm D; F Series Gen 3
      1) 12-24 Tapped sliding rails / 2-pair
      2) Single perforated metal front door with swing latch w/padlock feature
      3) Single Solid metal rear door with swing latch w/padlock feature
      4) Vertical Exhaust Duct System 34in-60in H (863mm-1523mm)
      5) Network / One-piece / 4 cable openings
      6) Two solid two piece side panels
      7) 6-slide
      8) (4) Vertical Ring cable managers installed one on each corner (39087-E02)
      9) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)
      10) Bottom Panel Installed
      11) Air Detector Installed
      12) No Casters
      13) No Leveling Feet
      14) Glacier white
   b. All Network cabinets to have 24 iPatch panel installed. See Specification 271500
   c. PDU Power Strips:
      1) Data Center Switch Cabinet QTY (2) Chatsworth Vertical eConnect Switched Pro PDUs (Part # P6-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s.
      2) And (1) Horizontal Metered Power Strip (Part # 13239-755) Input Nema 5-20P; Output (12) Nema 5-20R.
2. Grounding Bus Bar:
   a. Provide Rack-Mounted Ground Bar. See Specification 270526

F. Data Center Server Cabinet:

1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
   a. Chatsworth part # TS1023645 – 45RU; 600mm W; 1200mm D; F Series Gen 3
      1) Square-punched rails / 2-pair
      2) Single perforated metal front door with swing latch w/padlock feature
      3) Single Solid metal rear door with swing latch w/padlock feature
      4) Vertical Exhaust Duct System 34in-60in H (863mm-1523mm)
      5) Server / Two -piece / 4 cable openings
      6) Two solid two piece side panels
      7) 6-slide
      8) (4) Vertical Ring cable managers installed one on each corner (39087-E02)
      9) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)
      10) Bottom Panel Installed
      11) Air Detector Installed
      12) No Casters
      13) No Leveling Feet
      14) Glacier white
   b. All Server cabinets to have 24 patch panel installed. See Specification 271500 PDU
   c. PDU Power Strips:
      1) Server Cabinet QTY (4) Chatsworth Vertical eConnect Switched Pro PDUs (Part # P6-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s.
2. Grounding Bus Bar:
   a. Provide Rack-Mounted Ground Bar. See Specification 270526

G. Standard Wall Mount Cabinet:
1. Chatsworth (Cube-IT) 12U/19U/26U 11890-x24/36/48 13U screw/round hole or approve
2. PDU Power strip:?.
3. Provided Vertical wire management
4. Grounding Bus Bar:
   a. Provide Rack-Mounted Ground Bar. See Specification 270526

H. Co-location Cabinet – three compartment: .Chatsworth Part #TS1034205 Rev B

1. Dimensions: 600MM W x 800MM D (650mm Useable due to 150MM D Cable Raceway)
2. Provide Rack-Mounted Ground Bar. See Specification 270526
3. 12-24 Tapped sliding rails / 2-pair
4. Single perforated metal front doors (with beam) per compartment
5. Single perforated metal rear door per compartment; swing handle latches, with hasp lock
6. Standard top panel
7. Glacier White finish

I. Co-location Cabinet – two compartment: Chatsworth Part #TS1034203 Rev B

1. Dimensions: 750mm W x 800mm D (650mm Useable due to 150mm D Cable Raceway)
2. Provide Rack-Mounted Ground Bar. See Specification 270526
3. 12-24 Tapped sliding rails / 2-pair
4. Single perforated metal front doors (with beam) per compartment
5. Single perforated metal rear door per compartment; swing handle latches , with hasp lock

6. Standard top panel
7. Glacier White finish

2.4 CABLE MANAGEMENT

A. Horizontal Cable Managers for data racks shall be as follows:

1. For HAS:
   a. Chatsworth # CPI-30130-719 for single-sided manager.

B. Vertical Cable Managers for data racks shall be as follows:

1. For HAS:
   a. Chatsworth #11374-503 or equal for single-sided manager.
   b. Chatsworth #11729-503 or equal for double-sided manager.

2.5 WALL BACKBOARDS

A. All walls in telecommunication rooms (MDF/IDF's, Tenant etc.) will be covered with ¾ inch plywood installed in 4 x 8 sheets.

B. Plywood shall be A/C grade or better void-free with A grade side facing out.

B. Plywood shall be and either fire-rated or treated on all sides with at least 2 coats of fire-resistant light-colored paint. Do not paint the fire-rated stamp on the plywood, leave that area exposed.

C. Plywood shall be fastened with #12 flat-head sheet metal screws to metal studs every 16 - 24 inches on center depending on stud spacing. The use of a nail gun or explosive charge device is not allowed for installation of the plywood.

D. Plywood to be installed 6 inches above finished floor or raised deck.

E. Provide cut-outs for all electrical outlets and switches.

2.6 IDENTIFIERS, LABELS AND LABELING SYSTEM

A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. Any deviation from the specification must be approved by HAS IT prior to installation.

2.7 Energy Efficient Lighting for IDFs

A. General

1. The work covered here consists of the furnishing of all necessary labor, supervision, materials, accessories, parts, equipment, and services to provide and install a complete lighting system.

2. Lights shall be LED and controlled by an occupancy sensor so lights are turned off when the room is not occupied.

2.8 ENERGY EFFICIENT LIGHTING FOR MDFS COMPUTER ROOMS

A. Manufacturer: Columbia Lighting or submitted and owner-approved equivalent.

B. General

1. The work covered here consists of the furnishing of all necessary labor, supervision, materials, accessories, parts, equipment, and services to provide and install a complete lighting system.
2. System must be cabled to the HAS network so it can be remotely managed.
3. System must be configured with installed occupancy sensors, to facilitate the lights being turned off when the room is not occupied.

C. Lighting System
1. Columbia Lighting (division of Hubbell Lighting) fixture RLA22.
2. At least one fixture must provide emergency lighting in case of a power outage.
3. All UTP cabling must follow section 271500 and all other HAS standards.

PART 3 - EXECUTION

3.1 VERIFY FOR MINIMUM CRITERIA

A. Verify the following:

1. Minimum size of MDF is 1000 sqft.
2. Minimum size for IDF is 250 sqft.
3. HAS does not share MDF/IDF space with any other tenant and must be separated by a physical barrier be it a fence or wall. All tenants communication systems cabling and equipment shall be installed in the HAS controlled tenant space, as defined in the third item in this section. This shall apply to all tenants that do not have a dedicated MDF or IDF space for their individual telecommunications systems.
4. Conduit, raceways, and boxes are properly installed in accordance with BISCI recommended practices, ANSI/TIA/EIA 569 (latest issue) standards, and the City of Houston Intercontinental Airport Premises Distribution System Design Standards.
5. Conduit is minimum 1 -inch diameter.
6. Main grounding system is properly installed and tested.
7. The MDF is equipped with a smoke detector connected to the building alarm fire panel.
8. Portable fire extinguishers are provided and maintained within 75 feet travel distance from any part of the occupied space within the MDF per local code requirements. The size of the extinguisher shall be a minimum rating of 2-A:10-B:C
9. Ceiling protrusions have been placed to assure a minimum clear height of 8 feet 6 inches to provide space over the equipment frames for cables and suspended racks.
10. The doors are a minimum of 3 feet wide by 6 feet, 7 inches tall. If it is anticipated that large equipment will be delivered to the MDF, a double door 6 feet wide by 7 feet, 5 inches tall is recommended. The doors shall be keyed separately from other facility keys. Preferred method for keying communication room is badge access, limited to only IT personnel and related vendors. Doors shall open outward and be lockable. Access shall allow for future equipment changes. Door shall be fire rated for a minimum of one hour, or more as required by local code requirements.
11. Signage is consistent with Houston Airport System
12. The floor is sealed concrete or tile to minimize dust and static electricity. Carpet is strictly prohibited.

13. Floor loading capacity in the MDF is designed for a minimum distributed load rating of 100 lbf/ft² and a minimum concentrated load rating of at least 2000 lbf.
14. All HVAC systems that provide environmental conditioning (24 hours per day, 365 days per year) and UPS shall be connected to a motor generator for those cases of extend power outages.
15. The air handling system for MDF/IDF equipment rooms is designed to provide positive air flow and cooling even during times when the main building systems are shut down. This may require separate air handlers and/or small stand-alone cooling systems that are thermostatically controlled in this space.
16. Heating, ventilation, and air conditioning sensors and control equipment are located in the MDF/IDF.
17. The room temperature is between 64°F and 75°F, with a relative humidity between 30% and 55%.
18. Designer to provide heat load analysis for all equipment cabinets. Designer must use 100% name plate specifications to perform the heat load analysis. Note: Heat load with xx% diversity load factor is not recognized by HAS Technology.
19. The MDF/IDF is protected from contaminates and pollutants that could affect operation and material integrity of the installed equipment. When contaminates are present in concentrations greater than indicated in ANSI/TIA/EIA 569-A, Table 8.2-2, vapor barriers, positive room pressure or absolute filters shall be provided.
20. Positive air pressure differential is maintained with respect to surrounding areas.
21. Lighting to provide a minimum equivalent of 50 foot-candles when measured three feet above finished floor. The light fixtures shall be mounted a minimum of 8 feet, 6 inches above the finished floor. The light switches are located near the entrance of the MDF/IDF. Power for the lighting is from the same circuits as power for the telecommunications equipment. Emergency lighting has properly been placed that an absence of light will not hamper emergency exit. Lights must be energy efficient LED lights control by approved room lighting system utilizing UTP cabling.
22. The MDF/IDF cabinets are equipped with a minimum of two dedicated electrical circuits appropriately sized for equipment to be installed. Separate duplex 120V AC convenience outlets (for tools, test sets, etc.) shall also be installed at 18 inches above the finished floor at 6-foot intervals around perimeter walls. The outlets shall be on non-switched circuits and they shall be identified and labeled.
23. The MDF/IDF is provided with an electrical ground on a 4-inch or larger busbar as defined by NEC Article 250-71(b). The busbar shall be mounted 6 feet, 6 inches above the finished floor if ladder racking is included in the design. If ladder racking is not part of the design, the busbar shall be located near, but not behind, the riser sleeves between floors. This grounding bar is connected to a main building ground electrode, reference ANSI/EIA/TIA-607. (Refer to Specification 270526)
24. Connection between the MDF and IDF will be connected with both unshielded twisted pair Category 6 cable, when distance is less than 90 meters and fiber optics cable if the distance is beyond 90 meters. Fiber optics cable should include single-mode and multi-mode. The type of cable, actual count and termination of the fiber will be determined at the planning stage, taking into consideration the amount of network traffic between closets, the distance between the communications rooms and the difficulty of running other cables at future dates.
25. The MDF/IDF is equipped with a single Room wide Eaton Uninterruptible Power Supply that supports all active electronics for a minimum of 30 minutes. Eaton UPS will be connected to an emergency power such as motor generators for those cases of extend power outages. Designer to size for 50% growth.
26. All walls of MDF/IDF are lined with Trade Size 3/4-inch AC-grade plywood, 8 feet high.

Plywood will be mounted vertically starting 6 inches above finished floor and shall be securely fastened to the wall-framing members. Plywood to be fire treated and painted with two coats fire-retardant paint. Do not paint the fire-rated stamp on the plywood, leave that area exposed.

27. Additional equipment such as fire alarm panels and/or building monitoring devices are not be housed in the MDF/IDF. Separate space for these services can be provided as part of the electrical room or in a separate space.
28. These rooms shall be on separate fire protection loops, and a "dry" fire protection system such as FM-200 or Inergen for MDF and preaction for IDF's shall be used. However, an acceptable alternative for intermediate special systems rooms is a "dry" pipe sprinkler system, or no fire protection if enclosed by fire rated walls.
29. Access to the MDF/IDF shall be directly from hallways, not through offices, janitorial or mechanical rooms.
30. The MDF/IDF is located as close as possible to the center of the area served and preferably in the core area.
31. The MDF/IDF is located in any place that may not be subject to water or steam infiltration, humidity from nearby water or stream, heat, and any other corrosive atmospheric or environmental conditions.
32. The MDF/IDF is not located near electrical power supply transformers, motors, generators, x-ray equipment, radio transmitters, induction heating devices, and other potential sources of electromagnetic interference.
33. The MDF/IDF does not share space in or be located near or below electrical closets, boiler rooms, washrooms, janitorial closets, and storage rooms.
34. All new BDF, MDF, and/or Computer room spaces shall use Panduit fiber runner pathway to manage fiber optic patch cords between cabinets.
35. If any of these items are not provided, contact the HAS/IT representative.

3.2 INSTALLATION

A. Install work following drawings, manufacturer's instructions, and approved submittal data.

B. All installation shall be done in conformance with TIA/EIA 569 latest issue and BICSI installation guidelines. Failure to follow the appropriate guidelines will require the Contractor to provide, in a timely fashion, the additional material and labor necessary to properly rectify the situation.

C. The contractor shall adhere to the installation schedule of the general contractor and should attend all construction meetings scheduled by the general contractor.

D. As a general practice for rack mounted equipment, the contractor shall run power cables, control cables, and high-level cables on the left side of an equipment rack as viewed from the rear. The contractor shall run other cables on the right side of an equipment rack as viewed from the rear. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of not less than three feet and ensure that the cable is long enough to allow full extension of drawer or slide.

E. All racks and cabinets shall be floor mountable by design and permanently fixed to the floor with bolt-down kits. Manufacturer's procedures for floor mounting should be followed. Multiple racks and cabinets shall be connected together directly or indirectly via horizontal cable management hardware as indicated by drawings.

F. A minimum of 2 feet shall be left at the end of the row of equipment bays. A minimum of 5 feet between walls and equipment bays will allow space for wall mounted copper cable terminations and the required 36" distance from equipment for work space.

G. Typical Equipment Layout in Racks and Cabinets

1. Provide 2RU horizontal management in the top and center of each rack or cabinet.
2. Locate UPS and horizontal PDU in bottom of rack or cabinet.
3. Reserve space from middle horizontal management to PDU for owner installed active equipment.
4. Locate fiber patch panel in top below upper horizontal management.
5. Locate copper patch panels below fiber patch panels.
6. Reserve at least 10 RU for servers between the copper patch and middle horizontal management.

H. Vertical Cabinet Installation

1. All Cabinets shall be properly positioned, leveled, ganged, anchored, grounded and powered.
2. All Cabinets shall be populated as noted in drawings with termination hardware, equipment, proper patch cord lengths, and power outlets.
3. Install and anchor all vertical equipment cabinets to floor following the Drawings and manufacturer's instructions.
4. All cabinets shall be properly ganged in each bay as shown in the Drawings.
5. All cabinet doors shall be configured as shown in the Drawings.
6. All cabinets shall be properly labeled per Section 270553 – Identification and Labeling of Communication Infrastructure. Label as indicated in Drawings.
7. After final acceptance of the cabinets, coordinate with Owner to replace key/lock with silver barrel on front and back doors.

3.3 CONTRACTOR'S FIELD QUALITY CONTROL

A. The contractor shall be responsible for performing field inspections to ensure that all communications are installed in accordance with the contract drawings, specifications, and City of Houston requirements prior to the performance of field inspections by the City.

B. Should there be any discrepancies or a question of intent, refer the matter to the City for a decision before ordering any equipment, materials or before starting any related work.

C. The City shall perform field inspections and note all discrepancies that must be corrected prior to system acceptance.

D. For all new IDF Rooms installed in this project, the contractor must conform with Appendix C and Appendix D prior to Owner's acceptance of substantial completion or ability to begin installation of Owner furnished equipment.

E. Provide permanent label for all cabinets consisting of three-layer laminated plastic nameplate with white letters on a black background. For additional labeling requirements refer to Section 270553.

END OF SECTION 271100

Appendix A

This list below is intended as a minimum checklist. CM should ensure that the contractor's schedule has built in these components and the necessary buffer period – and associated access restrictions to the communications equipment rooms -- for HAS IT and tenant IT to prepare.

1. All communication rooms that will service the area to be opened must be completed. That means a final walkthrough of these areas has been completed. It is not necessary that the entire project achieve substantial completion, but IT cannot install equipment and begin work until the following minimum criteria is met:
   a. Space is built out and clean – free from dust/residues.
   b. Electrical w/UPS as required.
   c. All racks/cabinets installed and mounted. Padlocks eyes have been installed.
   d. Grounding bus bar installed and properly tied to main grounding bus bar in MDF
   e. HVAC functioning properly and is adequately filtering dust. Humidity is controlled.
   f. Door access control is installed (card reader) -or- an approved temporary provision. Simple key access is not permissible.
   g. Lighting is installed and operational.
   h. Cable trays/ladder racks installed and ready to use.
   i. Permanent or temporary signage identifying permanent room number.

2. All cabling necessary to operate the areas to be opened is completed.
   a. Backbone cabling (copper and fiber) from the applicable communication room(s) is installed, tested, labeled, and approved by the inspector and communications design consultant.
   b. Horizontal cabling for all areas to be occupied is installed, tested, labeled, and approved by the inspector and communications design consultant.
   c. Copper cross connects and/or fiber jumpers have been installed per the owner/tenant requirements.
   d. Cable records and redline drawings for installed cables are submitted and approved PRIOR to putting any active circuits on the new cables. Cable records reflect all installed cables **and** any cross connects or jumper assignments installed by the contractor.
   e. All iPatch Panels are programmed and operational.
   f. All jumpers and patch cords specified by the contract are transmitted to the owner for use.
   g. NOTE: cable labels and permanent room numbers need to match. CM needs to be sure to get design team, airport, IT, and CM / contractor reps together to review permanent room numbers prior to contractor installing cable labels.

3. Move-in buffer period needs to be minimum 6 **weeks** for HAS-IT to install/extend services within the area to be occupied prior to occupation of the facility or spaces. Additional time may be necessary if Tenant IT organization is involved, or if contractor has other systems that must be configured/tested which require HAS-IT resources (i.e. cabling or data network connections). This is frequently the case for PA System, television, radio, Fire Alarm, pay telephone, EFSO (Electronic Fuel Shutoff), access control & CCTV, etc.

4. Once HAS-IT accepts a communications equipment room and begins to install/configure equipment in preparation for hosting live applications, this room becomes a restricted area with access to be controlled by HAS-IT. Contractors must be substantially complete with systems inside the communications equipment room so that access is generally not required. Minor punch list and scheduled testing with escort can be arranged, but access will be very limited.

5. Other IT-related systems that must be operational, tested, and accepted or approved temporary provisions.
   a. PA System
   b. MATV and/or CNN TV (where applicable)
   c. Fire Alarm
   d. MUFIDS
   e. Pay Telephones (where applicable)
   f. EFSO (where applicable)
   g. Access Control & CCTV (note: must be PROGRAMMED, and approved acceptance test walk through by HAS)
   h. Crash phone (where applicable)
   i. Radio system enhancements (where applicable)
   j. Data Network switch installed and configured.

Appendix B

IDF Number:		Date:		
Grounding & Bonding:		YES	NO	COMMENTS
	TGB properly installed			
	Proper grounding conductor installed (6AWG min.)			
	Cable trays properly bonded			
	Equipment Racks, Armored Cables & Cabinets properly bonded			
	Conduit properly bonded			
	Cabling properly bonded			
	Splice Cases properly bonded			
Horizontal Cabling:		YES	NO	COMMENTS
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Pair twist meets spec			
	Proper termination scheme			
	Cable/jack part number meets spec			
	Plenum vs. PVC			
	Properly dressed in tray			
	Properly dressed in cable management			
	Cables bundled properly			
	Appropriate clearances observed (power)			
	Minimum about of cable exposed at termination			
Backbone Cabling:		YES	NO	COMMENTS
	Fiber strain relief properly applied			
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Properly dressed in tray			
	Fiber installed in inner duct			
	Properly dressed in termination shelf			
	Any splice cases properly supported			
Room Layout:		YES	NO	COMMENTS
	Room laid out according to project drawings			
	Proper clearances maintained			

	Is the room clean & neat in appearance			
	Liquid carrying pipes within the room			
Pathways:		YES	NO	COMMENTS
	Conduit properly routed & supported			
	Cable Tray properly routed & supported			
	Inner Duct used to route fiber and properly supported			
Labeling:		YES	NO	COMMENTS
	Grounding conductor			
	End-to-End labeling			
	Pair Count on Splice Case			
	Horizontal Cabling			
	Fiber Optic Cabling			
Other:		YES	NO	COMMENTS
	Appropriate fire stop material in place			
	Cabling test results submitted with proper information			
	Climate controlled environment (Temp. & Humidity)			
	Is the room access controlled			
Copper Cabling:				
	Total Pairs (Riser)			
	Pair Counts			
	Termination Type (66, 110, Protectors..)			
	Termination Location			
Fiber Optic Cabling:				
Multimode:				
	Total Strands			
	Termination Type (LC, SC)			
	Termination Location			
Single Mode				
	Total Strands			
	Termination Type (LC, SC)			
	Termination Location			

End of Appendix

SECTION 271300 - BACKBONE AND RISER MEDIA INFRASTRUCTURE (REV. 01-31-2020- SJS)

PART 1 - GENERAL

1.01 SUMMARY

A. Provide a Structured Cabling System (SCS) for the purpose of supporting voice, data and video communications at various locations within the Houston Airport System. The Houston Airport System (HAS) has established Systimax as the standard for cabling infrastructure installations.

1.02 SECTION INCLUDES

A. This section includes specifications for the installation of backbone and riser media infrastructure.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.

C. Backbone and Riser Media Infrastructure includes but not limited to copper, fiber cable types, Ipatch panels, imVision controllers, connectors, testing requirements, accessories and associated hardware.

1.03 REFERENCES

A. Related Sections: Use these Specifications for all related work not specifically covered in this specification:

1. Section 270500: Common Work Results for Communications
2. Section 270543: Exterior Communication Pathways
3. Section 270553: Identification and Labeling of Communication Infrastructure

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

C. 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 two weeks prior to the date of the Bidding Documents unless the document is shown dated.

D. Conflicts.

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

E. References.

1. ANSI/TIA/EIA-568, Commercial Building Telecommunications Wiring Standards

2. ANSI/TIA/EIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces (latest issue)
3. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
5. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
6. National Electrical Manufacturers Association (NEMA)
7. American Society for Testing Materials (ASTM)
8. National Electric Code (NEC®) Latest issue
9. National Electrical Safety Code (NESC) Latest issue
10. Institute of Electrical and Electronic Engineers (IEEE)
11. UL Testing Bulletin
12. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps
13. SYSTIMAX Structured Cabling Systems, Performance Specifications, Latest Issue
14. SYSTIMAX Structured Cabling Systems, Components Guide, Latest Issue
15. Sumitomo FutureFLEX Cabling System Specification, Latest Issue.Systimax Generic Specifications: Fiber Optic Outside Plant Cable, Latest Issue
16. BICSI Telecommunications Distribution Methods Manual (TDMM) Latest issue
17. Rural Utilities Service (RUS) Section 1755

F. All splicing methods, procedures and products shall comply with the following:

1. Rural Utilities Service (RUS) Section 1755
2. National Electrical Safety Code (NESC) Latest issue
3. National Electrical Code (NEC) Latest issue
4. Fiber closures: GR-771-Core
5. Copper splice cases: Bellcore Testing Requirement PUB-55003 (Pressure Tight Splice Closure)
6. UL 1863 classified
7. Applicable local codes, statutes, ordinances, regulations, license requirements.

1.04 SUBMITTALS

A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.05A below.

B. Manufacturers' data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment to include quantity of spare parts.

C. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Reference Specification 270553 for the Inside and Outside plant spread sheets. Information shall be provided on a CD.

D. Shop Drawings shall be submitted and approved before implementation is started. Shop Drawings to be submitted in accordance with Specification 01340.

E. Record Drawings: Furnish CAD drawings, following format in Section 01340, of completed work including cable numbers. Refer to Specification 270553 for labeling conventions. Contractor's on-site Building Industry Consulting Services International (BICSI)

Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

F. Include spares list to be approved by HAS IT Project Manager for approval.

G. Cable Testing Reports.

1. Submit Testing Plan prior to beginning cable testing.
2. Submit certified test reports of Contractor-performed tests in accordance with paragraph 3.04. of this document.
3. Electronic versions of the original raw data files and PDF versions of the test reports shall be submitted together and clearly identified with cable identification, reviewed and stamped by the Contractor's on-site RCDD.
4. Test reports shall be reviewed, approved and stamped by the Contractor's on-site RCDD.

H. Product data for all termination and test equipment to be used by Contractor to perform work.

1. Equipment shall be calibrated with traceability to National Institute of Standards and Technology (NIST) requirements.
2. Contractor shall include copy of calibration and certification that equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
3. Test equipment data shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting
4. Refer to 3.04. in this document for test equipment requirements.

I. Submit Technology Implementation Plan in accordance with 1.07 below.

J. Submit Cable Pulling Plan, as follows:

1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
2. Indicate contents of each conduit.
3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs andtensions.
4. Cable Pulling Plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submittal.
5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Architect/Engineer.

K. Submit installation plan indicating:

1. Equipment and personnel
2. Materials and staging area
3. Start and completion dates
4. Locations, including floor, room and building

5. Installation plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.

L. Cable Splicing Submittals

1. Submit fiber fusion splicing method and procedures.
2. Submit schedules of copper and fiber cables to be spliced.
3. Submit copper splicing method and procedures.
4. Submit certification documents for all splicing personnel.
5. Submit cut sheets, showing accurately scaled components, of fiber and copper splice closures, accessories, clamps, brackets, hangers, splice connectors, splice joint assemblies and fittings,
6. Submit manufacturer's data on fiber and copper splice closures including, but not limited to types, materials, finishes, and inside and outside dimensions (cross-sectional properties).

1.02 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

C. Maintain temperature of between 64 degrees Fahrenheit and 75 degrees Fahrenheit and between 30 and 55 percent humidity in areas of active electronic system work.

1.03 QUALITY ASSURANCE

A. Submit written proof that the following experience requirements are being met.

1. Contractor Qualifications
   a. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
   b. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.
   c. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses.
   d. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last five years.

e. The contractor who is installing the cabling infrastructure shall be a certified and currently registered Commscope/Systimax Premier Partner capable of issuing a numbered registration certificate for the entire cable system.
f. The contractor who is installing the cabling infrastructure shall have the following Systimax iPatch/imVision certifications:
   1) SP/ND3321 - SYSTIMAX SCS Design & Engineering
   2) SP/ND3351 - SYSTIMAX MasterClass
   3) SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
g. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.

2. Copper cable splicing personnel/technician requirements:
   a. All copper splicing personnel/technicians shall have a minimum of 900 pair in one project splicing experience.
   b. All copper splicing personnel/technicians shall have outside plant (OSP) and inside plant splicing experience.
   c. All copper splicing personnel/technicians shall be familiar with and shall have installed Systimax splicing modules.
   d. All copper splicing personnel/technicians shall have installed in-line and butt splicing configurations.
   e. All copper splicing personnel/technicians shall have installed OSP, underground, direct buried, aerial, pedestal, and vault splice closures.
3. Fiber splicing personnel/technicians requirements:
   a. All fiber spicing personnel/technicians shall have a minimum of 144 fibers in one project splicing experience.
   b. All fiber spicing personnel/technicians shall have OSP and inside plant splicing experience.
   c. All fiber spicing personnel/technicians shall be familiar and have installed fusion, rotary and mechanical splicing modules.
   d. All fiber spicing personnel/technicians shall be familiar and have installed mass fusion splice trays.
   e. All fiber spicing personnel/technicians shall be familiar and have installed ribbon fusion and mass fusion splicing.
   f. All fiber spicing personnel/technicians shall have installed in-line and butt splicing configurations.
   g. All fiber spicing personnel/technicians shall have installed OSP, underground, direct buried, aerial, pedestal, and vault splice closures.
4. Console installers shall be certified by console manufacturer and experienced in the installation of systems of similar complexity.
5. Manufacturer’s hardware experience: All components shall be produced by manufacturers who have been regularly engaged in the production of telecommunications cabling components of the types to be installed in this project for a period of five years.

B. Materials and equipment: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. The equipment shall meet the following requirements:

1. Interior controlled environment: 60 to 100 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.
2. Interior uncontrolled environment: 0 to 130 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.
3. Exterior environments: Minus 30 degrees to 130 degrees F dry bulb, and 10 to 100 percent relative humidity, condensing.
4. Hazardous environment: All system components located in areas where fire or explosion hazards may exist because of flammable gas or vapors, flammable liquids, combustible dust, or ignitable fibers or flying's, shall be rated and installed according to Chapter 5 of the NFPA 70 and as shown.

C. Standard products:

1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.
2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

1.04 CONTRACTOR'S DUTIES

A. Contractor's RCDD shall provide all calculations and analysis to support design and engineering decisions as specified in the Submittals section.

B. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services/programming to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.

C. Secure and pay for plan check fees, permits, fees, and licenses necessary for the execution of Work as applicable for the project.

D. Give required notices.

E. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.05 PROCUREMENT

A. Procure equipment specified in this document as dictated by the timeline in Appendix A "Technology Implementation Schedule" in order to ensure that the technology is acquired in a timely fashion, but not outdated by the installation date.

B. Submit a copy of Appendix A "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. Complete the columns headed "Quantity", "Purchasing Lead Time", "Start Date or Dependent", and "Installation Duration".

C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.

D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.

E. The Contractor shall not purchase any materials requiring submittals until the owner approves the product submittal and the Technology Implementation Schedule for that material.

F. The Contractor shall not purchase any materials requiring submittals until the date established by the owner as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix A as a part of the Submittal Review process.

1.06 MAINTENANCE AND SUPPORT

A. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568B or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty-year period.

B. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

C. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty period.

1.07 EXTENDED WARRANTY

A. The Extended Product Warranty shall meet all manufactures specification to ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568B and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for fiber links/channels, for a twenty year period. The warranty shall apply to all passive SCS components.

B. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products.

1.08 DELIVERY AND STORAGE

A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.

B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.

C. All products shall be purchased not more than 6 months prior to installation.

D. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the City.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to SYSTIMAX SCS for HAS, However, substitutions for Systimax products are not permitted.

2.02 GENERAL

A. Provide all cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in the Main Distribution Facility (MDF) and the Intermediate Distribution Facilities (IDFs).

B. All HAS Fiber terminations/connectors shall be pigtail fusion splice.

2.03 FIBER OPTIC CABLE GENERAL REQUIREMENTS

A. SYSTIMAX SCS Teraspeed Singlemode or LazrSPEED 550 50μ Multimode as required.

B. Fiber optic cable shall be certified to meet all parts of EIA-455 and comply with the NEC.

1. Cable installed in plenums or air-handling spaces shall meet UL 910 and shall be marked OFNP (optical fiber non-conductive plenum) in accordance with the NEC.
2. Riser cable shall meet UL 1666 and be marked OFNR (optical fiber non-conductive riser) in accordance with the NEC.

C. All fiber optic cable shall utilize the appropriate sheath for the particular application. This shall be in accordance with ANSI/EIA/TIA 568-B standards. Any cable placed in space used as an air return or in any way connected with air handling plenums or building ventilation shall be low-smoke, fire retarding cable, and shall comply with the National Electrical Code Articles 725, 760, and 800. No cabling shall be placed in plenums without written approval from HAS.

D. Outside Plant Fiber Cables.

1. Stranded loose tube dielectric or armored dry core fiber optic cable shall be utilized for underground conduit, direct buried or aerial applications.

E. Building Fiber Cables.

1. Non-plenum, riser rated cable consisting of multiple fibers, shall have a black, Polyvinyl Chloride (PVC) outer jacket. The cable shall be UL listed and meet the NEC requirements for OFNR.
2. Plenum Fiber rated cable consisting of multiple fibers shall have a Plenum PVC outer jacket. Each group of fibers shall have a color-coded Low Smoke PVC buffer. Teraspeed shall be yellow and LazrSPEED 550 shall be Aqua. The cable and each subunit shall be UL listed and meet the NEC requirements for OFNP.

F. Preparation for delivery: The fiber optic cable shall be shipped on reels in lengths as specified with a minimum overage of 10 percent.

1. The cable shall be wound on the reel so that unwinding can be done without kinking the cable.
2. Two meters of cable at both ends of the cable shall be accessible for testing.
3. Marking: Each reel shall have a permanent label attached showing length, cable identification number, cable size, cable type, attenuation, bandwidth, and date of manufacture. Labels shall be water resistant and the writing on the labels shall be indelible.
4. Storage: The cable shall have a minimum storage temperature range of minus 40 C to plus 70 C.

G. Unless otherwise specified, all fiber cables not installed in conduit shall be armored cable.

2.04 MULTIMODE FIBER OPTIC CABLE SPECIFICATIONS

A. Manufacturer: SYSTIMAX SCS – LazrSPEED 550 Multimode 50μ Cable.
1. Outdoor Cables: Systimax Multimode, Stranded Loose Tube Dielectric or Armored Dry core LazrSPEED 550 Outdoor Cable designed for underground conduit, direct buried or aerial applications consisting of multiple multimode 50/125μ fibers.
2. Building Cables: Multimode/non-plenum, Systimax LazrSPEED 550 Backbone/Riser Rated Cable, consisting of multiple multimode 50/125μ fibers with a PVC outer jacket.
3. Building Cables: Multimode/plenum, Systimax LazrSPEED 550 Backbone/plenum Rated Cable, consisting of multiple multimode 50/125 μfibers and an Aqua, PVC outer jacket.

2.05 SINGLE MODE FIBER OPTIC CABLE SPECIFICATIONS

A. Manufacturer: SYSTIMAX SCS – TeraSPEED Singlemode cable

1. Outdoor Cables: Systimax Singlemode, Stranded Loose Tube Dielectric or Armored Dry Core Outdoor Cable designed for underground conduit, direct buried or aerial applications.
2. Building Cables: Singlemode/Non-plenum: TeraSPEED Backbone/Riser Rated Cable consisting of multiple singlemode fibers with a PVC outer jacket.
3. Building Cables: Singlemode/plenum, Systimax TeraSPEED Backbone/plenum Rated Cable, consisting of multiple singlemode fibers and a yellow, PVC outer jacket.

2.06 FIBER HARDWARE TERMINATION STANDARDS – Real Time Infrastructure Management - Intelligent Fiber Patch Panel

A. All Fiber to terminate on iPatch or ImVision Control panels. If a rack manager does not exist in the cabinet one must be added to manage the fiber infrastructure.

B. Systimax Solution iPatch Intelligent Fiber Optic Patching System as follows:

1. When install make sure cabinet rails are move back from front door.
2. Make sure there is vertical and horizontal management for the fiber.

Product Number	Description
Fiber Shelves (19 inch rack-mountable)	

Product Number	Description
760193797	360-ip-G2-1U-LC-SD
760031856	RS-2AF-16SF
760105148	360 iPatch/imVision upgrade kit
760109470	12-LC-LS-AQ-Pigtails
760109488	12-LC-MM-BG-Pigtails
760109496	12-LC-SM-BL-Pigtails
760109504	12-LCA-SM-GR-Pigtails
760114975	24" Ribbon Cable
Copper Patch Panels - Cat 6	
760152355	360-iP-1100-E-GS3-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760152330	360-iP-1100-E-GS3-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
760152561	360-IPR-1100-E-GS3-1U-24 - 360 iPatch/imVision(ready) 24 port panel
760152579	360-IPR-1100-E-GS3-2U-48 - 360 iPatch/imVision(ready) 48 port panel
Copper Patch Panels - Cat 6A	
760152363	360-iP-1100-E-GS6-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760152348	360-iP-1100-E-GS6-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
imVision Rack manager	
760161380	360 imVision Controller (provides both Network and Panel Manager functionality)

2.07 PATCH CORDS

A. Fiber Patch Cords

1. Manufacturer: SYSTIMAX Solutions ONLY

2. The fiber patch cord shall consist of buffered, graded index fiber with a 50 micron core and a 125μ micron cladding for multimode with an Aqua Jacket and a stepped-index 8.3 micron core with a 125μ micron cladding for single mode with a Yellow Jacket. The fiber cladding shall be covered by aramid yarn and a jacket of flame retardant PVC.

3. Multimode Fiber Patch Cord

a. Multimode Fiber Patch Cord Part Numbers:

Product Number	Description
Multimode, 50μ Micron, Single, LC to LC, LC to SC and LC to STII	
MX1LC-LC-xxx	LC to LC (xxx length designator)
MX1LC-SC-xxx	LC to SC (xxx length designator)
MX1LC-EP-xxx	LC to STII (xxx length designator)
Multimode, 50μ Micron, Duplex, LC to LC, LC to SC and LC to STII	
MX2LC-LC-xxx	LC to LC (xxx length designator)
MX2LC-SC-xxx	LC to SC (xxx length designator)
MX2LC-EP-xxx	LC to STII (xxx length designator)

4. Singlemode Fiber Patch Cord

a. Single mode Fiber Patch Cord Part Numbers:

Singlemode, 8.3μ Micron, Single, LC to LC, LC to SC and LC to STII	
MS1LC-LC-xxx	LC to LC (xxx length designator)
MS1LC-SC-xxx	LC to SC (xxx length designator)
MS1LC-EP-xxx	LC to STII (xxx length designator)
Singlemode, 8.3μ Micron, Duplex, LC to LC, LC to SC and LC to STII	
MS2LC-LC-xxx	LC to LC (xxx length designator)
MS2LC-SC-xxx	LC to SC (xxx length designator)
MS2LC-EP-xxx	LC to STII (xxx length designator)

5. Patch Cord Quantity. Patch cord spares shall be provided to match fiber strand assignment as shown in the fiber cable schedules in the Drawings. Patch cords shall be various lengths to include but not limited to 3mm, 6mm, 10mm etc.

6. LC type connectors are HAS standard for all patch panel installations.

   a. When there is a requirement to transmit MATV service over the fiber infrastructure APC type pigtails must be used at. Patch cords shall be various lengths to include but not limited to 3mm, 6mm, 10mm, etc.

7. Fiber splicing and closures shall be Commscope/Systimax for HAS.

8. The fiber splice module shall meet the following specifications:

   a. Fusion
   b. Joins single mode or multi-mode fibers
   c. Establishes a permanent fusion splice
   d. May be used in OSP and/or premises applications
   e. Accept 250 and 900 micron fibers
   f. Re-enterable, re-arrangable and reusable
   g. Require no polishing
   h. Require no adhesives
   i. No loose parts
   j. Unlimited shelf life

2.08 BACKBONE COPPER CABLE – INSIDE PLANT

A. Manufacturer:

1. HAS - Systimax, unless otherwise noted.

B. Non-plenum Backbone Cable – 24 AWG

1. Multi-pair insulated with color-coded PVC copper cables shall be used as the vertical riser cables. The cable shall support voice, data, and building service applications. All 50-pair and larger cable shall be conformance tested to meet ANSI/TIA/EIA 568B for Category 3

cables. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation. No cable count larger than 100 pair accepted.

C. Non-plenum Backbone Cable – 22 AWG

1. Manufacturer – Superior Essex or submitted and owner-approved equivalent
2. 22 AWG 100-pair insulated with color-coded PVC copper cables shall be used only transition splices from OSP to inside cable. The ARAM cable shall be routed from the splice closure to the protector panel, as indicated in Drawings.
3. Superior Essex part number is 02-069-03.

D. Plenum Backbone Cable

1. The plenum cable shall consist of 24-AWG solid-copper conductors insulated with color-coded PVC. All 50-pair and larger cable shall be conformance tested to meet ANSI/TIA/EIA 568B for Category 3 cables. The cable shall be UL® and c (UL®) Listed for Fire Safety and ISO 9001 Certified. The plenum cable shall be available in 25, 50, and 100 pair.

E. The backbone copper cable shall meet or exceed the electrical specifications provided by the manufacture

2.09 BACKBONE COPPER CABLE – OUTSIDE PLANT

A. Manufacturer: Superior Essex or submitted and owner-approved equivalent

B. Superior Essex or submitted and owner-approved equivalent ASP-filled 22 AWG multi-pair copper cables shall be utilized for underground conduit or direct buried applications. The cable shall support voice, low-speed data, and building service applications. The bending radius and pulling strength requirements of all outside plant cables shall be observed during handling and installation. No cable count larger than 200 pair accepted.

C. Protectors (Outside Plant applications):

Product Number	Description	COM code
331901	Circa 1880NA1/NSC-200: 188-Type, 200-pair protector panel. Input on left side for front of cabinet.	N/A
331902	Circa 1880NA1/NSC-200: 188-Type, 200-pair protector panel. Input on right side for back of cabinet.	N/A
750031	Circa C4B1S: 5-pin solid-state protector module, black shell, 300 volt, sneak current protection and built-in test points.	N/A
4C3S-75	Solid-state protector unit for nonringing circuits (red)	105 581 086

D. Copper Cable Splice System

1. Copper Splice Systems are defined to include, but not limited to copper splice module, components, closure kits, supports and required accessories to provide a turnkey copper network system.
2. Copper cable to be spliced shall be 22 AWG OSP and 22 AWG inside cable as specified in the previous paragraphs.
3. Splices shall be inline, from underground OSP cable (filled metallic) to indoor cable (air core metallic).
4. Copper Splice Kit
   a. Manufacturer: Preformed Line Products or submitted and owner-approved equivalent.
   b. All splice kit products must be CommScope/Systimax Solutions material.
5. Copper Splice Closure Requirements
   a. Manufacturer: Preformed Line Products or submitted and owner-approved equivalent.
   b. Provide an inline, re-enterable copper cable closure.
      1) Metallic stainless steel.
      2) Finish shall be non-corrosive in all intended environments (see Drawings).
   c. Re-enterable without the need for special re-entry kit.

2.10 MULTI-PAIR CABLE TERMINATION HARDWARE

A. 110 Wiring Blocks

1. Manufacturer: SYSTIMAX
2. 110 blocks shall provide for the termination of horizontal, equipment, or tie cables. This high-density modular design shall be compatible with all voice and data circuits. The block shall be Underwriter's Laboratories (UL) listed.
3. Field-terminated, wall-mounted 110 Wiring Block part numbers are as follows:

Product Number	Description	COM code
110 Wiring Blocks With Legs (Small Installations)		
110AB2-100FT	4-pair	107 058 919
110AB2-300FT	4-pair	107 058 943
110 Wiring Block System With Back Panel (Larger Installations)		
110PB2-300FT	4-pair (Station)	107 058 810
110PB2-900FT	4-pair (Station)	107 058 869
110PB2-300FT	5-pair (Riser)	107 058 802
110PB2-900FT	5-pair (Riser)	107 058 851
188 Backboards w/distributing rings for 110 blocks		
188D3	300 pair	107 151 193
188C3	900 pair	107 151 185

4. Field-terminated, rack and cabinet mounted 110 Wiring Block part numbers are as follows:

Product Number	Description	COM code
110 Connector System Mounting Brackets		
110RD2-200-19	(2) 100-Pair Bracket	107 058 919
110 Wiring Block for Wiring Bracket		
110DW2-100	110 100-Pair Wiring Blocks	107 059 909

Product Number	Description	COM code
110 Jumper Troughs		
110B3	110 Troughs	107 831 141

B. Electrical requirements of Copper Termination Equipment per manufactures specification.

C. Wire Managers for Copper Termination Equipment

1. Vertical Wire Manager – Wall-mounted 110 Patch Panel System Backboard
   a. Manufacturer: Chatsworth or submitted and owner-approved equivalent
   b. One on each side
   c. Chatsworth part number(s) are as follows:

Product Number	Description	COM code
Single-Sided Narrow Vertical Cabling Section		
11730-7XX	Vertical Cabling Mgr (Black)	N/A

2. Horizontal Wire Managers –Wall-mounted 110 Patch Panel System Backboard
   a. Manufacturer: Systimax
   b. Above and below each hardware shelf.
   c. Systimax part number(s) are as follows:

Product Number	Description	COM code
110 Jumper Troughs		
110B3	110 Troughs	107 831 141

3. Horizontal Wire Managers – Racks and cabinets
   a. Manufacturer: Chatsworth or submitted and owner-approved equivalent
   b. Above and below each equipment shelf
   c. Not required with RJ45 patch panels
   d. Chatsworth part number(s) are as follows:

Product Number	Description	COM code
Horizontal Wire Managers		
11753-719	19” Medium Wire Manager	

D. Hybrid RJ45 to 110 Patch Cords.

1. Manufacturer: Systimax 119P2PS
2. As required provide Category 5e, Hybrid Patch Cords for each assigned data/voice port on the patch panel. Cords shall RJ45 connector on one end and 110GS on the other end. Cords shall be provided in appropriate lengths to accommodate all tenant voice or specialty ports as shown in detailed drawings. All Category 5e cordage shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pair and shall meet or exceed the Category 5e specifications.
3. Hybrid patch cords shall conform to the TIA 568B wiring scheme.
4. Hybrid patch cords shall be provided for each installed port designated as “Tenant Voice or Specialty jack” in the drawings.
5. Hybrid patch cord single pair part numbers are as follows (last 3 digits designates length):

Length	Material ID
8FT	CPC8662-03F-008
10FT	CPC8662-03F-010

6. Hybrid patch cord 2 pair part numbers are as follows(last 3 digits designates length):

Length	Material ID
8FT	CPC3852-03F-008
10FT	CPC3852-03F-010

7. Hybrid patch cord 4 pair part numbers are as follows(last 3 digits designates length):

Length	Material ID
8FT	CPC3812-03F-008
10FT	CPC3812-03F-010

2.11 IDENTIFIERS, LABELS AND LABELING SYSTEM

A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. **Any deviation from the specification must be approved by HAS IT prior to installation.**

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify raceways, boxes, hand holes and maintenance holes are properly installed following Sections 270528, and 270543.

B. All communication media shall be installed in conduit or cable tray unless an alternate method has been approved by HAS/IT Infrastructure.

C. Verify backboards are properly installed.

D. Verify telecommunications grounding system is properly installed and tested following Section 270526.

E. Verify liquid-carrying pipes are shall not be installed in or above any IDF/MDF that has active electronic equipment. Do not proceed with installation in affected areas until removed.

3.02 PREPARATION

A. Environmental controlled communication rooms shall maintain temperature of between 64 degrees Fahrenheit and 78 degrees F and between 30 and 55 percent humidity in areas of active electronic system work.

B. Cable Splicing: Exact cable routing, splice enclosure locations, distances, elevations, work space and purpose of splice will be governed by actual field conditions. Contractor shall perform field surveys prior to submitting layout drawings.

C. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

3.03 INSTALLATION

A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data are included on the drawings.

B. All installation shall be done in conformance with ANSI/TIA/EIA 568 (latest issue) standards, BICSI methods, Industry standards and SYSTIMAX SCS Leviton SCS and Sumitomo Standard Procedures and Practices installation guidelines. 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. 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. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

C. The SCS installation shall comply with all applicable national and local codes pertaining to low voltage cable system installations.

D. The contractor shall adhere to the installation schedule of the general contractor and shall attend all construction meetings scheduled by the general contractor.

E. Upon structural completion of the communications room(s) and prior to the installation of any communications equipment or supporting devices inside the room, the City Engineer shall consult the Communications Designer in order to:

1. Perform construction administration activities to compare as-built configuration to the design.
2. Observe all "not-to-design" compliance issues and issue corrective advisement of actions.
3. Upon completion of 1 and 2 above, the Communications Designer shall mark with masking tape the general layout of the equipment placement.

F. Cable Splicing

1. Splicing optical fibers shall be accomplished with the fusion method only; mechanical splices are not allowed.
2. Copper splicing shall be accomplished using Systimax modules.
3. Copper splicing shall be done using the fold-back method.
4. All closures and splice cases shall be installed according to the manufacturer's installation procedures.
5. All closures and splice cases shall be "flash tested" to ensure they are properly sealed.
6. All splicing work and splicing hardware shall comply with the following:
   a. Cables shall be neatly routed and properly secured.
   b. Minimum bending radius for fiber and copper cables shall not be exceeded.
   c. Closures shall be properly mounted and secured.
7. All closures, entry and exit cabling shall be labeled per specification 270553, easily visible from the finished floor.

G. The contractor shall perform all required cross connections of the horizontal cable runs to the backbone cable system. The equipment connections to the data systems shall be performed by the vendors installing and/or maintaining those systems.

H. The contractor is responsible for providing a CD with all the cable/patch panel information in the same format that will be accepted for download in HAS's iPatch database **1 month** prior any patching occurs.

I. The contractor is responsible and must perform the following task associated with the iPatch system:

1. Connect iPatch Network Manger (or imVision Controller) to designated port on HAS network switch.
2. Inter-connect iPatch Network Manager to rack managers if applicable.
3. Confirm that all iPatch patch panels are on line.
4. Configure network settings for iPatch Network Manage (or imVision Controller) with IP address, Mask and Gateway.
5. Resolve patching conflicts associated with "Confirm" message on the iPatch Network Manager (or imVision Controller) Display.
6. Resolve conflicts associated with "Alarms" on iPatch Network Manager or imVision Controller.
7. Provide fiber cut sheet depicting fiber port to port or port to equipment connectivity.
8. Provide an excel file compatible with imVision Import Wizard. The file will be used to build rooms, faceplates and jacks in iPatch database.
9. Label all new devices including the iPatch Network Manager according to HAS labeling specs.
10. Label all ports according to HAS labeling specs.
11. Provide floor plans depicting rooms lay out and outlet locations.
12. Confirm iPatch ports are pointing toward the proper end device (iPatch to equipment or iPatch to iPatch connection).

J. The contractor shall provide service loops (slack) for cables terminating in the IDFs. A minimum of 10-foot service loop shall be provided above the access ceiling or cable trays unless specified otherwise. This allows for future changes or expansion without installing new cables.

K. The installation contractor shall be responsible for coordination, testing and problem resolution with the system vendors.

L. Label cable terminations on designation strips per specification 270553. Coordinate numbering with the City's automated cable management system for HAS SCS.

M. Labels for backbone/riser cables shall be placed in the following locations: on jack face plates, on cable inside back boxes, junction boxes, access points, maintenance holes, and hand holes, on cable above the terminations in the IDF and MDF, on patch panels, and every 100 feet when not in conduit. Refer to specification 270553. Provide all copper and fiber optic patch cords with a unique identifier at each end.

N. City inspector or their designated representative shall randomly perform unannounced, on-site reviews during the installation. In addition, this person shall perform a final inspection and a complete review of the test results before the installation is accepted.

O. Upon completion of the installation, Contractor shall prepare as-built documentation of the entire SCS. This documentation shall include:

1. As-Built Drawings
   a. All drawings shall be provided on a minimum of four (4) USB flash drives in a form compatible with AutoCAD Version 14. A complete set of project plans will be provided to the Contractor on a drve. The Contractor shall modify the drawings by placing the cable information on a separate layer. All of the requested drawings shall be placed on these plans so that all cable routes are to scale and provide accurate information for use in the future when changes are made and the exact location of cables are required to avoid service interruptions.
   b. A complete diagram of all terminations in the IDFs.
   c. A complete diagram of all copper, fiber, and coax riser cable.
   d. A complete diagram of all copper, fiber, and coax inter-building cable.
   e. Floor plans showing exact cable routings with each outlet clearly marked with cable number.
   f. A complete diagram of all cable tray, conduits and conduit sleeves.
2. Documentation
   a. All cable inventory data documentation shall be submitted in designated Microsoft Excel 2007 format, or ASCII, comma delimited files with fields in identical order so that data can be incorporated into existing databases.
   b. Documentation on horizontal cable shall include cable number and length of cable.
   c. Documentation on riser cable and inter-building cable shall include cable number, source and destination, type of cable, length of cable and number of pairs or fibers.
   d. Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.
3. As-built Drawings and Documentation shall be reviewed, approved and stamped by Contractor's on-site RCDD.

3.04 POST-INSTALLATION TESTING AND CERTIFICATION

A. Contractor Requirements

1. Contractor shall provide sufficient skilled labor to complete testing within a reasonable test period.
2. Contractor shall have a minimum of three years' experience installing and testing structured cabling systems. All installers assigned by the Contractor to the installation shall be certified by the factory to install and test the provided products.
3. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
4. Contractor is responsible for submitting acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved as defined below.
5. Contractor to insure that the database information for iPatch meets the HAS requirements.

B. Test Procedure

1. City Engineer reserves the right to be present during any or all testing. Notify City Engineer at least 48 hours prior to beginning test procedures.

2. Testing shall be of the Basic Link. However, Contractor shall warrant performance based on Channel performance and provide patch cords that meet channel performance.
3. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the Owner.
4. Testing of all copper and fiber wiring shall be performed prior to system(s) cutover.
5. 100% of the installed cabling shall be tested. All tests shall pass acceptance criteria defined in below.
6. Cable testing shall be performed by a fully charged tester, and the charging unit shall be disconnected during testing.
7. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor at no charge to the City. Complete end-to-end test results shall be submitted to the City.

C. Standards Compliance and Test Requirements

1. Copper Cabling shall meet the indicated performance specifications:
   a. Category 3 Riser Cabling – ANSI/TIA/EIA 568B.2 Category 3 Backbone Cabling
2. Fiber Optic Cable shall meet the indicated performance specifications:
   a. Per manufactures specifications and standards.
3. All test equipment used shall meet the performance specifications defined below.

D. Cable Test Documentation

1. Test reports shall be submitted in electronic format via a minimum of four (4) USB flash drives and certified by the contractor's RCDD to be a complete and accurate record of cabling installed. Hand-written test reports are not acceptable.
2. Electronic reports are to be submitted with an attached affidavit verifying passing execution of all tests. For large installations (greater than 300 pair copper and/or greater than 72 strand fiber), electronic reports with electronic summaries are preferred. Electronic summary reports shall contain the following information on each row of the report: circuit ID, test specification used, cable length, date of test, and pass/fail result.
3. Electronic reports shall be submitted on a minimum of four (4) USB flash drives in PDF format. 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. Certificate shall reference traceable circuit numbers that match the electronic record.
4. Electronic reports for each cable route shall be submitted together in one submittal. The submittal description shall include the type of test performed, type of cable, and cable ID (including originating and terminating room numbers) of cable tested. Partial or unclear documentation will be returned without reviewing.
5. Test reports shall include the following information for each cabling element tested:
   a. Wiremap results that indicate that 100% of the cabling has been tested for shorts, opens, miswires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
   b. For Category 3 cabling: Attenuation and NEXT 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 to 16 MHz. Information shall be provided for all pairs or pair combinations and in both directions. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
   c. Length (in meters), 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.

d. Cable manufacturer, cable model number/type, and NVP
e. Tester manufacturer, model, serial number, hardware version, and software version
f. Circuit ID number and project name
g. Auto test specification used
h. Overall pass/fail indication
i. Date of test

6. Test reports shall be submitted within seven business days of testing.

E. Test Equipment

1. 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.
   a. Category 6 – Level III tester or owner-approved equivalent.
   b. Category 3 copper backbone/riser – 3M Dynatel 965 DSP Subscriber Loop Analyzer with Far End Device or submitted and owner-approved equivalent.
   c. Fiber Optic – Calibrated and certified OTDR, and optical power meter or submitted and owner-approved equivalent.
2. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.
3. Test adapter cables shall be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.
4. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
5. Test equipment shall be capable of certifying Category 6 links.
6. Test equipment shall have a dynamic range of at least 100 dB to minimize measurement uncertainty.
7. Test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
8. Test equipment shall include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
9. Test equipment shall be capable of running individual NEXT, return loss, etc measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
10. Test equipment shall include a library of cable types, sorted by major manufacturer.
11. Test equipment shall store at least 1000 Category 6 auto tests in internal memory.
12. Test equipment shall be able to internally group auto tests and cables in project folders for good records management.
13. Test equipment shall include DSP technology for support of advanced measurements.
14. Test equipment shall make swept frequency measurements in compliance with TIA standards.
15. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
16. The Category 3 copper backbone/riser test equipment shall be capable of making frequency sweeps at an impedance of 135 Ohms at the following frequencies (kHz): 20, 30, 50, 69, 90, 110, 138, 276, 400, 600, 800, 1000, and 1100. A far-end device shall be used for all frequencies measurements. The loss at 138kHz shall not exceed -46 dB. The test set shall have the ability to store 100 tests and be able to upload to a PC.

17. The Category 3 copper backbone/riser test equipment shall be able to measure resistance between the following conductors: tip to ring, tip to ground, ring to ground. All measurements shall be greater than 9999 M ohms.

F. Optical Fiber Cable Testing w/ Optical Time Domain Reflectometer (OTDR) and Optical Power Loss Meter

1. Test all lightguide cable prior to the installation of the cable. Assume liability for the replacement of the cable should it be found defective at a later date.
2. All fiber testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end-to-end OTDR trace performed per TIA/EIA 455-61and end-to-end in one direction for Optical Power loss meter measurement. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.
3. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no charge to the City.
4. End point locations.
5. Test direction.
6. Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
7. Measured attenuation of the link segment.
8. Acceptable link attenuation.
9. Acceptable Attenuation Values shall comply with Systimax latest version of “Fiber Attenuation Calculation” spread sheet.

3.05 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted and approved, and City Engineer is satisfied that all work is in accordance with contract documents, the City Engineer will notify Contractor in writing of formal acceptance of the system.

B. Acceptance Requirements

1. Contractor’s RCDD shall warrant in writing that 100% of the installation meets the requirements specified under 3.04. “Standards Compliance & Test Requirements” above.
2. City reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent of the cable plant to confirm documented results. Random re-testing, if performed, shall be at the expense of the City, using standard labor rates. Any failing cabling shall be re-tested and restored to a passing condition at no cost to the City. In the event more than two percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
3. City Engineer may agree to allow certain cabling runs to exceed standardized performance criteria (e.g. length). In this event, such runs shall be explicitly identified and excluded from requirements to pass standardized tests.
4. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described in 3.04.
5. See Appendix A & B.

3.06 DEMOLITION

A. The contractor shall be responsible for maintaining all communications service to areas of the building scheduled to remain in service during the period of renovation.

B. Notify HAS Information Technology (IT) or Owner IT department 30 days prior to the start of demolition work taking place in existing communications rooms. Coordinate removal of equipment and cabling within existing communications rooms with HAS IT or Owner IT.

C. Where removal is indicated in Drawings, remove communications cable from termination point back to originating communications room, MDF or tenant communications room. Coordinate removal at terminating blocks and panels with HAS IT or Owner IT. Coordinate removal of cross-connects and patch cables with HAS IT or Owner IT.

D. Ensure systems and circuits are no longer active before removing and prior to the demolition of existing communications rooms. If active circuits exist at time of scheduled demolition, coordinate with City Engineer or Owner Rep to reroute or deactivate circuit(s).

E. Demolition and removal of cabling shall not impact the operation of active systems.

F. Unless otherwise noted, discard all removed cable, patch cables and cross-connects. Except where re-routing of cable is specified in Drawings or by Designer, do not reuse cable.

G. Remove all loose unterminated cabling to source found above ceiling, under floor or in wall.

H. All Demo shall include ALL Abandoned cables shall be removed in accordance with NEC 800.25

3.07 CLEANING

A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where work has been completed unless designated for storage.

END OF SECTION 271300

APPENDIX A
MDF/IDF Check List

This list is intended as a minimum checklist. CM should ensure that the contractor's schedule has built in these components and the necessary buffer period – and associated access restrictions to the communications equipment rooms -- for HAS IT and tenant IT to prepare.

1. All communication rooms that will service the area to be opened must be completed. That means a final walkthrough of these areas has been completed. It is not necessary that the entire project achieve substantial completion, but IT cannot install equipment and begin work until the following minimum criteria is met:
   a. Space is built out and clean – free from dust/residues.
   b. Electrical w/UPS as required.
   c. All racks/cabinets installed and mounted. Padlocks eyes have been installed.
   d. Grounding bus bar installed and properly tied to main grounding bus bar in MDF
   e. HVAC functioning properly and is adequately filtering dust. Humidity is controlled.
   f. Door access control is installed (card reader) -or- an approved temporary provision. Simple key access is not permissible.
   g. Lighting is installed and operational.
   h. Cable trays/ladder racks installed and ready to use.
   i. Permanent or temporary signage identifying permanent room number.

2. All cabling necessary to operate the areas to be opened is completed.
   a. Backbone cabling (copper and fiber) from the applicable communication room(s) is installed, tested, labeled, and approved by the inspector and communications design consultant.
   b. Horizontal cabling for all areas to be occupied is installed, tested, labeled, and approved by the inspector and communications design consultant.
   c. Copper cross connects and/or fiber jumpers have been installed per the owner/tenant requirements.
   d. Cable records and redline drawings for installed cables are submitted and approved PRIOR to putting any active circuits on the new cables. Cable records reflect all installed cables **and** any cross connects or jumper assignments installed by the contractor.
   e. All iPatch Panels are programmed and operational.
   f. All jumpers and patch cords specified by the contract are transmitted to the owner for use.
   g. NOTE: cable labels and permanent room numbers need to match. CM needs to be sure to get design team, airport, IT, and CM / contractor reps together to review permanent room numbers prior to contractor installing cable labels.

3. Move-in buffer period needs to be minimum 6 **weeks** for HAS-IT to install/extend services within the area to be occupied prior to occupation of the facility or spaces. Additional time may be necessary if Tenant IT organization is involved, or if contractor has other systems that must be configured/tested which require HAS-IT resources (i.e. cabling or data network connections). This is frequently the case for PA System, television, radio, Fire Alarm, pay telephone, EFSO, access control & CCTV, etc.

4. Once HAS-IT accepts a communications equipment room and begins to install/configure equipment in preparation for hosting live applications, this room becomes a restricted area with access to be controlled by HAS-IT. Contractors must be substantially complete with systems inside the communications equipment room so that access is generally not required. Minor punch list and scheduled testing with escort can be arranged, but access will be very limited.

5. Other IT-related systems that must be operational, tested, and accepted or approved temporary provisions.
   a. PA System
   b. MATV and/or CNN TV (where applicable)
   c. Fire Alarm
   d. MUFIDS
   e. Pay Telephones (where applicable)
   f. EFSO (where applicable)
   g. Access Control & CCTV (note: must be PROGRAMMED, and approved acceptance test walk through by HAS)
   h. Crash phone (where applicable)
   i. Radio system enhancements (where applicable)
   j. Data Network switch installed and configured.

APPENDIX B

IDF Number:		Date:		
Grounding & Bonding:		YES	NO	COMMENTS
	TGB properly installed			
	Proper grounding conductor installed (6AWG min.)			
	Cable trays properly bonded			
	Equipment Racks & Cabinets properly bonded			
	Conduit properly bonded			
	Cabling properly bonded			
	Splice Cases properly bonded			
Horizontal Cabling:		YES	NO	COMMENTS
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Pair twist meets spec			
	Proper termination scheme			
	Cable/jack part number meets spec			
	Plenum vs. PVC			
	Properly dressed in tray			
	Properly dressed in cable management			
	Cables bundled properly			
	Appropriate clearances observed (power)			
	Minimum about of cable exposed at termination			
Backbone Cabling:		YES	NO	COMMENTS
	Fiber strain relief properly applied			
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Properly dressed in tray			
	Fiber installed in inner duct			
	Properly dressed in termination shelf			
	Any splice cases properly supported			
Room Layout:		YES	NO	COMMENTS
	Room laid out according to project drawings			

	Proper clearances maintained			
	Is the room clean & neat in appearance			
	Liquid carrying pipes within the room			
Pathways:		YES	NO	COMMENTS
	Conduit properly routed & supported			
	Cable Tray properly routed & supported			
	Inner Duct used to route fiber and properly supported			
Labeling:		YES	NO	COMMENTS
	Grounding conductor			
	End-to-End labeling			
	Pair Count on Splice Case			
	Horizontal Cabling			
	Fiber Optic Cabling			
Other:		YES	NO	COMMENTS
	Appropriate fire stop material in place			
	Cabling test results submitted with proper information			
	Climate controlled environment (Temp. & Humidity)			
	Is the room access controlled			
Copper Cabling:				
	Total Pairs (Riser)			
	Pair Counts			
	Termination Type (66, 110, Protectors..)			
	Termination Location			
Fiber Optic Cabling:				
Multimode:				
	Total Strands			
	Termination Type (LC, SC)			
	Termination Location			
Single Mode				
	Total Strands			
	Termination Type (LC, SC)			
	Termination Location			

SECTION 271500 - HORIZONTAL MEDIA INFRASTRUCTURE (REV. 01-14-2020-TAB)

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a Structured Cabling System (SCS) for the purpose of supporting voice, data and video communications at various locations within the Houston Airport System. The Houston Airport System (HAS) has established Systimax as the standard for cabling infrastructure installations.

B. Related Work:
1. Section 270526: Telecommunications Grounding and Bonding
2. Section 270543: Exterior Communication Pathways
3. Section 270553: Identification and Labeling of Communication Infrastructure
4. Section 271100: Communication Cabinets and Equipment Rooms
5. Section 271300: Backbone and Riser Media Infrastructure
6. Section 272100: Data Communication Network Equipment

1.2 SUBMITTALS

A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.05A below.

B. Manufacturers' data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment.

C. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Reference Specification 270553 for the Inside and Outside plant spread sheets. Information shall be provided on a CD.

D. Shop Drawings to be submitted and approved before implementation is started. Shop Drawings to be submitted in accordance with Specification 01340.

E. Record Drawings: Furnish CAD drawings, following format in Section 01340, of completed work including cable numbers. Refer to Specification 270553 for labeling conventions. Contractor's on-site Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

F. Include spares list to be approved by HAS IT Project Manager for approval.

G. Cable Testing and Reports.
1. Submit Testing Plan prior to beginning cable testing.
2. Submit certified test reports of Contractor-performed tests in accordance with paragraph 3.04. of this document.
3. Electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable identification. Test results must be in both PDF and original raw format of approved tester.
4. Test reports shall be reviewed, approved and with a stamped cover letter by the Contractor's on-site RCDD.

H. Product data for all termination and test equipment to be used by Contractor to perform work.
   1. Equipment shall be calibrated with traceability to National Institute of Standards and Technology (NIST) requirements.
   2. Contractor shall include copy of calibration and certification that equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
   3. Test equipment data shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
   4. Refer to 3.04. in this document for test equipment requirements.

I. Submit Technology Implementation Plan in accordance with 1.07 below.

J. Submit Cable Pulling Plan, as follows:
   1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
   2. Indicate contents of each conduit.
   3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
   4. Cable Pulling Plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submittal.
   5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Architect/Engineer.

K. Submit installation plan indicating:
   1. Equipment and personnel
   2. Materials and staging area
   3. Start and completion dates
   4. Locations, including floor, room and building
   5. Installation plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.

1.3 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

C. Maintain temperature of between 64 degrees Fahrenheit and 75 degrees Fahrenheit and between 30 and 55 percent humidity in areas of active electronic system work.

1.4 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 two weeks prior to the date of the Bidding Documents unless the document is shown dated.

C. Conflicts.
1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

D. References.
1. ANSI/TIA/EIA-568-D, Commercial Building Telecommunications Wiring Standards
2. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
3. ANSI/TIA/EIA-607-B – Commercial Building Grounding and Bonding Requirements
4. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
5. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
6. National Electrical Manufacturers Association (NEMA)
7. American Society for Testing Materials (ASTM)
8. National Electric Code (NEC®) Latest Issue
9. National Electrical Safety Code (NESC) Latest Issue
10. Institute of Electrical and Electronic Engineers (IEEE)
11. UL Testing Bulletin
12. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps
13. SYSTIMAX Structured Cabling Systems, Performance Specifications, Latest Issue
14. SYSTIMAX Structured Cabling Systems, Components Guide, Latest Issue
15. BICSI Telecommunications Distribution Methods Manual (TDMM) Latest Issue
16. Rural Utilities Service (RUS) Section 1755

1.5 QUALITY ASSURANCE

A. Submit written proof that the following experience requirements are being met.
1. Contractor Qualifications
   a. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
   b. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.
   c. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses.
   d. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last five years.
   e. The contractor who is installing the cabling infrastructure shall be a certified and currently registered Commscope/Systimax Premier Partner capable of issuing a numbered registration certificate for the entire cable system.
   f. The contractor who is installing the cabling infrastructure shall have the following Systimax iPatch/imVision certifications:
      1) SP/ND3360 - SYSTIMAX SCS 360 Solutions
      2) SP/ND3321 - SYSTIMAX SCS Design & Engineering

3) SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
4) GL5555 - SYSTIMAX SCS Certified imVision Support Specialist
5) SP/ND5500 - SYSTIMAX SCS iPATCH Design & Engineering
6) SP/ND5510 - SYSTIMAX SCS Certified iPATCH Support Specialist (CISS)

g. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.

2. Manufacturer's hardware experience: All components shall be produced by manufacturers who have been regularly engaged in the production of telecommunications cabling components of the types to be installed in this project for a period of five years.

B. Materials and equipment: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. The equipment shall meet the following requirements:
1. Interior controlled environment: 60 to 100 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.
2. Interior uncontrolled environment: 0 to 130 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.
3. Exterior environments: Minus 30 degrees to 130 degrees F dry bulb, and 10 to 100 percent relative humidity, condensing.
4. Hazardous environment: All system components located in areas where fire or explosion hazards may exist because of flammable gas or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings, shall be rated and installed according to Chapter 5 of the NFPA 70 and as shown.

C. Standard products:
1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.
2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

1.6 CONTRACTOR'S DUTIES

A. Contractor's RCDD shall provide all calculations and analysis to support design and engineering decisions as specified in the Submittals section.

B. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services/programming to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.

C. Secure and pay for plan check fees, permits, fees, and licenses necessary for the execution of Work as applicable for the project.

D. Give required notices.

E. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.7 PROCUREMENT

A. Procure equipment specified in this document as dictated by the timeline in Appendix A "Technology Implementation Schedule" in order to ensure that the technology is acquired in a timely fashion, but not outdated by the installation date.

B. Submit a copy of Appendix A "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. Complete the columns headed "Quantity", "Purchasing Lead Time", "Start Date or Dependent", and "Installation Duration".

C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.

D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.

E. The Contractor shall not purchase any materials requiring submittals until the owner approves the product submittal and the Technology Implementation Schedule for that material.

F. The Contractor shall not purchase any materials requiring submittals until the date established by the owner as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix A as a part of the Submittal Review process.

1.8 MAINTENANCE AND SUPPORT

A. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568B or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty-year period.

B. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.

C. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty period.

1.9 EXTENDED WARRANTY

A. The Extended Product Warranty shall meet all manufactures specification to ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568B and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for fiber links/channels, for a twenty year period. The warranty shall apply to all passive SCS components.

B. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products.

1.10 DELIVERY AND STORAGE

A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.

B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.

C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the City.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 GENERAL

A. Provide all cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in the Main Distribution Facility (MDF) and the Intermediate Distribution Facilities (IDFs).

2.3 COPPER CABLE GENERAL REQUIREMENTS

A. Manufacturer Qualifications: ISO 9001 Certified and included in the Underwriters Laboratories LAN Certification and Follow-up Program.

2.4 COPPER HORIZONTAL CABLING

A. Manufacturer: SYSTIMAX SCS XL7– XX71.

B. All horizontal cabling shall meet or exceed the ANSI/EIA/TIA-568 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components.

C. Cables shall be marked as UL verified with a minimum of Category 6 rating.

D. All horizontal cabling shall be color-coded as follows to differentiate between tenant and owner cabling. All voice circuits will be terminated on patch panels. All horizontal cabling will terminate on patch panels. All tenant and specialty circuits will be cross connected to multi-pair cabling as required.
   1. Green – HAS Data. (This applies to all HAS devices needing data cabling)
      a. IP Cameras
      b. Wireless Access Points(APs) – (Requires two CAT6A data cables for 802.11ACv2)
      c. Access Control Panels
      d. IP Phones
      e. Etc

2. Yellow – Tenant Data
3. Red – Special circuits, including Automated External Defibrillation (AED) Circuits

E. High-performance (71 Series) Category 6 UTP, 4 Pair cabling shall be utilized to provide the signal medium from the individual workstation location to the IDF(s) unless denoted otherwise on the drawings. This cabling shall be installed in accordance with the contract drawings and shall adhere to the specifications listed below:
1. 4 pair UTP
2. 23 AWG Solid Bare Copper
3. Cable jacket shall comply with NEC Article 800 for use as a plenum cable and shall be UL and c (UL) Listed Type CMP.
4. Cable shall terminate on 8 pin modular jack at each outlet.

F. The high-performance Category 6 UTP cable shall be of the traditional round design with mylar separator tape between pairs 2/3 and 1/4. The cable shall support Voice, Analog Baseband Video/Audio, Fax, Modem, Switched-56, T-1, ISDN, RS-232, RS-422, RS-485, 10BASE-T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet, 155 Mbps ATM, AES/EBU Digital Audio, 270 Mbps Digital Video, 622 Mbps 64-CAP ATM and emerging high-bandwidth applications, including 1 Gbps Ethernet, gigabit ATM, as well as all 77 channels (550 Mhz , single swept margin) of analog broadband video.

G. The high-performance Category 6 cables shall meet or exceed the electrical characteristics set by the manufactures specifications.

H. The high-performance Category 6 cable shall be specified to 550 MHz and shall meet the guaranteed swept margin as set by the manufacture.

I. Systimax part numbers for Plenum-rated Horizontal Cabling are as follows:

Product Number	Color	COM code	Qty per Unit
2071E YEL C6 4	Yellow	700210123	W1000
2071E SGR C6 4	Green	700210164	W1000
2071E RED C6 4	Red	700210263	W1000

2.5 VIDEO COAXIAL CABLE (MATV)

A. Manufacturer: CommScope or approved equivalent.

B. The shielded, plenum RG-11 cable shall be used where the horizontal run is greater than 350 feet or specified in the Contract Drawings.
1. Shall consist of a 14-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
2. CommScope part number – 2287K WHRL RG11 QD 1000 4103304/10
3. Must use compression type connectors from IDEAL part number:
   a. IDEAL F connector - #89-011
4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.

C. The Quad shielded, plenum RG-6 cable shall be used as horizontal where specified in the Contract Drawings.
1. Shall consist of a 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.

2. CommScope part number – 2227V WHRL RG6 QD 1000 4103304/10
3. Must use compression type connectors from IDEAL part number:
   a. IDEAL F connector - #RG6-F-XR-RTQ #92-651
   b. IDEAL BNC connector – RG6-INSITE-bnc #89-048 (security camera install only)
4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.

2.6 SECURITY CABLES

A. Manufacturer: CommScope or approved equivalent.

B. RG-6(for analog cameras) cable shall be used as horizontal where specified in the Contract Drawings. This cable supplies both video and power media.
1. Shall consist of an 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
2. CommScope part number – 5654
3. Must use compression type connectors from IDEAL part number:
   a. IDEAL F connector - #RG6-F-XR-RTQ #92-651
   b. IDEAL BNC connector - RG6-INSITE-bnc #89-048 (security camera install only)
4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.

C. RG-6(for analog cameras) cable shall be used as horizontal OUTDOOR use where specified in the Contract Drawings.
1. Shall consist of an 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
2. CommScope part number – 5720
3. Must use compression type connectors from IDEAL part number:
   a. IDEAL F connector - #89-056
   b. IDEAL BNC connector - #89-057(security camera install only)
4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.

D. Composite Cables: Cable between controlled portals and IFPs shall consist of multiple conductor bundles affixed together via a central spline. The conductor bundles shall consist of the following:
1. 4C, 18 AWG 16/30 STR, shielded
2. 3P, 22 AWG 7/30 STR, shielded
3. 2C, 22A AWG 7/30 STR, shielded
4. 4C, 22 AWG 7/30 STR, shielded
5. The composite access control cable shall be Honey Well Genesis 3295 or approved equivalent.

E. 4 CONDUCTOR CABLE (for use with dry contact devices including door position switches, duress alarm switches, etc.
1. 4 stranded (7 x28) tinned copper conductors
2. Nominal O.D.: .217”
3. Belden 9444 or approved equivalent

2.7 FIBER PATCH CORDS

A. Manufacturer: SYSTIMAX Solutions ONLY. If required see specification 271300.

2.8 COPPER HARDWARE TERMINATION STANDARDS - Real Time Infrastructure Management - Intelligent Patch Panel System

A. All horizontal data cables to terminate on iPatch panel. If a rack manager does not exist in the cabinet one must be added to manage the horizontal infrastructure.

B. Systimax Solution iPatch Intelligent Fiber Optic Patching System as follows:

Product Number	Description
Fiber Shelves (19 inch rack-mountable) and accessories	
760209940	HD-1U - 1U sliding fiber shelf (holds four modules)
760148502	360-LP-STACK-SPT
760109470	12-LC-LS-AQ-Pigtails
760109496	12-LC-SM-BL-Pigtails
760109504	12-LCA-SM-GR-Pigtails
Copper Patch Panels - Cat 6	
760201137	360-iP-1100-E-GS3-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760201111	360-iP-1100-E-GS3-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
760152561	360-IPR-1100-E-GS3-1U-24 - 360 iPatch/imVision(ready) 24 port panel
760152579	360-IPR-1100-E-GS3-2U-48 - 360 iPatch/imVision(ready) 48 port panel
Copper Patch Panels - Cat 6A	
760201145	360-iP-1100-E-GS6-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760201129	360-iP-1100-E-GS6-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
imVision Rack manager	
760161380	360-imV-CNTRLR - 360 imVision Panel Manager (1 per rack / cabinet)

C. Modular Patch Cords
1. Manufacturer: Systimax SCS-GS8E
2. Provide Category 6, Modular Patch Cords for each installed port designated as “Data” in the Drawings.
3. All cords shall conform to the requirements of ANSI/TIA/EIA 568 Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL® LAN Certification and Follow-up Program. Cords shall be equipped with an 8 pin modular connector on each end and shall conform to the length(s) specified on the detailed drawing. All Category 6 cordage shall be round, and consist of 23-AWG copper, stranded conductors, tightly twisted into individual pairs and shall meet or exceed the electrical specifications set by the manufacture.
4. UTP Patch cord lengths will be deployed as follows:

Length	Location/Application
3 ft	MDF, IDF, Computer Room, and Lab
5 ft	MDF, IDF, Computer Room, and Lab
7 ft	MDF, IDF, Computer Room, and Lab
9 ft	MDF, IDF, Computer Room, Office, Cubicle, or Lab
15 ft	Office, Cubicle, or Lab

5. Copper patch cord part numbers are as follows:

Product Number	Length	Material ID
GS8E-3ft	3FT	CPC3312-03F003
GS8E-5ft	5FT	CPC3312-03F005
GS8E-7ft	7FT	CPC3312-03F007
GS8E-9ft	9FT	CPC3312-03F009
GS8E-15ft	15FT	CPC3312-03F015

a. NOTE: 15 ft. UTP patch cords shall be used at the workstation only.

D. Hybrid RJ45 to 110 Patch Cords.
1. Manufacturer: Systimax 119P2PS
2. As required provide Category 6, Hybrid Patch Cords for each assigned data/voice port on the patch panel. Cords shall RJ45 connector on one end and 110GS on the other end. Cords shall be provided in appropriate lengths to accommodate all tenant voice or specialty ports as shown in detailed drawings. All Category 6 cordage shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pair and shall meet or exceed the Category 5e specifications.
3. Hybrid patch cords shall conform to the TIA 568B wiring scheme.
4. Hybrid patch cords shall be provided for each installed port designated as “Tenant Voice or Specialty jack” in the drawings.
5. Hybrid patch cord single pair part numbers are as follows(last 3 digits designates length):

Length	Material ID
8FT	CPC8662-03F-008
10FT	CPC8662-03F-010

6. Hybrid patch cord 2 pair part numbers are as follows(last 3 digits designates length):

Length	Material ID
8FT	CPC8352-03F-008
10FT	CPC8352-03F-010

7. Hybrid patch cord 4 pair part numbers are as follows(last 3 digits designates length):

Length	Material ID
8FT	CPC8312-03F-008
10FT	CPC8312-03F-010

E. Outlets
1. Manufacturer: Systimax
2. Systimax MGS400 Modular GigaSpeed Information Outlets - 8 position/8 conductor non-keyed modular outlets for applications up 1 Gbps and ANSI/TIA/EIA 568-B compliant for Category 6 transmission requirements and be part of the UL® LAN Certification and Follow-up Program.
3. Outlets shall meet or exceed the following electrical and mechanical specifications set by the manufacture.

4. Standard installations shall utilize orange outlets for data. Dust Cover/Blanks shall match faceplate cover.
5. All IMO's (Interactive Media Outlet) shall have at a minimum 4-data ports at each location unless otherwise specified by the contract documents.
6. Systimax MGS400 Modular GigaSpeed Information Outlets part numbers are as follows:

Product Numbering	# per pack	Color	COM code
MGS400-112	1	Orange	700 206 683

7. Systimax M-Series Modular Faceplates designed for use with M-Series Modular Information Outlets:

Product Numbering	# of ports	# per pack	Color	COM code
M10L-262	1	1	White	108 258 427
M10LW-262	1 (wall)	1	White	108 258 468
M12L-262	2	1	White	108 168 469
M14L-262	4	1	White	108 168 543

8. Systimax M-Series Modular Surface Mount Box designed for use with one to four M-Series Modular Information Outlets. May be mounted on a flat surface with screws, Box color shall match wall/furniture surface color:

Product Numbering	# of ports	# per pack	Color	COM code
M104SMB-262	4	1	White	107 952 459
M104SMB-270	4	1	Gray	107 952 467

2.9 IDENTIFIERS, LABELS AND LABELING SYSTEM

A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. **Any deviation from the specification must be approved by HAS IT prior to installation.**

2.10 CABLE MANAGEMENT

A. Horizontal Manager

1. Manufacturer: CPI – 30130-719

B. Fiber Patch Cords

1. Manufacturer: Panduit – Fiber runner (Applies to all new or expand existing BDF/MDF/Computer room build outs).

2.11 SPECIAL APPLICATIONS SHIELDED TWISTED PAIR SOLUTION

A. Shielded Cable

1. CommScope Shielded Cable, F/UTP Plenum Rated Category 6A, Black Jacket, 1000ft Length

Product Number	# per pack	Color	COM code
2291B BK 4/23 R1000	1000 ft	Black	760171025
2291B GRN 4/23 R1000	1000 ft	Green	760122663

B. Shielded Outlets

1. CommScope Shielded Cable, Category 6A, F/UTP

Product Number	# per pack	Color	COM code
HGS620	1	Silver (F/UTP)	760152801

*If the HGS620 information outlet is to be used at WAO, the depth of any backboxes must be increased.

C. Shielded Patch Panels

1. CommScope Shielded Panel, 1U, 24 Port, F/UTP Flat. imVision / iPatch system preinstalled, ships with 24 shielded outlets

Product Number	# per pack	Color	COM code
360-iP-MFTP-E-HD6B-1U-24	1	Silver	760201178

D. High Density M-Series Adapter

1. Systimax High Density M-Series Adapter - White

Product Number	# per pack	Color	COM code
HGS-A-MS-WHITE	1	White	760154187

E. Shielded Patch Cords

1. CommScope Shielded Patch Cords, F/UTP, Black Jacket, RJ45-RJ45, 7ft

Product Number	# per pack	Color	COM code
G10FP-BK-7FT	1	Black	CPCGGJ2-01F007

2.12 IDENTIFIERS, LABELS AND LABELING SYSTEM

A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. **Any deviation from the specification must be approved by HAS IT prior to installation.**

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify raceways, boxes, hand holes and maintenance holes are properly installed following Sections 270528, and 270543.

B. All communication media must be installed in conduit or cable tray unless an alternate method has been approved by HAS/IT.

C. Verify horizontal conduit is minimum 1-inch diameter.

D. Verify backboards are properly installed.

E. Verify telecommunications grounding system is properly installed and tested following Section 270526.

F. Verify liquid-carrying pipes are not installed in or above any IDF/MDF that has active electronic equipment. Do not proceed with installation in affected areas until removed.

3.2 PREPARATION

A. Environmental controlled communication rooms shall maintain temperature of between 64 degrees Fahrenheit and 78 degrees F and between 30 and 55 percent humidity in areas of active electronic system work.

B. Cable Splicing: Exact cable routing, splice enclosure locations, distances, elevations, work space and purpose of splice will be governed by actual field conditions. Contractor shall perform field surveys prior to submitting layout drawings.

C. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

3.3 INSTALLATION

A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data are included on the drawings.

B. All installation shall be done in conformance with ANSI/TIA/EIA 568B standards, BICSI methods, Industry standards and SYSTIMAX SCS installation guidelines. 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. 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. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

C. The SCS installation shall comply with all applicable national and local codes pertaining to low voltage cable system installations.

D. The contractor shall adhere to the installation schedule of the general contractor and shall attend all construction meetings scheduled by the general contractor.

E. Upon structural completion of the communications room(s) and prior to the installation of any communications equipment or supporting devices inside the room, the HAS IT Representative shall consult the Communications Designer in order to:
   1. Perform construction administration activities to compare as-built configuration to the design.
   2. Observe all "not-to-design" compliance issues and issue corrective advisement of actions.
   3. Upon completion of 1 and 2 above, the Communications Designer shall mark with masking tape the general layout of the equipment placement.

F. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) with the origination, destination and device name (if applicable) location.

G. Vertical Cabinet Installation
   1. All Cabinets shall be properly positioned, leveled, ganged, anchored, grounded and powered.
   2. All Cabinets shall be populated as noted in drawings with termination hardware, equipment, proper patch cord lengths, and power outlets.
   3. Install and anchor all vertical equipment cabinets to floor following the Drawings and manufacturer's instructions.
   4. All cabinets shall be properly ganged in each bay as shown in the Drawings.
   5. All cabinet doors shall be configured as shown in the Drawings.
   6. All cabinets shall be properly labeled per specification 270553.
   7. After final acceptance of the cabinets, coordinate with Owner to replace key/lock with silver barrel on front and back doors.

H. The contractor shall perform all required cross connections of the horizontal cable runs to the backbone cable system. The equipment connections to the data systems shall be performed by the vendors installing and/or maintaining those systems.

I. The contractor is responsible for providing a CD with all the cable/patch panel information in the same format that will be accepted for download in HAS's iPatch/imVision database **1 month** before any patching is completed.

J. The contractor is responsible and must perform the following task associated with the iPatch system:
   1. Connect iPatch/imVision Network Manger to designated port on HAS network switch.
   2. Inter-connect iPatch/imVision Network Manager to rack managers if applicable.
   3. Confirm that all iPatch/imVision patch panels are on line.
   4. Configure network settings for iPatch Network Manage with IP address, Mask and Gateway.
   5. Resolve patching conflicts associated with "Confirm" message on the iPatch Network Manager Display.
   6. Resolve conflicts associated with "Alarms" on iPatch/imVision Network Manager.
   7. Provide fiber cut sheet depicting fiber port to port or port to equipment connectivity.
   8. Provide an excel file compatible with iPatch/imVision Bulk Import tool. The file will be used to build rooms, faceplates and jacks in iPatch/imVision database.
   9. Label all new devices including the iPatch/imVision Network Manager according to HAS labeling specs.
   10. Label all components according to HAS labeling specs.
   11. Provide floor plans depicting rooms lay out and outlet locations.
   12. Confirm iPatch/imVision ports are pointing toward the proper end device (iPatch/imVision to equipment or iPatch/imVision to iPatch/imVision connection).
   13. Data cabling contractor is to provide and install an iPatch/imVision 48 port copper patch panel for all new network switches/blades that are related to the project. Provide solid conductor patch cables with RJ-45 on one end and terminate the other end on the patch panel. Patch port 1 of the patch panel to port 1 on the switch until all ports on the switch are connected to the patch panel matching the port numbers.

K. The contractor shall provide service loops (slack) for cables terminating in the IDFs. A 6-foot service loop shall be provided above the access ceiling or cable trays unless specified otherwise. This allows for future changes or expansion without installing new cables.

L. The installation contractor shall be responsible for coordination, testing and problem resolution with the system vendors.

M. City inspector or their designated representative shall randomly perform unannounced, on-site reviews during the installation. In addition, this person shall perform a final inspection and a complete review of the test results before the installation is accepted.

N. Upon completion of the installation, Contractor shall prepare as-built documentation of the entire SCS. This documentation shall include:
   1. As-Built Drawings
      a. All drawings shall be provided on disk in a form compatible with AutoCAD Version 14. A complete set of project plans will be provided by the Contractor on CD.
      b. A complete diagram of all terminations in the IDFs.
      c. A complete diagram of all copper, fiber, and coax riser cable.
      d. A complete diagram of all copper, fiber, and coax inter-building cable.
      e. Floor plans showing exact cable routings with each outlet clearly marked with cable number.
      f. A complete diagram of all cable tray, conduits and conduit sleeves.
   2. Documentation
      a. All cable inventory data documentation shall be submitted in designated as specified in specification 270553
      b. Documentation on horizontal cable shall include cable number and length of cable.
      c. Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.
   3. As-built Drawings and Documentation shall be reviewed, approved and stamped by Contractor's on-site RCDD.

3.4 POST-INSTALLATION TESTING AND CERTIFICATION

A. Contractor Requirements
   1. Contractor shall provide sufficient skilled labor to complete testing within a reasonable test period.
   2. Contractor shall have a minimum of three years experience installing and testing structured cabling systems. All installers assigned by the Contractor to the installation shall be certified by the factory to install and test the provided products.
   3. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
   4. Contractor is responsible for submitting acceptance documentation as defined in 3.04.D below. No cabling installation is considered complete until test results have been completed, submitted and approved as defined in 3.04.D below.
   5. Contractor to ensure that the database information for iPatch meets the HAS requirements.

B. Test Procedure
   1. HAS IT Representative reserves the right to be present during any or all testing. Notify HAS IT Representative at least 48 hours prior to beginning test procedures.
   2. Testing shall be of the Permanent Link. However, Contractor shall warrant performance based on Channel performance and provide patch cords that meet channel performance.
   3. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the Owner.
   4. Testing of all copper and fiber wiring shall be performed prior to system(s) cutover.

5. 100% of the installed cabling shall be tested. All tests shall pass acceptance criteria defined in 3.05 below.
6. Cable testing shall be performed by a fully charged tester, and the charging unit shall be disconnected during testing.
7. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor at no charge to the City. Complete end-to-end test results shall be submitted to the City.

C. Standards Compliance and Test Requirements
1. Copper Cabling shall meet the indicated performance specifications:
   a. Category 6 Horizontal Cabling shall be tested to the manufactures specification for Category 6 Cabling and SYSTIMAX SCS GigaSpeed System.
2. All test equipment used shall meet the performance specifications defined in 3.04.

D. Cable Test Documentation
1. Test reports shall be submitted in hardcopy and electronic format and certified by the contractor's RCDD to be a complete and accurate record of cabling installed. Hand-written test reports are not acceptable.
2. Hardcopy reports are to be submitted in labeled three-ring binders with an attached affidavit verifying passing execution of all tests. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, cable length, date of test, and pass/fail result.
3. Electronic reports shall be submitted on CD in PDF format. 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. Certificate shall reference traceable circuit numbers that match the electronic record.
4. Hardcopy and electronic reports for each cable route shall be submitted together in one submittal. The submittal description shall include the type of test performed, type of cable, and cable ID (including originating and terminating room numbers) of cable tested. Partial or unclear documentation will be returned without reviewing.
5. Test reports shall include the following information for each cabling element tested:
   a. Wiremap results that indicate that 100% of the cabling has been tested for shorts, opens, miswires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
   b. For Category 6 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. Test shall also include mutual capacitance and characteristic impedance.
   c. Length (in feet), 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.
   d. Cable manufacturer, cable model number/type, and NVP
   e. Tester manufacturer, model, serial number, hardware version, and software version
   f. Circuit ID number and project name
   g. Autotest specification used
   h. Overall pass/fail indication

i. Date of test

6. Test reports shall be submitted within seven business days of testing.

E. Test Equipment

1. 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.
   a. Category 6 – At minimum a Level III tester or submitted and owner-approved equivalent.
   b. Refer to spec section 27 13 00 for fiber testing procedures.
2. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.
3. Test adapter cables shall be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.
4. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
5. Test equipment shall be capable of certifying Category 6 links.
6. Test equipment shall have a dynamic range of at least 100 dB to minimize measurement uncertainty.
7. Test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
8. Test equipment shall include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
9. Test equipment shall be capable of running individual NEXT, return loss, etc measurements in addition to autotests. Individual tests increase productivity when diagnosing faults.
10. Test equipment shall include a library of cable types, sorted by major manufacturer.
11. Test equipment shall store at least 250 Category 6 autotests (in full graphic format) in internal memory, with the option for additional storage card via expansion slot.
12. Test equipment shall be able to internally group autotests and cables in project folders for good records management.
13. Test equipment shall include DSP technology for support of advanced measurements.
14. Test equipment shall make swept frequency measurements in compliance with TIA standards.
15. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.

3.5 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted and approved, and HAS IT Representative is satisfied that all work is in accordance with contract documents, the HAS IT Representative will notify Contractor in writing of formal acceptance of the system.

B. Acceptance Requirements

1. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified under 3.04. "Standards Compliance & Test Requirements" above.
2. HAS IT Representative reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent of the cable plant to confirm documented results. Random re-testing, if performed, shall be at the expense of the City, using standard labor rates. Any failing cabling shall be re-tested and restored to a passing condition at no

cost to the City. In the event more than two percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.

3. HAS IT Representative may agree to allow certain cabling runs to exceed standardized performance criteria (e.g. length). In this event, such runs shall be explicitly identified and excluded from requirements to pass standardized tests.
4. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described in 3.04.
5. See Appendix A & B. Acceptance requirements are not limited to these sheets

3.6 DEMOLITION

A. The contractor shall be responsible for maintaining all communications service to areas of the building scheduled to remain in service during the period of renovation.

B. Notify HAS Information Technology (IT) department 30 days prior to the start of demolition work taking place in existing communications rooms. Coordinate removal of equipment and cabling within existing communications rooms with HAS IT.

C. Where removal is indicated in Drawings, remove communications cable from termination point back to originating communications room, MDF or tenant communications room. Coordinate removal at terminating blocks and panels with HAS IT. Coordinate removal of cross-connects and patch cables with HAS IT.

D. Ensure systems and circuits are no longer active before removing and prior to the demolition of existing communications rooms. If active circuits exist at time of scheduled demolition, coordinate with HAS IT Representative to reroute or deactivate circuit(s).

E. Demolition and removal of cabling shall not impact the operation of active systems.

F. Unless otherwise noted, discard all removed cable, patch cables and cross-connects. Except where re-routing of cable is specified in Drawings or by Designer, do not reuse cable.

G. Remove all loose unterminated cabling to source found above ceiling, under floor or in wall.

H. Demo all abandoned cable in accordance with NEC 800.25.

3.7 CLEANING

A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

END OF SECTION 271500

APPENDIX A

MDF/IDF Check List

This list is intended as a minimum checklist. CM should ensure that the contractor's schedule has built in these components and the necessary buffer period – and associated access restrictions to the communications equipment rooms -- for HAS IT and tenant IT to prepare.

1. All communication rooms that will service the area to be opened must be completed. That means a final walkthrough of these areas has been completed. It is not necessary that the entire project achieve substantial completion, but IT cannot install equipment and begin work until the following minimum criteria is met:
   a. Space is built out and clean – free from dust/residues.
   b. Electrical w/UPS as required.
   c. All racks/cabinets installed and mounted. Padlocks eyes have been installed.
   d. Grounding bus bar installed and properly tied to main grounding bus bar in MDF
   e. HVAC functioning properly and is adequately filtering dust. Humidity is controlled.
   f. Door access control is installed (card reader) -or- an approved temporary provision. Simple key access is not permissible.
   g. Lighting is installed and operational.
   h. Cable trays/ladder racks installed and ready to use.
   i. Permanent or temporary signage identifying permanent room number.

2. All cabling necessary to operate the areas to be opened is completed.
   a. Backbone cabling (copper and fiber) from the applicable communication room(s) is installed, tested, labeled, and approved by the inspector and communications design consultant.
   b. Horizontal cabling for all areas to be occupied is installed, tested, labeled, and approved by the inspector and communications design consultant.
   c. Copper cross connects and/or fiber jumpers have been installed per the owner/tenant requirements.
   d. Cable records and redline drawings for installed cables are submitted and approved PRIOR to putting any active circuits on the new cables. Cable records reflect all installed cables **and** any cross connects or jumper assignments installed by the contractor.
   e. All iPatch Panels are programmed and operational.
   f. All jumpers and patch cords specified by the contract are transmitted to the owner for use.
   g. NOTE: cable labels and permanent room numbers need to match. CM needs to be sure to get design team, airport, IT, and CM / contractor reps together to review permanent room numbers prior to contractor installing cable labels.

3. Move-in buffer period needs to be minimum 6 **weeks** for HAS-IT to install/extend services within the area to be occupied prior to occupation of the facility or spaces. Additional time may be necessary if Tenant IT organization is involved, or if contractor has other systems that must be configured/tested which require HAS-IT resources (i.e. cabling or data network connections). This is frequently the case for PA System, television, radio, Fire Alarm, pay telephone, EFSO (Electronic Fuel Shutoff), access control & CCTV, etc.

4. Once HAS-IT accepts a communications equipment room and begins to install/configure equipment in preparation for hosting live applications, this room becomes a restricted area with access to be controlled by HAS-IT. Contractors must be substantially complete with systems inside the communications equipment room so that access is generally not required. Minor punch list and scheduled testing with escort can be arranged, but access will be very limited.

5. Other IT-related systems that must be operational, tested, and accepted or approved temporary provisions.
   a. PA System
   b. MATV and/or CNN TV (where applicable)
   c. Fire Alarm
   d. MUFIDS
   e. Pay Telephones (where applicable)
   f. EFSO (where applicable)
   g. Access Control & CCTV (note: must be PROGRAMMED, and approved acceptance test walk through by HAS)
   h. Crash phone (where applicable)
   i. Radio system enhancements (where applicable)
   j. Data Network switch installed and configured.

APPENDIX B

IDF Number:		Date:		
Grounding & Bonding:		**YES**	**NO**	**COMMENTS**
	TGB properly installed			
	Proper grounding conductor installed (6AWG min.)			
	Cable trays properly bonded			
	Equipment Racks, Armored Cables & Cabinets properly bonded			
	Conduit properly bonded			
	Cabling properly bonded			
	Splice Cases properly bonded			
Horizontal Cabling:		**YES**	**NO**	**COMMENTS**
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Pair twist meets spec			
	Proper termination scheme			
	Cable/jack part number meets spec			
	Plenum vs. PVC			
	Properly dressed in tray			
	Properly dressed in cable management			
	Cables bundled properly			
	Appropriate clearances observed (power)			
	Minimum about of cable exposed at termination			
Backbone Cabling:		**YES**	**NO**	**COMMENTS**
	Fiber strain relief properly applied			
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Properly dressed in tray			
	Fiber installed in inner duct			
	Properly dressed in termination shelf			
	Any splice cases properly supported			
Room Layout:		**YES**	**NO**	**COMMENTS**

	Room laid out according to project drawings			
	Proper clearances maintained			
	Is the room clean & neat in appearance			
	Liquid carrying pipes within the room			
Pathways:		YES	NO	COMMENTS
	Conduit properly routed & supported			
	Cable Tray properly routed & supported			
	Inner Duct used to route fiber and properly supported			
Labeling:		YES	NO	COMMENTS
	Grounding conductor			
	End-to-End labeling			
	Pair Count on Splice Case			
	Horizontal Cabling			
	Fiber Optic Cabling			
Other:		YES	NO	COMMENTS
	Appropriate fire stop material in place			
	Cabling test results submitted with proper information			
	Climate controlled environment (Temp. & Humidity)			
	Is the room access controlled			
Copper Cabling:				
	Total Pairs (Riser)			
	Pair Counts			
	Termination Type (66, 110, Protectors..)			
	Termination Location			
Fiber Optic Cabling:				
Multimode:				
	Total Strands			
	Termination Type (LC, SC)			
	Termination Location			
Single Mode:				
	Total Strands			
	Termination Type (LC, SC)			
	Termination Location			

SECTION 272100 - DATA COMMUNICATION NETWORK EQUIPMENT (REV. 01-14-2020-TAB)

PART 1 - GENERAL

1.01 SUMMARY

A. Provide the Local Area Network (LAN) active components and interfaces to be implemented and utilized in the Houston Airport System network to support present and future communications systems requirements.

B. Provide HAS wireless connectivity for all new construction and/or remodel.

1.02 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. Related Work:

1. Section 270500: Common Work Results for Communications
2. Section 270510: Telecommunication Administrative Requirements
3. Section 270526: Telecommunications Grounding and Bonding
4. Section 270528: Interior Communication Pathways
5. Section 270553: Identification and Labeling of Communication Infrastructure
6. Section 271100 Communication Cabinets and Equipment Rooms
7. Section 271300: Backbone and Riser Media Infrastructure
8. Section 271500: Horizontal Media Infrastructure

D. Conflicts.

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

E. References:

1. National Electrical Manufacturers Association (NEMA)
2. American Society for Testing Materials (ASTM)
3. National Electric Code (NEC)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. UL Testing Bulletin
6. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps
7. Houston Airport System Standards and Specifications located http://www.houstonairports.biz/TIP

1.03 DEFINITIONS

A. ANSI – American National Standards Institute

B. ATM – Asynchronous Transfer Mode

C. EIA – Electronics Industries Alliance

D. Gbps – Gigabits per second

E. IEEE – Institute of Electrical and Electronic Engineers

F. ISO – International Organization for Standardization

G. Mbps – Megabits Per Second

H. MIMO – Multiple-In and Multiple-Out

I. Multi-path – The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction.

J. NEC – National Electrical Code

K. NEMA – National Electrical Manufacturing Association

L. RF (Radio Frequency) – Signal generated by a radio transmitter and sent out through an antenna. The frequency of the transmission is described in terms of the number of cycles per second or Hertz (Hz).

M. SFP – Small Form-Factor Pluggable – Hot-pluggable transceiver used for both telecommunication and data communication applications. Comes in both copper and fiber.

N. SNMP – Simple Network Management Protocol

O. TIA – Telecommunications Industry Association

P. TR – Telecommunications Room

Q. UL – Underwriter's Laboratories

R. VoIP – Voice over Internet Protocol

S. WAP – Wireless Application Protocol

T. WPA/WPA2 – WiFi Protected Access / WiFi Protected Access II – IEEE 802.11i-2004

1.04 DESIGN AND PERFORMANCE STANDARDS

A. Standards supported should include, but be not limited to, IEEE 802.3, 10BASET, IEEE 802.3u, 100BaseTX, 1000BaseFX, IEEE 802.11, IEEE 802.3ae-2002, Ethernet MIB (RFC 1643), SNMP MIB II (RFC 1213).

B. All designs must adhere to HAS Cyber Security Standards.

1.05 SUBMITTALS

A. Qualifications: Demonstrate compliance with requirements below.

B. Submit Technical Implementation Plan in accordance with requirements below.

C. Submit manufacturer's technical data for each product provided.

D. Submit technical and operations manuals. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed. Manuals shall include required maintenance to be performed.

1. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed. Manuals shall include required maintenance to be performed.
2. Manuals shall be suitable for the training of future personnel by the City, and for use as a reference by currently employed personnel in performing work assignments.

E. As-built documentation. Notes shall be kept during initial installation and shall be made a permanent part of the installation manual pages as required.

F. For each active device installed, provide a printed configuration including a printout of the device as displayed on the network management system. Printed configuration parameters for each port on the device shall accompany the written report.

G. Other information in support of the design, fabrication, and installation of the LAN system.

H. An implementation schedule listing dates for LAN equipment installations for approval by the City Engineer. The dates of LAN equipment installations shall be in accordance with dates for installation of the various special systems and users. It is incumbent upon the LAN implementers to include the dates for special system and user installs into the schedule.

I. Include spares list to be approved by Owner IT Project Manager for approval.

1.06 CONTRACTOR'S DUTIES

A. Perform all work, coordination, systems integration, engineering design, and testing, and shall provide all products required in order to ensure a fully operative system and proper installation of equipment. System operability and proper installation shall be verified via completion of the acceptance test plan.

B. Coordinate all installation activities and details with the Houston Airport Systems' Information Technology (HAS IT) Representative. The HAS IT Representative shall be responsible for approving the final configuration of all equipment supplied as part of this specification.

C. Provide all system documentation and submittals.

D. Provide warranty and maintenance support as specified.

E. Provide all calculations and/or analysis to support design and engineering decisions as specified in Submittals.

F. Provide and pay for all labor, materials, and equipment. Pay required sales, gross receipts, and other taxes.

G. Secure and pay for plan check fees, permits, fees, and licenses necessary for execution of Work as applicable for the project.

H. Give required notices.

I. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.07 QUALITY ASSURANCE

A. Contractor Qualifications:

1. The contractor must be certified by the manufacturer of the products to be installed adhere to the engineering, installation and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
2. All members of the installation team must be certified by the manufacturer(s) as having completed the necessary training to complete their part of the installation.
3. Contractor shall provide five references for projects of approved equivalent scope, type and complexity of work completed within the last five years.

B. Equipment and materials supplied for the LAN shall be a standard product of manufacturers regularly engaged in the manufacture and installation of information backbone technologies and shall be the manufacturer's latest standard design. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of the FCC (Federal Communications Commission) Title CFR 47 Part 15.

C. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the “contemporary technical equivalent” of that specified. “Contemporary technical equivalent” shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the City.

1.08 MAINTENANCE AND SUPPORT

A. Provide the manufacturer’s standard maintenance and support services for all hardware and software associated with this system at no additional charge for a period of not less than three years. It will be the responsibility of the HAS IT Representative to provide the operational maintenance and support of the installed system. Coordination through the City Engineer and the HAS IT Representative shall be required by the installation contractor to ensure that all documentation for the manufacturer’s maintenance and support programs are in place.

B. All lead technicians performing installation shall have a minimum of two years experience on the proposed system and be manufacturer certified on all hardware/software applications.

1.09 EXTENDED WARRANTY

A. Provide the manufacturer's warranty for all equipment installed at no additional charge for a period of not less than three years. The warranty shall ensure that the installed equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. The warranty shall allow for replacement or repair at the discretion of the City Engineer and shall include all upgrades for firmware and/or operating systems.

B. Software License

1. Required software licenses shall be identified and supplied by the Contractor. Licenses shall be "Site Licenses" which shall cover all equipment installed now or in the future.
2. All software licenses and warranties shall be registered in the name of Houston Airport System.

1.10 PROCUREMENT

A. Procure equipment specified in this document as dictated by the timeline in Appendix B in order to make sure that the technology is acquired in a timely fashion, but not outdated by the installation date.

B. Submit a copy of Appendix B "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. The Contractor shall complete the columns headed "Quantity", "Procurement Lead Time", "Start Date or Dependent", and "Installation Duration".

C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.

D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.

E. The Contractor shall not purchase any materials requiring submittals until the City Engineer approves the submittal for that material and the Technology Implementation Schedule.

F. The Contractor shall not purchase any materials requiring submittals until the date established by the City Engineer as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix B as a part of the Submittal Review process.

PART 2 - PRODUCTS

2.01 EQUIPMENT MANUFACTURERS

A. LAN Equipment: Unless otherwise specified, furnish products manufactured by Cisco Systems. Substitutions for specified Cisco Systems components are NOT permitted.

B. Uninterruptible Power Supply (UPS): Eaton or submitted and approved equivalent.

C. Workstations: Reference Specification 272200 – PC, Laptop and Server Equipment.

D. Network Printers: Reference Specification 272200 - PC, Laptop and Server Equipment.

E. Wireless Access Point: Aruba or submitted and approved equivalent.

F. Wireless Access Point Enclosure: American Access Technologies, Inc. or submitted and approved equivalent.

G. For cabinets/racks and cabling infrastructure: Reference Specification 271100 – Cabinets and Equipment Rooms.

H. Courtesy Phone: CEECO or submitted and approved equivalent

I. CAT 6 Media extenders Veracity Global or submitted and approved equivalent.

2.02 GENERAL LAN REQUIREMENTS

A. The LAN configuration shall be a hierarchical star utilizing centralized core switches that star out to individual edge level devices located throughout the premises in designated areas. Single Mode Fiber Optic Cable (provided in Section 271300) provides the connectivity between all devices. Each edge level device services the HAS communications equipment (Administrative LAN workstations, building management stations, etc.) via UTP Copper Cabling.

B. All LAN equipment shall provide Internet Protocol (IP) switching across all types of network technologies and topologies, including Ethernet, Fast Ethernet and Gigabit Ethernet.

C. The LAN architecture shall be based on 10 Gbps between the two core networking switches located in the MDF and the edge level networking equipment located in the TR. In addition, the edge level equipment shall be dual homed to the separate core devices where applicable.

D. Each active device shall be accessible from a network, console or auxiliary RS-232 port. A configuration specialist shall be able to enter supervisory mode and change default configurations as appropriate for required operation of special system components.

E. Each active device shall be capable of generating Simple Network Management Protocol (SNMP) or SNMP3 alarms. The device shall be respondent to RMON inquiries from an expert level network management inquirer.

F. All network equipment shall be compliant to physical and operational parameters. The equipment shall be capable of responding to SNMP, SNMP3 and/or RMON network management program calls from the Network Management System.

G. Network equipment shall provide multimedia and multicast support through use of Protocol Independent Multicast (PIM), Internet Group Management Protocol (IGMP).

H. Network equipment shall support full-duplex connectivity on links (10Base-TX, 100Base-TX, 1000Base-TX, 100Base-F/TX, and 1000Base-FX).

I. All fiber interfaces on network switches must support Digital Optical Monitoring (DOM) feature.

J. All network equipment shall be Virtual Local Area Network (VLAN) compatible based on both port and MAC addresses. VLAN assignments shall be configurable from a centralized administrative console.

K. Network equipment shall not require re-configuration of end-station network interface cards or network interface card drivers to accommodate intra-VLAN and inter-VLAN traffic.

L. Network equipment shall support automated VLAN creation and administration capabilities.

M. Network equipment shall support port mirroring. This shall be done by sending frames directly from a specified port to another switch port or from an external network analyzer.

N. Network equipment for use in the main MDF and TRs shall belong to one family of product. The equipment must allow for common sparing of all Interface Processor Modules and all Supervisor Modules.

O. Network equipment shall support Terminal Access Controller Access Control System (TACACS), in order to provide secure port filtering. The equipment must enable individual ports to allow access only to certain workstations.

P. All active LAN devices shall include all software as required for interconnectivity. All active devices shall have fully functional network management options installed.

2.03 LAN HARDWARE REQUIREMENTS

A. All equipment shall be rack mountable in standard 19-inch racks. Contractor is responsible for providing fans, shelves, drawers, special power wiring, ground connections, and adapters of any kind necessary to accommodate the system installation, operation, testing, or maintenance. Contractor shall provide the appropriate factory or custom rack mount adapters for all equipment installed in the equipment rack, whether specifically itemized or not. Contractor shall cover unused slots using blank panels.

B. Fiber and Copper Patch Cords – Adequately sized fiber and copper patch cords shall be provided for each installed port in the LAN under Section 271500, “Horizontal Media Infrastructure.”

C. Core Networking Equipment

1. The core layer networking equipment shall be located in the MDF as shown in the contract drawings.
2. The chassis shall accommodate a minimum of nine (9) interface modules and provide connectivity to mixed network topologies. The use of a chassis is to support networking topologies without the use of external bridges or routers. The chassis shall have redundant power supplies, in the form of hot-swappable modules which can equally share the chassis power load. If one power supply fails the system shall notify the network manager and also provide a display on the front of the chassis. The chassis shall support quality of service through support of IP Precedence, Resource Reservation Protocol (RSVP), and 802.1p.
3. The switch backplane shall provide a minimum of 1440 Gbps switching fabric on the network bus.
4. The chassis shall include modules with a minimum of 24 Gigabit Ethernet (single mode

fiber) ports to be connected to distribution layer switches in the Terminal MDFs.

5. The chassis shall support:
   a. Redundant supervisor modules.
   b. Hot swappable line cards.
   c. Layer 2 and Layer 3 IP switching.
   d. Up to 240 10/100/1000 Ethernet ports.
   e. Support broadcast suppression.
   f. Support IGMP snooping and pruning.
6. The core switching equipment shall, at a minimum, a Cisco Catalyst 6509 with the following modules:
   a. Two Supervisor 1440 modules with integrated fabric, Mutlilayer Switching Feature Card 4 (MSFC4) and Policy Feature Card 4 (PFC4).
   b. Fabric-enabled Gigabit Ethernet module(s) with enough SFP ports to support the connectivity requirements for core to core and core to distribution switch uplinks. All SFP ports shall include Long Wavelength / Long Haul (1000Base LX/LH) SFPs (single-mode).
   c. Fabric-enabled, inline power 48-port 10/100/1000Base TX module(s) to provide connectivity for the Layer 3 switch ports.
   d. Network Analysis Module.
   e. Intrusion Detection Module.
   f. Firewall Services Module.
   g. Two 6000W AC power supplies.

D. Edge Level Equipment

1. The edge level networking equipment shall be located in the individual TR as shown in the contract drawings unless noted otherwise.
2. The devices shall provide a minimum of 10 Gbps switching fabric.
3. The device shall include a module(s) with the appropriate RJ45 Category 6 UTP 10/100/1000BaseTX ports to support the port requirements shown on the contract drawings. In addition, the device shall have the capability to "stack" with additional devices to increase the available port count.
4. The edge level devices shall have the capability to simultaneously accommodate a minimum of two Gigabit Ethernet uplinks and 24 10/100/1000 VoIP Ethernet ports.
5. The devices shall support the bonding and trunking of Fast Ethernet and Gigabit Ethernet ports.
6. The edge level switching equipment shall be Cisco Catalyst C9300-24U-E or submitted and owner-approved equivalent. Use 24 port switch if 16 ports or less are active. Upgrade to the 48 port switch (C9300-48U-E) if more than 16 ports are active. Switches must also come with network module C9300-NM-4G (4 x 1gb), single-mode SFPs, and three year term license (C9300DNA-E-24-3Y for 24 port and C930DNA-E-48-3Y for 48 port). Switches are to be ordered with the following power supply - PWR-C1-1100WAC – 1100W AC power supply.
7. The edge level equipment for industrial environment applications shall be Cisco IE-3200-8P2S-E or submitted and owner-approved equivalent. The switch supports 8 POE/POE+ copper connections and 2 SFP ports for uplinks. Power supply to be provided is PWR-IE170W-PC-AC=.

2.04 UPS HARDWARE REQUIREMENTS

A. If a room wide UPS is not installed provide a rack-mounted UPS in equipment cabinet in the Telecommunications Room that houses LAN equipment. The UPS shall have an output capacity of 5KVA (3750 Watts). All remaining TRs shall be supported by a UPS as well. Unit must have enough batteries to keep all equipment attached to the unit running for minimum of one (1) hour. If specified UPS cannot be installed due to space restraints a smaller UPS (Eaton 5PX1500RTN) can be substituted if submitted and owner-approved prior to installation, runtime requirements and environmental probe are still required.

B. The UPS interface port shall have an RS-232 communications port and a 10/100 Base-T Ethernet for LAN management. Include optional environmental probe (Eaton part #42R4317).

C. The control panel shall have a LED status display for load and battery bar-graphs in addition to replace battery and overload indicators.

D. The Output Connections shall include as a minimum one NEMA L6-30R, two NEMA L6-20R, and eightteen NEMA 5-15R.

E. Input connection shall be nominal 208 V via L6-30P plug.

F. Include software and interface card to provide Web/SNMP management through 10Base-T Ethernet port. Management software shall include the following attributes:

1. Shall allow complete configuration of the UPS devices from a remote location
2. Shall provide periodic UPS self-tests
3. Shall provide full control over UPS transfer settings
4. Shall provide user name and password security
5. Shall log all power events with a description

G. UPS shall be Eaton 9PX5KTF5 5000VA RM 5U 208V series with Web / SNMP Management Card for Ethernet and optional environmental probe, or submitted and owner-approved equivalent.

2.05 WIRELESS ACCESS POINT

A. General: One 802.11acv2 Wireless Access Point shall be installed per the Drawings.

B. INDOOR Access Points

1. AP-330 series specifications
   a. AP-335 and IAP-335
   b. 2.4- GHz (600 Mbps max) and 5-GHz (1.733 Gbps max) radios, each with 3x3 MIMO and three integrated omni-directional downtilt antennas.
2. AP-334 and IAP-334
   a. 2.4-GHz (600 Mbps max) and 5-GHz (1.733 Gbps max) radios, each with 3x3 MIMO and three combined, diplexed external antenna connectors.

C. Wireless radio specifications

1. AP type: Indoor, dual radio, 5 GHz 802.11acv2 and 2.4 GHz 802.11n

a. In addition to 802.11n data rates, the 2.4-GHz radio supports 802.11acv2 data rates using 256-QAM modulation. This gives TurboQAM-enabled clients a 33% boost above the maximum supported data rate.

2. Software-configurable dual radio supports 5 GHz and 2.4 GHz
3. 4x4 MIMO with three spatial streams and up to 1.733 Gbps wireless data rate
4. Supported frequency bands:
   a. 2.4000 GHz to 2.4835 GHz
   b. 5.150 GHz to 5.250 GHz
   c. 5.250 GHz to 5.350 GHz
   d. 5.470 GHz to 5.725 GHz
   e. 5.725 GHz to 5.850 GHz
5. Available channels: Dependent upon configured regulatory domain
6. Dynamic frequency selection (DFS) optimizes the use of available RF spectrum
7. Supported radio technologies:
   a. 802.11b: Direct-sequence spread-spectrum (DSSS)
   b. 802.11a/g/n/ac: Orthogonal frequency-division multiplexing (OFDM)
   c. 802.11n/acv2: 4x4 MIMO with up to three spatial streams
8. Supported modulation types:
   a. 802.11b: BPSK, QPSK, CCK
   b. 802.11a/g/n: BPSK, QPSK, 16-QAM, 64-QAM
   c. 802.11ac: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM
9. Transmit power: Configurable in increments of 0.5 dBm
10. Maximum (aggregate, conducted total) transmit power (limited by local regulatory requirements):
    a. 2.4-GHz band: +23 dBm (18 dBm per chain)
    b. 5-GHz bands: +23 dBm (18 dBm per chain)
11. Advanced cellular coexistence (ACC) feature to effectively deal with interference from cellular systems
12. Maximum ratio combining (MRC) for improved receiver performance
13. Cyclic delay diversity (CDD) for improved downlink RF performance
14. Short guard interval for 20-MHz, 40-MHz and 80-MHz channels
15. Space-time block coding (STBC) for increased range and improved reception
16. Low-density parity check (LDPC) for high-efficiency error correction and increased throughput
17. Transmit beam-forming (TxBF) for increased reliability in signal delivery
18. Supported data rates (Mbps):
    a. 802.11b: 1, 2, 5.5, 11
    b. 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54
    c. 802.11n: 6.5 to 450 (MCS0 to MCS23)
    d. 802.11ac: 6.5 to 1,300 (MCS0 to MCS9, NSS = 1 to 3)
19. 802.11n high-throughput (HT) support: HT 20/40
20. 802.11acv2 very high throughput (VHT) support: VHT 20/40/80/160
21. 802.11n/acv2 packet aggregation: A-MPDU, A-MSDU

D. Power

1. Maximum power consumption: 25.3 watts, plus up to 5.9 watts for attached USB device and internal overhead.
2. Power sources sold separately
3. Direct DC source: 12 Vdc nominal, +/- 5%
4. Power over Ethernet (PoE): 48 Vdc (nominal) 802.3af or 802.3at-compliant source

a. Efficient mode PoE – power save with 802.3af PoE and limited functionality
   1) USB port disabled
   2) Second Ethernet port disabled
   3) 2.4-GHz 802.11n radio in 1x3:1 spatial-stream mode
   4) 5-GHz 802.11ac radio operates without restrictions*
b. Unrestricted functionality with 802.3at PoE+

5. *With ArubaOS software 6.3.0, the 5-GHz 802.11ac radio operates in 2x3:2 spatial stream mode when the AP is powered by 802.3af PoE. This restriction has been removed in 6.3.1.

E. Antennas

1. AP-334: Four RP-SMA connectors for external dual-band antennas. Internal loss between radio interface and external antenna connectors (due to diplexing circuitry): 1.5 dB in 2.4 GHz and 3.0 dB in 5 GHz.
2. AP-335: Eight integrated down-tilt omni-directional antennas for 4x4 MIMO with maximum antenna gain of 3.5 dBi in 2.4 GHz and 4.5 dBi in 5 GHz. Built-in antennas are optimized for horizontal ceiling mounted orientation of AP-335.

F. Other interfaces

1. Two 10/100/1000BASE-T Ethernet network interfaces (RJ-45)
   a. Auto-sensing link speed and MDI/MDX
   b. Load balancing support to achieve platform throughput greater than 1 Gbps
   c. 802.3az Energy Efficient Ethernet (EEE)
   d. PoE-PD: 48 Vdc 802.3af PoE or 802.3at PoE+
2. DC power interface, accepts 1.7/4.0mm center-positive circular plug with 9.5 mm length.
3. USB 2.0 port (Type A connector)
4. Serial console interface (RJ-45, TTL levels)
5. Visual indicators (LEDs):
   a. Power/system status
   b. Ethernet link status (2x; ENET0, ENET1)
   c. Radio status (2x; RAD0, RAD1)
6. Bluetooth Low Energy (BLE) radio
   a. --Up to 4 dBm transmit power (class 2) and -91 dBm receive sensitivity
   b. --Integrated antenna with roughly 30 degrees downtilt and peak gain of 5.1 dBi (AP-334/IAP-334) or 2.2 dBi (AP-335/IAP-335)
7. Kensington security slot
8. Reset button

G. Mounting

1. Included with AP:
   a. Mounting brackets (2) for attaching to 9/16-inch or 15/16-inch T-bar drop-tile ceiling
2. Optional mounting kits:
   a. AP-220-MNT-C2: Aruba 220 series AP mount kit contains two ceiling-grid rail adapters for Interlude and Silhouette style rails.
   b. AP-220-MNT-W1: Aruba 220 series AP mount kit contains one flat-surface wall/ceiling mount bracket.
   c. AP-220-MNT-W2: Aruba 220 series AP mount kit contains one flat-surface wall/ceiling secure mount cradle.

H. Mechanical

1. Dimensions/weight (unit, excluding mount accessories):
   a. 203 mm (W) x 203 mm (D) x 54 mm (H), 8.0” (W) x 8.0” (D) x 2.1” (H)
   b. 750 g/27 oz
2. Dimensions/weight (shipping):
   a. 315 mm (W) x 265 mm (D) x 100 mm (H), 12.4” (W) x 10.4” (D) x 3.9” (H)
   b. 1,250 g/44 oz

I. Environmental

1. Operating:
   a. Temperature: 0° C to +50° C (+32° F to +122° F)
   b. Humidity: 5% to 95% non-condensing
2. Storage and transportation:
   a. Temperature: -40° C to +70° C (-40° F to +158° F)

J. Regulatory

1. FCC/Industry of Canada
2. CE Marked
3. R&TTE Directive 1995/5/EC
4. Low Voltage Directive 72/23/EEC
5. EN 300 328
6. EN 301 489
7. EN 301 893
8. UL/IEC/EN 60950
9. EN 60601-1-1 and EN 60601-1-2

K. Regulatory Model Numbers

1. AP-334 and IAP-334: APIN0334
2. AP-335 and IAP-335: APIN0335

L. Certifications

1. CB Scheme Safety, cTUVus
2. UL2043 plenum rating
3. Wi-Fi Alliance certified 802.11a/b/g/n/ac

M. Warranty

1. Limited lifetime warranty

N. Minimum operating system software versions

1. ArubaOS 6.3.0.0
2. Aruba Instant 4.0.0.0

O. RF Performance Table

	Maximum transmit power (dBm) per transmit chain	Receiver sensitivity (dBm) per receive chain
802.11b 2.4 GHz		
1 Mbps	18.0	-92.0
2 Mbps	18.0	-92.0
5.5 Mbps	18.0	-90.0
11 Mbps	18.0	-88.0
802.11g 2.4 GHz and 802.11a 5 GHz		
6 Mbps	18.0	-88.0
54 Mbps	16.0	-75.0
802.11n HT20 2.4 GHz and 5 GHz		
MCS0/8	18.0	-88.0
MCS7/15	14.0	-71.0
802.11n HT40 2.4 GHz and 5 GHz		
MCS0/8	18.0	-85.0
MCS7/15	14.0	-68.0
802.11ac VHT20 5 GHz		
MCS0	18.0	-88.0
MCS9	12.0	-65.0
802.11ac VHT40 5 GHz		
MCS0	18.0	-85.0
MCS9	12.0	-62.0
802.11ac VHT80 5 GHz		
MCS0	18.0	-82.0
MCS9	12.0	-59.0

P. Enclosures

1. Wireless Access Points shall be installed in lockable, stainless steel Nema 4 Enclosure when mounted outdoors or in garage spaces.
2. Include back-plate, ground bus-bar, cable management, document holder, pole/wall mount adapters.
3. Provide 120VAC@15A quad receptacle with surge protection per drawings.
4. Enclosure shall be bonded to ground per NEC.
5. All conduit penetrations shall be made to prevent water ingress through the connections.
6. Enclosure size per drawings.

Q. Wireless Access Point Ceiling Enclosure

1. The 802.11ac wireless access point shall be installed in a lockable enclosure mounted to the ceiling. The enclosure shall meet the following specifications:
   a. Enclosure shall be Oberon Wireless model # 1075-WA or submitted and owner approved equivalent.
   b. The WAP is installed in such a manner that the antennas, or face of WAP if antennas are integrated, are largely within the ABS plastic dome; there is little impact on WAP coverage with antennas largely inside dome
   c. Back-box is 16 ga. aluminum; door and bezel are textured, white powder-coated steel; RoHS compliant
   d. Dome is 10” x 10” x 1 ½”; textured white ABS dome (-WA) is UL 94-5VA classified, and clear polycarbonate dome (-CP) is UL 94-5VB classified
   e. Size: Bezel is 15” x 15”, back-box is 12 ¾” x 12 ¾” x 3” deep
   f. Knockouts for AC receptacle, (2) keystone jacks, (2) ¾” trade conduit connector
   g. Maximum weight to be installed inside the unit is 25 lbs.
   h. De-rate upper operating temperature limit from +50°C to +40°C when AP in the enclosure

i. Enclosure must be supported by the tile bridges; when installed in the ceiling, enclosure must be supported by the building structure, independent of the suspended ceiling.

2.06 OUTDOOR ACCESS POINTS

A. AP-270 Series Specifications

1. AP-275 and IAP-275
   a. 2.4-GHz and 5-GHz radios, each with 3x3 MIMO and three integrated omni-directional antennas
2. AP-274 and IAP-274
   a. 2.4-GHz and 5-GHz radios, each with 3x3 MIMO and three combined, diplexed external antenna connectors

B. Wireless Radio Specifications

1. AP type: Outdoor, dual radio, 5-GHz 802.11ac and 2.4-GHz 802.11n
   a. In addition to 802.11n data rates, the 2.4-GHz radio supports 802.11ac 256-QAM modulation. This gives TurboQAMenabled clients a 33% boost to deliver up to 600 Mbps.
2. Supported frequency bands (country-specific restrictions apply):
   a. 2.4000 GHz to 2.4835 GHz
   b. 5.150 GHz to 5.250 GHz
   c. 5.250 GHz to 5.350 GHz
   d. 5.470 GHz to 5.725 GHz
   e. 5.725 GHz to 5.875 GHz
3. Available channels: Dependent upon configured regulatory domain
4. Dynamic frequency selection (DFS) optimizes the use of available RF spectrum
5. Supported radio technologies:
   a. 802.11b: Direct-sequence spread-spectrum (DSSS)
   b. 802.11a/g/n/ac: Orthogonal frequency-division multiplexing (OFDM)
   c. 802.11n/ac: 3x3 MIMO with up to three spatial streams
6. Supported modulation types:
   a. 802.11b: BPSK, QPSK, CCK
   b. 802.11a/g/n: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (with TurboQAM clients)
   c. 802.11ac: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM
7. Transmit power: Configurable in increments of 0.5 dBm
8. Maximum (aggregate, conducted total) transmit power (limited by local regulatory requirements):
   a. 2.4-GHz band: +28 dBm (23 dBm per chain)
   b. 5-GHz bands: +28 dBm (23 dBm per chain)
9. Advanced cellular coexistence (ACC) feature to minimize interference from cellular systems
10. Maximum ratio combining (MRC) for improved receiver performance
11. Cyclic delay diversity (CDD) for improved downlink RF performance
12. Short guard interval for 20-MHz, 40-MHz and 80-MHz channels
13. Space-time block coding (STBC) for increased range and improved reception
14. Low-density parity check (LDPC) for high-efficiency error correction and increased throughput

15. Explicit transmit beam-forming (TxBF) for increased reliability in signal delivery
16. Supported data rates (Mbps):
    a. 802.11b: 1, 2, 5.5, 11
    b. 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54
    c. 802.11n: 6.5 to 450 (MCS0 to MCS23, 1 to 3 spatial streams)
    d. 802.11ac: 6.5 to 1,300 (MCS0 to MCS9, 1 to 3 spatial streams
17. 802.11n high-throughput (HT) support: HT 20/40
18. 802.11ac very high throughput (VHT) support: VHT 20/40/80
19. 802.11n/ac packet aggregation: A-MPDU, A-MSDU Power
20. Maximum power consumption: 23 watts
21. Direct AC source: 100-240-Volt AC
22. Power over Ethernet (PoE): 48 Vdc (nominal) 802.3at-compliant source

C. Antennas

1. AP-274: Six N-type female connectors for external antennas
2. AP-275: Six integrated omni-directional antennas for 3x3 MIMO with maximum antenna gain of 5 dBi in 2.4 GHz and 5 dBi in 5 GHz. Built-in antennas are optimized for horizontal mounted orientation of AP-275.

D. Other Interfaces

1. One PoE+ PD port 10/100/1000BASE-T Ethernet network interface (RJ-45)
2. One port 10/100/1000BASE-T Ethernet network interface (RJ-45)
3. AC power interface, power cords sold separately
4. Serial console interface (micro USB)
5. Reset button
6. Visual indicator (LED):
    a. Power/system status; automatically disabled after initial operation period

E. Mounting

1. Must be ordered separately
2. Optional mounting kits:
    a. AP-270-MNT-V1: Aruba 270 series AP long mount kit for pole/wall mounting. Reduces impact of obstruction by pole or extends away from corner.
    b. AP-270-MNT-V2: Aruba 270 series AP short mount kit for pole/wall mounting

F. Mechanical AP-274

1. Dimensions/weight (excluding mount):
    a. 23 cm (W) x 24 cm (D) x 19 cm (H) with aesthetic cover
    b. 9.0” (W) x 9.4” (D) x 7.5” (H)
    c. 2.7 kg/6 lbs
    d. 23 cm (W) x 24 cm (D) x 14 cm (H) without aesthetic cover
    e. 9.0” (W) x 9.4” (D) x 5.5” (H)
    f. 2.4 kg/5.3 lbs

G. Mechanical AP-275

1. Dimensions/weight (excluding mount):

a. 23 cm (W) x 24 cm (D) x 27 cm (H)
b. 9.0” (W) x 9.4” (D) x 10.6” (H)
c. 2.4 kg/5.3 lbs

H. Environmental

1. Operating:
   a. Temperature: -40° C to +65° C (-40° F to +150° F)
   b. Humidity: 5% to 95% non-condensing
2. Storage and transportation:
   a. Temperature: -40° C to +70° C (-40° F to +158° F)
3. Operating Altitude: 3000m
4. Chassis Rating: IP66 and IP67
5. Wind Survivability: Up to 165 mph
6. Shock and Vibration: ETSI 300-19-2-4 spec T41.E 4M3

I. Regulatory

1. FCC/Industry of Canada
2. CE Marked
3. R&TTE Directive 1995/5/EC
4. Low Voltage Directive 72/23/EEC
5. EN 300 328
6. EN 301 489
7. EN 301 893
8. UL/IEC/EN 60950
9. EN 60601-1-1, EN60601-1-2

J. Regulatory Model Numbers

1. AP-274 and IAP-274: APEX0101
2. AP-275 and IAP-275: APEX0100

K. Certifications

1. CB Scheme Safety, cTUVus
2. UL2043 plenum rating
3. Wi-Fi Alliance certified 802.11a/b/g/n/ac

L. Warranty

1. Limited lifetime warranty

M. Minimum operating system software versions

1. ArubaOS 6.4
2. Aruba Instant 4.1 (planned availability mid 2014)

N. RF Performance Table

	Maximum transmit power (dBm) per transmit chain	Receiver sensitivity (dBm) per receive chain
802.11b 2.4 GHz		
1 Mbps	23.0	-92.0
2 Mbps	23.0	-92.0
5.5 Mbps	23.0	-90.0
11 Mbps	23.0	-88.0
802.11g 2.4 GHz and 802.11a 5 GHz		
6 Mbps	23.0	-88.0
54 Mbps	18.0	-75.0
802.11n HT20 2.4 GHz and 5 GHz		
MCS0/8	23.0	-88.0
MCS7/15	17.0	-71.0
802.11n HT40 2.4 GHz and 5 GHz		
MCS0/8	23.0	-85.0
MCS7/15	17.0	-68.0
802.11ac VHT20 5 GHz		
MCS0	23.0	-88.0
MCS9	16.0	-65.0
802.11ac VHT40 5 GHz		
MCS0	23.0	-85.0
MCS9	16.0	-62.0
802.11ac VHT80 5 GHz		
MCS0	23.0	-82.0
MCS9	16.0	-59.0

O. Enclosures

1. Wireless Access Points shall be installed in lockable, stainless steel Nema 4 Enclosure when mounted outdoors or in garage spaces.
2. Include back-plate, ground bus-bar, cable management, document holder, pole/wall mount adapters.
3. Provide 120VAC@15A quad receptacle with surge protection per drawings.
4. Enclosure shall be bonded to ground per NEC.
5. All conduit penetrations shall be made to prevent water ingress through the connections.
6. Enclosure size per drawings.

P. Lightning Arrestors

1. AP-LAR-1 N-type male to N-type female in-line lightning surge arrestor (2GHz-6GHz). (AP-274 ONLY).

Q. Installation Materials

1. AINS2KKIT-00 Optional Weather proofing materials: Suggested for antenna end connections only. (AP-274 ONLY).

R. RF cables for non-direct mount of antenna (optional) (AP-274 ONLY).

1. AP-CBL-1 For remoting omnis or antennas with pigtails
2. ANT-CBL-1 1m Flexible Cable
3. ANT-CBL-2 2m Flexible Cable
4. AFC7DL03-01 3m Low loss cable. AP-LAR-1 recommended
5. AFC7DL04-01 4m Low loss cable. AP-LAR-1 recommended

S. Antenna for Radio 0 (5 GHz) (AP-274 ONLY)

1. ANT-3x3-5005 MIMO, Omni, 5 dBi, 5 GHz, Direct mount to chassis or remoted with N male to N female cable (x3)
2. ANT-3x3-5010 MIMO, Omni, 10 dBi, 5 GHz, Direct mount to chassis or remoted with N male to N female cable (x3)
3. ANT-2x2-5314 MIMO, Sector 30° x 30°, 14 dBi, 5 GHz, Requires N male to N male cables (x2)
4. ANT-3x3-5712 MIMO, Sector 70° x 25°, 12 dBi, 5 GHz, Requires N male to N male cables (x3)
5. ANT-3x3-D608 MIMO, Sector 60°, 2.4/5 GHz, Requires N male to N male cables (x3)
6. ANT-3x3-D905 MIMO, Sector 90°, 2.4/5 GHz, Requires N male to N male cables (x3)

T. Antenna for Radio 1 (2.4 GHz) (AP-274 ONLY)

1. ANT-3x3-2005 MIMO, Omni, 5 dBi, 2.4 GHz, Direct mount to chassis or remoted with N male to N female cable (x3)
2. ANT-2x2-2314 MIMO, Sector 30° x 30°, 14 dBi, 2.4 GHz, Requires N male to N male cables (x2)
3. ANT-2x2-2714 MIMO, Sector 70°, 14 dBi, 2.4 GHz, Requires N male to N male cables (x2)
4. ANT-3x3-D608 MIMO, Sector 60°, 2.4/5 GHz. Requires N male to N male cables (x3)
5. ANT-3x3-D905 MIMO, Sector 90°, 2.4/5 GHz. Requires N male to N male cables (x3)

U. AP Mount Kit

1. AP-270-MNT-V1 Aruba 270 Series Access Point Long Mount Kit. Pole/Wall Mount for P-270 300 mm from vertical mounting asset.
2. AP-270-MNT-V2 Aruba 270 Series Access Point Short Mount Kit. Pole/Wall Mount for AP-270 75-mm from vertical mounting asset.

V. Ethernet Surge Protection Device (SPD)

1. Use in field for outdoor applications. Device shall be rated for outdoor use.
   a. Transtector 1101-1158(Gigabit PoE) No Exceptions.
   b. Transtector ALPU-L130(Gigabit PoE+) No exceptions.
   c. Transtector ALPU-F140(Gigabit PoE++) No exceptions.

2.07 ETHERNET AND POE+ EXTENSION UNIT

A. The Enable-IT™ 828 Gigabit Ethernet and PoE+ Extension Unit.

2.08 PoE + POWER INJECTOR

A. Enable-IT 360 60W- 56VDC IEEE 802.3AT Gigabit PoE + Injector.

2.09 MOBILITY CONTROLLER

A. Aruba Networks

1. Aruba Model 7200 Series Mobility Controllers. Refer to drawings for Qty.

Model Number Aruba 7200 Controller	Number of APs Supported
7240	2048

B. Front Panel

1. The front panel of the Aruba 7200 mobility controller contains the following components:
   a. Four 10GBase-X (SFP+) ports
   b. Two Dual-Media Ports
   c. LINK/ACT and Status LEDs
   d. Management/Status LED
   e. LCD Panel and Navigation Buttons
   f. Console Connections - RJ-45 and Mini-USB
   g. Expansion Slot (reserved for future use)

C. Physical

1. Device Dimensions (without mounting brackets) (HxWxD)
   a. All Models: 1.75” x 17.5” x 17.5”
   b. All Models: 4.4 cm x 44.5 cm x 44.5 cm
2. Device Weight (with one AC power supply installed)
   a. All Models: 16.43 lbs (7.45 kg)

D. Power Supply Specifications

1. 350W AC Power Supply
   a. AC Input Voltage: 100 VAC to 240 VAC
   b. AC Input Current: 5-2.5A
   c. AC Input Frequency: 50 - 60 Hz
   d. Weight: 2.8 lbs (1.3 kg)

E. Operating Specifications

1. Operating Temperature Range: 0°C to 40°C (32°F to 104°F)
2. Operating Humidity Range: 5% to 95% (RH), non-condensing

F. Package Checklist

1. Inform your supplier if there are any incorrect, missing, or damaged parts. If possible, retain the carton, including the original packing materials (see Table). Use these materials to repack and return the unit to the supplier if needed.

Item	Quantity
Aruba 7200 Series Controller	1
Power Supply Unit - Installed	1

Fan Tray - Installed	1
Expansion Slot Cover - Installed	1
Blank Panel over unpopulated PSU Intake - Installed	1
Rack Mounting Brackets	2
M6 x 15mm Rack Mounting Screws	4
M4 x 6mm Rack Mount Bracket Screws	8
USB Console Cable	1
Power Cable	1
Aruba 7200 Series Installation Guide (Printed)	1
End User License Agreement (Printed)	1
Aruba Document Pointer (Printed)	1

2.10 CLEARPASS POLICY MANAGER

A. ClearPass Policy Manager-5000. Refer to drawings for Qty.

1. Aruba ClearPass Policy Manager 5K hardware platform supporting a maximum of 5,000 authenticated devices.
2. Appliance Specifications:
   a. CPU - (1) Quad Core Xeon
   b. Memory - 8 GB
3. Hard drive storage:
   a. (2) 3.5” SATA (7.2K RPM) 500GB hard drives, RAID-1 controller
4. Appliance Scalability:
   a. Maximum devices - 5,000
5. Form Factor:
   a. Dimensions (W x H x D) - 17.53” x 1.7” x 16.8”
   b. Weight (max config) - 18 Lbs
6. Power:
   a. Power consumption (maximum) - 250 watts max
   b. Power supply - Single
   c. AC input voltage - 110/220 VAC auto-selecting
   d. AC input frequency - 50/60 Hz auto-selecting

2.11 LAN PERFORMANCE REQUIREMENTS

A. The wired system shall perform as designed providing a minimum of 10/100/1000 Mbps to each end user device and 1Gbps from edge switch to core switch on the backbone.

2.12 TELEPHONE SYSTEM HARDWARE REQUIREMENTS

A. Courtesy Telephones

1. Courtesy Telephone stations shall be class of service restricted to internal calls only, i.e. no local, collect, long distance toll (1+), toll free, (800, 888, 877, 866), operator assisted (0,0+), or directory assistance (411, 555-1212, etc.) calls shall be allowed.
2. Each Courtesy Telephone shall be capable of dialing 9+911 for an emergency and have the capacity to dial six-digit internal directory numbers (DN).
3. Each Courtesy Telephone shall transmit its DN to internal called parties.

4. Each Courtesy Telephone shall have a call party name display (CPND) associated with its DN.
5. Each Courtesy Telephone shall be manufactured by CEECO:
   a. Model SSW-321-F-ACHW-PBVC-C
   b. CALL RESTRICT Stainless steel wall telephone, chrome tone dial, MCRK-2 P.C. board, Lexan 32" armored cord, WHITE handset, pushbutton volume control and confidence. CAC 6.00 software.
   c. 301-037 Security tool – 5/32" #9020 BLUE. Required for installation.
   d. CEEC Contact – pmccreary@ceeco.net – 1-888-357-0798
6. Courtesy Phone Stainless Steel Backboards
   a. "COURTESY PHONE" Letters 1-1/4" Height Helvetica Medium engraved and painted black.
   b. Distributed by Volume Millwork Inc.
   c. Part#: 10-SPTELLETTE
   d. Description: Courtesy Tellette
   e. Contact: Edwin Chatoor– (713) 538-1451 - robin@vmillwork.com
   f. Must be lockable using key (contractor to request in writing from HAS Technology what key the lock shall be keyed to)

2.13 CAT 6 MEDIA EXTENDER

A. Manufactured by Veracity Global

1. Model – Outreach Max XT
   a. POE/POE+ compatible
   b. IP 66 rating
   c. Can be wall mounted but preferred method is inside of a NEMA enclosure
   d. RJ45 connectors

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install components in accordance with contract drawings, manufacturer's instructions and approved submittal data.

B. System installation and construction methods shall conform to the requirements of the Federal Communications Commission.

C. The Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.

D. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

E. The HAS IT Representative shall perform final configuration of the network equipment. This includes, but is not limited to: VLAN configuration, IP addressing schemas, final port assignments, and trunking/bonding configurations. Installation contractor shall ensure that the proper documentation is provided to assist in the final system configuration.

F. The Contractor shall coordinate with the cabling contractor with the installation if the iPatch/imVision crossconnect panel to create a true cross-connect per iPatch/imVision standards.

3.02 PRODUCT HANDLING

A. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the City for HAS, as applicable.

3.03 HARDWARE INSTALLATION

A. The Contractor shall obtain written permission from the City Engineer or Owner before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the City Engineer or Owner before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.

B. The Contractor shall take all steps necessary to ensure that all public areas remain clear or are properly marked during installation or maintenance.

C. The Contractor shall develop a detailed network map to be utilized as a road map during the implementation of the LAN. This map shall show all segments, all interconnects between segments and all active network devices. This network map shall not include the individual nodes interconnected to each concentrator, but will have the modules, interfaces, protocols, addresses and other identifying features for each concentrator and other active device.

D. The Contractor shall also develop a Cable Plant interconnectivity chart showing all fiber patch panels and individual identifiers for each fiber associated with the interconnectivity of each network device.

E. Prior to installing Wireless Access Points, conduct and document an RF site survey to determine the maximum operating range between an AP (fixed location) and mobile stations for a specified transmit power level. Survey shall also identify holes of coverage due to multi-path, interference sources, and interference from other wireless installations.

F. The contractor shall place materials only in those locations that have been previously approved. The City Engineer or Owner Rep shall approve any other locations, in writing.

G. For all concealed in ceiling, Wireless Access Points drops, the contractor shall provide a secondary device ID label located on the suspended ceiling grid structure.

3.04 SYSTEM STARTUP

A. The Contractor shall not apply power to the system until after:

1. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.
2. A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
3. System wiring has been tested and verified as correctly connected as indicated.

4. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
5. The City Engineer and the HAS IT Representative or the Engineer, as applicable, have approved the installation.

B. Satisfaction of the above requirements shall not relieve the contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of contractor's deficient work/defective equipment.

3.05 ACCEPTANCE TESTING

A. The contractor shall develop and execute an onsite acceptance-testing program.

B. The plan shall address all requirements identified in this specification and test all contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification described.

C. Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.

3.06 IDENTIFIERS, LABELS AND LABELING SYSTEM

A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. Any deviation from the specification must be approved by HAS IT prior to installation.

END OF SECTION 272100

APPENDIX A

LAN Equipment Schedule (EXAMPLE)

Item	Qty
COMM ROOM 11611	
WS-3750X-24P-S	3
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	6
COMM ROOM 11715	
WS-3750X-24P-S	1
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	2
COMM ROOM 11908	
WS-3750X-24P-S	2
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	4
COMM ROOM 12015	
WS-3750X-24P-S	1
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	2
COMM ROOM 11812	
WS-3750X-24P-S	2
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	4
COMM ROOM 12606	
WS-3750X-24P-S	3
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	6
MDF	
WS-X6848-SFP-2T (for 6509)	4
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	36
WS-X6824-SFP-2T (for 6509)	2

APPENDIX B

TECHNOLOGY IMPLEMENTATION SCHEDULE

	(from Designer)		(Contractor Submittal)				(Submittal Response)		
	Product Description	Spec. Ref.	Qty.	Procurement Lead Time	Start Date or Dependent	Installation Duration	Submittal Approved	Purch. Auth.	Remarks
1	WS-3750X-24P-S	2.04.D							
2	GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	2.04.D							
3	WS-X6824-SFP-2T (for 6509)	2.04.C							
4	General Workstation	2.04.G							
5	Network Printer	2.04.H							
6	Cisco Wireless Access Point	2.04.I							
7	Wireless Access Point Enclosure	2.04.J							
8	Cisco 16-port 10 Gigabit Ethernet Copper Module with DFC4 WS-X6816-10T-2T	2.04.E							
9	Cisco 48-port SFP fiber Gigabit Ethernet Module with DFC4 WS-X6848-SFP-2T	2.04.E							
10	Cisco Gigabit Ethernet Module WSX6848-GE-TX	2.04.E							
12	Cisco IOS® Software Release 15.05Y or higher	2.04.E							

THIS PAGE INTENTIONALLY LEFT BLANK